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Open Science

Open Science Philosophy

Open science encompasses unrestricted access to scientific research articles, access to data from public research, and collaborative research enabled by information and communication technology tools, models, and incentives. Broadening access to scientific research publications and data is at the heart of open science. The objective of open science is to make research outputs and its potential benefits available to the entire world and in the hands of as many as possible:

- Open science promotes a more accurate verification of scientific research results. Scientific inquiry and discovery can be sped up by combining the tools of science and information technologies. Open science will benefit society and researchers by providing faster, easier, and more efficient availability of research outputs.
- Open science reduces duplication in collecting, creating, transferring, and re-using scientific material.
- Open science increases productivity in an era of tight budgets.
- Open science results in great innovation potential and increased consumer choice from public research.
- Open science promotes public trust in science. Greater citizen engagement leads to active participation in scientific experiments and data collection.

Open Science Index

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Open Science

Open Society

An open society allows individuals to change their roles and to benefit from corresponding changes in status. Open science depends to a greater or lesser extent on digital technologies and innovations in structural processes by an open society. When realized, open science research and innovation can create investment opportunities for new and better products and services and therefore increase competitiveness and employment. Open science research and innovation is a key component of thematic open science priorities. Central to the open science digital infrastructure is enabling industry to benefit from digital technology and to underpin scientific advances through the development of an open society. Open science research and innovation can also contribute to society as a global actor because scientific relations can flourish even where global relations are strained. Open science has a critical role across many areas of decision making in providing evidence that helps understand the risks and benefits of different open science choices. Digital technology is making the conduct of open science and innovation more collaborative, more global, and more open to global citizens. Open society must embrace these changes and reinforce its position as the leading power for science, for new ideas, and for investing sustainably in the future.

It is apparent in open society that the way science works is fundamentally changing, and an equally significant transformation is taking place in how organizations and societies innovate. The advent of digital technology is making research and innovation more open, collaborative, and global. These exchanges are leading open society to develop open science and to set goals for research and innovation priority. Open science goals are materializing in the development of scientific research and innovation platforms and greater acceptance of scientific data generated by open science research. Open science research and innovation do not need help from open society to come up with great ideas, but the level of success ideas ultimately reach is undoubtedly influenced by regulation, financing, public support, and market access. Open society is playing a crucial role in improving all these success factors.

Open Science

Open science represents a new approach to the scientific process based on cooperative work and new ways of diffusing knowledge by using digital technologies and collaborative tools. These innovations capture a systemic change to the way science and research have been carried out for the last fifty years. Science is shifting from the standard practice of publishing research results in scientific publications after the research and reviews are completed. The shift is towards sharing and using all available knowledge at an earlier stage in the research process. Open science is to science what digital technology is to social and economic transactions: allowing end users to be producers of ideas, relations, and services and in doing so, enabling new working models, new social relationships and leading to a new modus operandi for science. Open science is as important and disruptive as e-commerce has been for the retail industry. Just like e-commerce, the open science research paradigm shift affects the whole business cycle of doing science and research. From the selection of research subjects to the carrying out of research, to its use and re-use, to the role of universities, and that of publishers are all dramatically changed. Just as the internet and globalization have profoundly changed the way we do business, interact socially, consume culture, and buy goods, these changes are now profoundly impacting how one does research and science.

The discussion on broadening the footprint of science and on novel ways to produce and spread knowledge gradually evolved from two global trends: Open Access and Open Source. The former refers to online, peer-reviewed scholarly outputs, which are free to read, with limited or no copyright and licensing restrictions, while open source refers to software created without any proprietary restriction and which can be accessed and freely used. Although open access became primarily associated with a particular publishing

or scientific dissemination practice, open access already sought to induce a broader practice that includes the general re-use of all kinds of research products, not just publications or data. It is only more recently that open science has coalesced into the concept of a transformed scientific practice, shifting the focus of researchers' activity from publishing as fast as possible to sharing knowledge as early as possible. Open science is defined as the idea that scientific knowledge of all kinds should be openly shared as early as is practical in the discovery process. As a result, the way science is done in the future will look significantly different from the way it is done now. Open science is the ongoing evolution in the modus operandi of doing research and organizing science. This evolution is enabled by digital technology and is driven by both the globalization of the scientific community and increasing public demand to address the societal challenges of our times. Open science entails the ongoing transitions in the way research is performed, researchers collaborate, knowledge is shared, and science is organized.

Open science impacts the entire research cycle, from the inception of research to its publication, and on how this cycle is organized. The outer circle reflects the new interconnected nature of open science, while the inner circle shows the entire scientific process, from the conceptualization of research ideas to publishing. Each step in the scientific process is linked to ongoing changes brought about by open science, including the emergence of alternative systems to establish a scientific reputation; changes in the way quality and impact of research are evaluated; the growing use of scientific blogs; open annotation; and open access to data and publications. All institutions involved in science are affected, including research organizations, research councils, and funding bodies. The trends are irreversible, and they have already grown well beyond individual projects. Theses changes predominantly result from a bottom-up process driven by a growing number of researchers who increasingly employ social media in their research and initiate globally coordinated research projects while sharing results at an early stage in the research process.

Open science is encompassed in five schools of thought:

- the infrastructure school, concerned with technological architecture
- the public school, concerned with the accessibility of knowledge creation
- the measurement school, concerned with alternative impact assessment
- the democratic school, concerned with access to knowledge
- the pragmatic school, concerned with collaborative research

According to the measurement school, the reputation and evaluation of individual researchers are still mainly based on citation-based metrics. The h-index is an author-level metric that attempts to measure both the productivity and citation impact of the publications of a scientist or scholar. The impact factor is a measure reflecting the average number of citations to articles published in an academic journal and is used as a proxy for the relative importance of a journal.

Numerous criticisms have been made of citation-based metrics, primarily when used, and often misused, to assess the performance of individual researchers. These metrics:

- are often not applicable at the individual level
- do not take into account the broader social and economic function of scientific research
- are not adapted to the increased scale of research
- cannot recognize new types of work that researchers are performing

Web-based metrics for measuring research output, popularized as altmetrics, have recently received much attention: some measure the impact at the article level, others make it possible to assess the many outcomes of research in addition to the number of scientific articles and references. The current reputation and evaluation system has to adapt to the new dynamics of open science and acknowledge and incentivize

engagement in open science. Researchers engaging in open science have growing expectations that their work, including intermediate products such as research data, will be better rewarded or taken into account in their career development. Vice-versa, the use, and reuse of open data will require appropriate codes of conduct requiring, for example, the proper acknowledgment of the original creator of the data.

These ongoing changes are progressively transforming scientific practices with innovative tools to facilitate communication, collaboration, and data analysis. Researchers that increasingly work together to create knowledge can employ online tools and create a shared space where creative conversation and collaboration can occur. As a result, the problem-solving process can be faster, and the range of problems that can be solved can be expanded. The ecosystem underpinning open science is evolving very rapidly. Social network platforms for researchers already attract millions of users and are being used to begin and validate more research projects.

Furthermore, the trends towards open access are redefining the framework conditions for science and thus have an impact on how open innovation is produced by encouraging a more dynamic circulation of knowledge. It can enable more science-based startups to emerge thanks to the exploitation of openly accessible research results. Open science, however, does not mean free science. It is essential to ensure that intellectual property is protected before making knowledge publicly available in order to subsequently attract investments that can help translate research results into innovation. If this is taken into account, fuller and broader access to scientific publications and research data can help to accelerate innovation. Investments that boost research and innovation in open science would benefit society with fewer barriers to knowledge transfer, open access to scientific research, and greater mobility of researchers. In this context, open access can help overcome the barriers that innovative organizations face in accessing the results of research funded by the public.

Open innovation

An open society is the largest producer of knowledge, but the phenomenon of open science is changing every aspect of the scientific method by becoming more open, inclusive, and interdisciplinary. Ensuring open society is at the forefront of open science means promoting open access to scientific data and publications alongside the highest standards of research integrity. There are few forces in this globe as engaging and unifying as science. The universal language of science maintains open channels of communication globally. Open society can maximize its gains through maintaining its presence at the highest level of scientific endeavor, and by promoting a competitive edge in the knowledge society of the information age. The ideas and initiatives described in this publication can stimulate anyone interested in open science research and innovation. It is designed to encourage debate and lead to new ideas on what and open society should do, should not do, or do differently.

An open society can lead to a research powerhouse; however, open society rarely succeeds in turning research into innovation and in getting research results to the global market. Open society must improve at making the most of its innovation talent, and that is where open innovation comes into play. The basic premise of open innovation is to open up the innovation process to all active players so that knowledge can circulate more freely and be transformed into products and services that create new markets while fostering a stronger culture of entrepreneurship. Open innovation is defined as the use of purposive inflows and outflows of knowledge to accelerate internal innovation. This original notion of open innovation was primarily based on transferring knowledge, expertise, and even resources from one company or research institution to another. This notion assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they seek to improve their performance. The concept of open innovation is continually evolving and is moving from linear, bilateral transactions and collaborations

towards dynamic, networked, multi-collaborative innovation ecosystems. This means that a specific innovation can no longer be seen as the result of predefined and isolated innovation activities but rather as the outcome of a complex co-creation process involving knowledge flows across the entire economic and social environment. This co-creation takes place in different parts of the innovation ecosystem and requires knowledge exchange and absorptive capacities from all the actors involved, whether businesses, academia, financial institutions, public authorities, or citizens.

Open innovation is a broad term, which encompasses several different nuances and approaches. Two main elements underpin the most recent conceptions of open innovation: the users are in the spotlight and invention becomes an innovation only if users become a part of the value creation process. Notions such as user innovation emphasize the role of citizens and users in the innovation processes as distributed' sources of knowledge. This kind of public engagement is one of the aims of open science research and innovation. The term 'open' in these contexts has also been used as a synonym for 'user-centric'; creating a well-functioning ecosystem that allows co-creation and becomes essential for open innovation. In this ecosystem, relevant stakeholders are collaborating along and across industry and sector-specific value chains to co-create solutions for socio-economic and business challenges. One important element to keep in mind when discussing open innovation is that it cannot be defined in absolutely precise terms. It may be better to think of it as a point on a continuum where there is a range of context-dependent innovation activities at different stages, from research to development through to commercialization, and where some activities are more open than others. Open innovation is gaining momentum thanks to new large-scale trends such as digitalization and the mass participation and collaboration in innovation that it enables. The speed and scale of digitalization are accelerating and transforming the way one designs, develops, and manufactures products, the way one delivers services, and the products and services themselves. It is enabling innovative processes and new ways of doing business, introducing new cross-sector value chains and infrastructures.

Open society must ensure that it capitalizes on the benefits that these developments promise for citizens in terms of tackling societal challenges and boosting business and industry. Drawing on these trends, and with the aim of helping build an open innovation ecosystem in open society, the open society's concept of open innovation is characterized by:

- combining the power of ideas and knowledge from different actors to co-create new products and find solutions to societal needs
- creating shared economic and social value, including a citizen and user-centric approach
- capitalizing on the implications of trends such as digitalization, mass participation, and collaboration

In order to encourage the transition from linear knowledge transfer towards more dynamic knowledge circulation, experts agree that it is essential to create and support an open innovation ecosystem that facilitates the translation of knowledge into socio-economic value. In addition to the formal supply-side elements such as research skills, excellent science, funding and intellectual property management, there is also a need to concentrate on the demand side aspects of knowledge circulation, making sure that scientific work corresponds to the needs of the users and that knowledge is findable, accessible, interpretable and reusable. Open access to research results aims to make science more reliable, efficient, and responsive and is the springboard for increased innovation opportunities, e.g. by enabling more science-based startups to emerge. Prioritizing open science does not, however, automatically ensure that research results and scientific knowledge are commercialized or transformed into socio-economic value. In order for this to happen, open innovation must help to connect and exploit the results of open science and facilitate the faster translation of discoveries into societal use and economic value.

Open Science

Collaborations with global partners represent important sources of knowledge circulation. The globalization of research and innovation is not a new phenomenon, but it has intensified in the last decade, particularly in terms of collaborative research, international technology production, and worldwide mobility of researchers and innovative entrepreneurs. Global collaboration plays a significant role both in improving the competitiveness of open innovation ecosystems and in fostering new knowledge production worldwide. It ensures access to a broader set of competencies, resources, and skills wherever they are located, and it yields positive impacts in terms of scientific quality and research results. Collaboration enables global standard-setting, allows global challenges to be tackled more effectively, and facilitates participation in global value chains and new and emerging markets.

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Open Science

Scholarly Research Review

The scholarly research review is a multidimensional evaluation procedure in which standard peer review models can be adapted in line with the ethos of scientific research, including accessible identities between reviewer and author, publishing review reports and enabling greater participation in the peer review process. Scholarly research review methods are employed to maintain standards of quality, improve performance, provide credibility, and determine suitability for publication. *Responsible Peer Review Procedure:* Responsible peer review ensures that scholarly research meets accepted disciplinary standards and ensures the dissemination of only relevant findings, free from bias, unwarranted claims, and unacceptable interpretations. Principles of responsible peer review:

• Honesty in all aspects of research
• Accountability in the conduct of research
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• Good stewardship of research on behalf of others

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All submitted manuscripts are subject to the scholarly research review process, in which there are three stages of evaluation for consideration: pre-review manuscripts, chair-review presentation, and final-review manuscripts. All submitted full text papers, that may still be withstand the editorial review process, are presented in the conference proceedings. Manuscripts are tracked and all actions are logged by internal and external reviewers according to publication policy. External reviewers' editorial analysis consists of the evaluation reports of the conference session chairs and participants in addition to online internal and external reviewers' reports. Based on completion of the scholarly research review process, those manuscripts meeting the publication standards are published 10 days after the event date.

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Simulations of NACA 65-415 and NACA 64-206 Airfoils using Computational Fluid Dynamics

David Nagy
Faculty of Arts and Sciences, University of Toronto, Canada

***Abstract*—This paper exemplifies the influence of the purpose of an aircraft on the aerodynamic properties of its airfoil. In particular, the research takes into consideration two types of aircraft, namely cargo aircraft and military high-speed aircraft and compares their airfoil characteristics using their NACA airfoils as well as computational fluid dynamics. The results show that airfoils of aircraft designed for cargo have a heavier focus on maintaining a large lift force whereas speed-oriented airplanes focus on minimizing the drag force.**

Keywords— computational fluid dynamics, aerodynamic simulation, airfoil, aircraft, NACA 65-415, NACA 64-206, lift to drag ratio

I. Introduction

Aerodynamics details the behavior and interaction of gases with an object moving through them. One of the many applications of aerodynamics is in developing and testing aircraft models to deduce their efficiency and viability in the aircraft industry. As aerodynamics must consider many variables that affect the airflow around objects, it is virtually impossible to design the perfect form for an aircraft to ensure maximum efficiency for any possible purpose aircraft are used for.

The main variables to categorize airplanes are by their purpose and by their mass. The three main categories of aircraft are commercial airplanes, private jets, and propeller planes. These three categories can be further subdivided depending on the maximum speed of the aircraft and its size. For example, the commercial plane category can include large cargo jets manufactured to be able to hold lots of cargo, as well as light passenger jets which are small airplanes designed to hold a few tens of passengers.

Airplane manufacturers must keep in mind the purpose of the aircraft when designing a new aircraft. The category of an aircraft plays a huge role in how it is designed and what features are included in the design, which is why there are so many different wing shapes used in the aircraft industry. Some of which are rectangular, tapered, elliptical, and trapezoidal wing shapes.

The airfoil is one of the main elements to take into consideration when designing an aircraft and will be the focus of this paper. An airfoil is the two-dimensional shape of a wing if looked at horizontally. It is designed specifically to a certain category of aircraft to provide efficient and effective flight according to the purpose of the aircraft. Airfoils differ vastly among different types of aircraft because they are tailored to be most efficient at different speeds, altitudes, and conditions. The main characteristic used to differentiate airfoils is its symmetry. Airfoils have many elements used to define them including the chord line, the camber line, and the angle of attack (see Figure 1). The chord line is a straight line starting from the leading edge (front of the airfoil) and ending on the trailing edge (back of the airfoil). The camber line also starts on the leading edge and ends on the trailing edge but is drawn in such a way that at any point on the camber line the distance from that point to the lower and upper surface of the airfoil are equal. This means that the chord line coincides with the camber line in symmetrical airfoils, but the camber line has a curved shape in asymmetrical airfoils [7]. The angle of attack refers to the angle between the direction of the wind and that of the chord line. Note that the angle of attack of an airfoil does not affect the actual shape of an airfoil but only affects its orientation, therefore it is rarely used when defining airfoils.

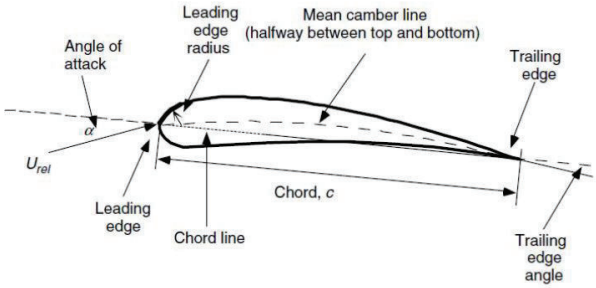


Figure 1: Terminology of Airfoil Elements [7]

Using the chord line, camber line, and the thickness of the airfoil we can accurately define the shape of an airfoil.

Big airline companies generally use their own customized airfoils developed using complex algorithms and testing, but there are still many aircraft that use NACA airfoils such as the Pilatus PC-12 introduced in 1994 and still in use today, which uses a NACA 0313 airfoil at its tip [8]. Additionally aircraft manufacturers often begin designing the airfoil using the NACA system and later add customized elements to tailor to the purpose of the aircraft. Although there are more accurate and intricate methods of describing airfoils in use, for the context of this paper the NACA Nomenclature will be used due to its simplicity and wide range of use over the years.

The rest of the paper is organized as follows: section II defines the hypothesis on aircraft design and describes the setting of the experiments, section III tests the airfoil design of NACA 6-series, section IV presents the use of computational fluid dynamics to test airfoil design and section V concludes the paper.

II. Hypothesis and Aircraft types

A. Aircraft Types

The category of the aircraft and its purpose heavily affects the way it is designed particularly the airfoil it has. In order to analyze this phenomenon, the study focuses on two main purposes of flight: first, aircraft that sustain large amounts of loads and second, smaller aircraft built with the purpose of speed. Then the the airfoils for each category will be compared.

B. Hypothesis

The hypothesis to be tested is that aircraft with the purpose of very high speeds have airfoils that are optimized with a streamlined shape that causes very little air resistance. Less focus will be on providing a strong lift force, and more focus on ensuring the least amount of air resistance which will mean the airfoil will have a very flat surface. By contrast, heavy cargo planes and passenger jets will have much more focus on generating a sufficient lift force which will result in much larger airfoils with more thickness and a longer camber line.

This hypothesis has been tested both experimentally, using an aerodynamic simulator, as well as theoretically by the use of the NACA numbers of the airfoil of each aircraft in order to determine the lift coefficient. The simulations provide the lift and drag coefficients for the airfoils which allow the comparison of the the lift to drag ratio of each airfoil with the other, to determine if aircraft built to carry larger loads do have a greater lift coefficient than smaller aircraft geared more towards speed.

For this study takes into consideration two aircraft for analysis. They are chosen to have NACA 6-series airfoils, and they had to each match the categories of passenger or cargo aircraft and light aircraft built for high speed. The first one is the Airspeed AS.57 Ambassador, a British piston-engined airliner. This aircraft represents the category of aircraft built to sustain heavy loads as it was built to seat a total of 47 passengers. It was produced between the years 1947 and 1953. The airfoil data for this aircraft is retrieved from [4]. The airfoil of the wing root of the Airspeed Ambassador is NACA 65-416, while the airfoil of the wing tip is 65-414. To simplify the study and have one airfoil for each aircraft, the average of the two airfoils will be taken, meaning that the airfoil of approximately the middle of the airplane wing will be considered. This means that for the purpose of this study we will assume that the airfoil of the Airspeed Ambassador is NACA 65-415.

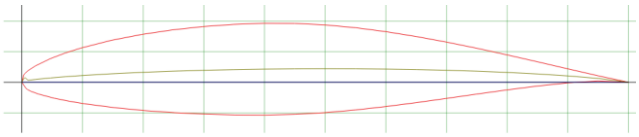


Figure 2: Airfoil of Airspeed AS.57 Ambassador, NACA 65-415 [2]

The second aircraft is the General Dynamics F-16 Fighting Falcon, a single engine supersonic fighter aircraft for the United States Air Force. This fighter aircraft represents the category of airplanes built mainly for high speeds. Although it is a supersonic aircraft, and at such speeds the calculation of lift and drag can be nearly impossible, the airfoil can still be analyzed at subsonic speeds and should still produce reliable results. It was produced from 1973 to the present. The airfoil data was retrieved from a study done on the numerical analysis of military airfoils [1]. The airfoil for this aircraft is NACA 64-206.

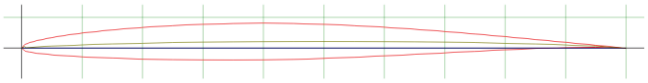


Figure 3: Airfoil of General Dynamics F-16 Fighting Falcon, NACA 64-206 [2]

These aircraft were chosen with many restrictions in mind, one of which being that they had to have NACA 6-series airfoils. This specific restriction greatly reduced the scope of aircraft that could be chosen, as many modern aircraft no longer use NACA airfoils at all, and of which those that do, they often use the NACA airfoil as a baseline design and add to it based on their own tests and purposes. In light of this, the options for choosing an aircraft were quite restricted as not only did the aircraft have to have a NACA airfoil, but it had to specifically be a NACA 6-series airfoil so that the lift coefficient could be deduced and compared between the models. This resulted in the aircraft chosen being slightly older and may be slightly outdated, but the aerodynamic principles should be the same even for older models of airplanes.

III. Testing Airfoil Designs on NACA 6-series

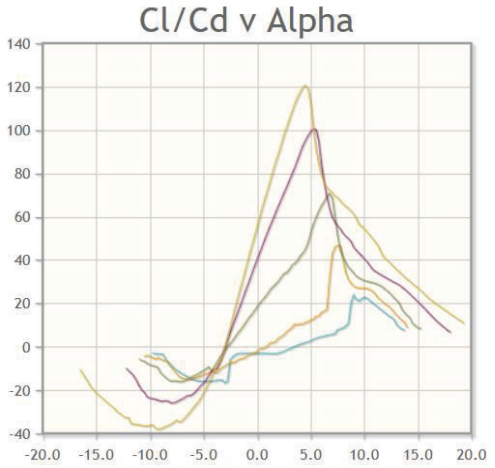
For the first part of this investigation, we will use the NACA nomenclature to determine the theoretical lift coefficient of the airfoils, similar to the method used in [3]. The two airfoils that will be tested are both defined with the NACA 6 series. The NACA 6-series is defined using a group of 2 digits and a group of 3 digits separated by a hyphen (ex: NACA 65-416). The first digit indicates the series. The second digit indicates the minimum pressure area distance based on the tenths of a chord. Occasionally a subscript is added to the second digit which indicates the range of the theoretical lift coefficient. The digit after the hyphen represents the design lift coefficient in tenths. The last two digits represent the percentage of the maximum thickness based on the chord length.

By deducing the theoretical lift coefficient from the digit after the hyphen and comparing this lift coefficient for each of the airfoils we can predict which airfoil has a greater focus on maintaining a higher lift force. Note that the design lift coefficient approximates a range of values that the lift coefficient can take. However, the values can still provide a good mode of comparison between airfoils. The airfoil of the Airspeed AS.57 Ambassador is NACA 65-415, therefore we can deduce that the design lift coefficient is 0.4. As for the General Dynamics F-16 Fighting Falcon, the airfoil is NACA 64-206, from which we can deduce a design lift coefficient of 0.2. From these observations we can conclude that the Airspeed Ambassador puts a greater focus on maintaining a strong lift force than the Fighting Falcon. This conclusion is logical given the fact that the Airspeed Ambassador is a passenger airline built to be able to hold almost 50 passengers on board, while the Fighting Falcon is a military aircraft, meaning it does not need to hold such great loads, and instead must focus its design on speed. In this case, the airfoils accurately reflect the purpose of the two aircraft.

Given the fact that this method of comparison is inaccurate and does not consider the drag coefficient of the airfoils at all, it is important to compare the relationship of the lift and drag coefficients between the two airfoils in order to reach a more

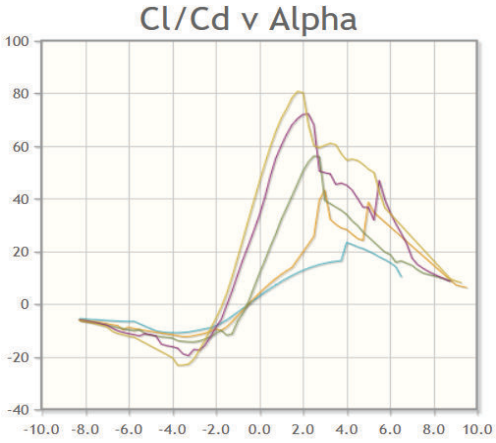
accurate and supported conclusion. The following graphs were retrieved from an online database containing information on various NACA airfoils [2]. The database can provide graphs based on a range of two variables: the Reynolds number and the Ncrit value. The Reynolds number is a measure of the degree of laminar or turbulent flow. The higher the Reynolds number the closer it is to having a more chaotic (turbulent flow) as opposed to a more regular(laminar) flow. The graphs show a range of 5 Reynolds numbers from 50,000 all the way up to 1,000,000. The Ncrit value represents the turbulence and roughness of the airfoil. For both airfoils this is set at a value of 9 which models an average wind tunnel [2]. The graphs are a comparison of the lift to drag ratio as the Angle of Attack (Alpha) changes, with the angle of attack as the x-axis, the drag to lift coefficient as the y-axis, and the colors of the lines representing the Reynolds number.

The lift and drag coefficients of the two aircraft are now directly compared on one graph for the highest Reynolds number in the range (1,000,000), as we assume that the aircraft will be travelling at relatively high speeds, which will cause more turbulent flow to be produced.



Plot	Airfoil	Reynolds #	Ncrit	Max Cl/Cd	Description
	naca652415-il	50,000	9	23.9 at α=9°	Mach=0 Ncrit=9
	naca652415-il	100,000	9	46.7 at α=7.75°	Mach=0 Ncrit=9
	naca652415-il	200,000	9	70.8 at α=6.75°	Mach=0 Ncrit=9
	naca652415-il	500,000	9	100.4 at α=5.25°	Mach=0 Ncrit=9
	naca652415-il	1,000,000	9	120.6 at α=4.5°	Mach=0 Ncrit=9

Figure 4: Lift/Drag Coefficient Graph for NACA 65-415(Airspeed Ambassador) [2]



Plot	Airfoil	Reynolds #	Ncrit	Max Cl/Cd	Description
	naca64206-il	50,000	9	23.4 at α=4°	Mach=0 Ncrit=9
	naca64206-il	100,000	9	43.2 at α=3°	Mach=0 Ncrit=9
	naca64206-il	200,000	9	56.2 at α=2.5°	Mach=0 Ncrit=9
	naca64206-il	500,000	9	72.2 at α=2.25°	Mach=0 Ncrit=9
	naca64206-il	1,000,000	9	80.8 at α=1.75°	Mach=0 Ncrit=9

Figure 5: Lift/Drag Coefficient Graph for NACA 64-206(Fighting Falcon) [2]

As shown in the graph, the NACA 65-415 airfoil associated with the Airspeed Ambassador aircraft, sustains a higher lift to drag coefficient ratio than the NACA 64-206 associated with the Fighting Falcon aircraft, for all positive angles of attack. Additionally, the optimal angle of attack for the Airspeed Ambassador airfoil, which can be observed at the peak of the graph when the ratio between the lift and drag coefficient is highest, is approximately 40 units greater than that of the Fighting Falcon, showing a significant distinction between the two aircraft. The Airspeed Ambassador airfoil is shown to prioritize increasing its lift coefficient over reducing its drag coefficient due to its purpose of carrying large loads, while the Fighting Falcon is shown to prioritize reducing its drag coefficient over increasing its lift coefficient due to the importance of speed in military aircraft. This supports my hypothesis that aircraft aimed at carrying larger loads have an airfoil designed to create a large lift force to be able to sustain all the added weight, while aircraft aimed at achieving high speed have an airfoil designed to minimize the drag force, pulling the aircraft back, thereby allowing higher speeds.

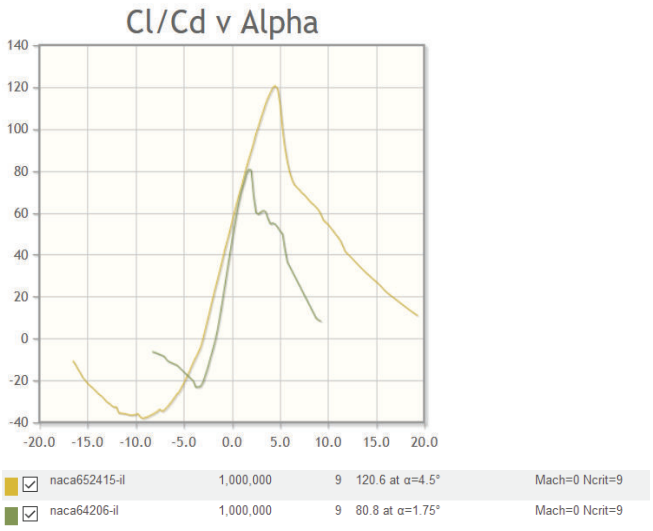


Figure 6: Lift/Drag Coefficient Graph for NACA 65-415(Airspeed Ambassador) and NACA 64-206(Fighting Falcon) [2]

IV. Using Computational Fluid Dynamics To Test Airfoil Designs

Aircraft manufacturers use Computational Fluid Dynamics to test the efficiency of airfoil designs before building the airfoil. Computational Fluid Dynamics or CFD, uses numerical calculations to solve conservation equations for fluid dynamics. This process is fast and cost effective, as the aircraft manufacturers can test a large pool of airfoils and narrow down viable options before building them and testing them in a real wind tunnel. In this way, the invention of CFD has revolutionized the aerodynamic field and has allowed for a more effective testing phase.

The CFD Workflow follows a definite process beginning with the model of the airfoil and ending with the visualization of a smooth distribution of values. The simulation must start with a watertight CAD model of the airfoil being simulated. Next a virtual domain is created around the CAD model to simulate the wind tunnel. Afterwards, the mesh is generated around the model and more specifically on the surface of the airfoil. The mesh is a vital step in the CFD process as it defines how accurate the results of the simulation will be. When creating the mesh, the domain is split into small cells for which the aerodynamic values will be calculated. These cells get progressively smaller the closer it gets to the surface of the airfoil to increase the accuracy in the more vital areas. Once the mesh is generated around the model, the simulator calculates motion governing equations, more specifically the Navier-Stokes equation, for each cell in the domain, based on the center of the cell. The Navier-Stokes equation is a complex partial differential equation used to describe the movement of incompressible fluids. This results in a set of data of physical values based on the center of each cell in the mesh. This set leads to a smooth distribution of values around the model which can be visualized in different ways and can be used to calculate average aerodynamic values such as Lift and Drag force.

There are many parameters that must be taken into consideration when creating an aerodynamic simulation, which is why the field of CFD is so widely studied. One of the main decisions to make when creating a simulation is whether to run a three-dimensional simulation or a two dimensional one. Two dimensional simulations greatly reduce computational cost, however three-dimensional simulations are often needed to accurately acquire quantitative data on the aerodynamics of the model. Considering this, two dimensional simulations are mostly used for qualitative data [5].

Due to computing constraints the data displayed in this paper was collected using two dimensional simulations. While trying to create three dimensional simulations, many issues arose regarding the reliability of the results and the computing time required to perform the simulations. Given this, a switch to a simpler format of simulations was needed, however the results obtained from these simulations should prove useful in the scope of this paper. Initially, the SimScale software was used, which is a computational fluid dynamics online platform capable of simulating three dimensional models, however, to support this change to two dimensional simulations it was required to switch to a desktop program called Star CCM+.

Aerodynamic simulations depend on many parameters, most notable of which are the velocity of the aircraft, the angle of attack, and the type of air flow (turbulent or laminar). The velocity on which the simulations were run had to be a relatively low number so that the calculation of the motion governing equations was as straightforward as possible. The type of airflow used in the simulations was turbulent flow to be able to represent the chaotic patterns arising from the motion of the air around the airfoil, rather than using laminar flow which models a more predictable flow of air in parallel layers. Lastly the angle of attack was the independent variable as simulations were run for angles ranging from zero degrees up to twenty degrees in 5-degree intervals. While the maximum angle of attack for most passenger airplanes ranges from 10 to 15 degrees, these values are well within tolerances [6] and higher angles of attack can still provide valuable information about the airfoil's aerodynamic behavior at these angles. Through this a conclusion can be drawn with the additional element of how the angle of attack changes the lift to drag ratio of the airfoils.

Simulation Parameters:
Material: gas
Flow: coupled flow (vs segregated flow)
Equation of state: constant density (incompressible flow)
Viscous regime: turbulent
Reynolds averaged turbulence: Spalart-Allmaras turbulence
Velocity: 17 m/s

Table 1: Lift and Drag Forces Simulation Results

	Airspeed AS.57 Ambassador NACA 65-415		General Dynamics F-16 Fighting Falcon NACA 64-206	
AoA (degrees)	Lift (N)	Drag (N)	Lift (N)	Drag (N)
0	0.038203	0.00777158	0.0259639	0.00528376
5	0.13545	0.0105854	0.135175	0.00834235
10	0.209298	0.0182598	NA	NA
15	NA	NA	0.203803	0.0578702
20	0.211344	0.0819217	0.231006	0.088457

In the table above, the lift and drag forces calculated in the simulations are displayed for each angle between 0 and 20 degrees and both airfoils. The NACA 65-415 airfoil simulation at 15 degrees and the NACA 64-206 airfoil simulation at 10 degrees do not contain values because the simulator did not produce stable values for the lift and drag forces in a reasonable amount of time. Given this, the results cannot be compared for the 10 degrees simulation and 15 degrees simulation.

To reach a conclusion based on these results, the lift and drag forces for each airfoil must be compared. Therefore, we must compute the lift to drag ratio for each angle of attack and then compare these ratios between the two airfoils. The proportion between these two ratios were also calculated for each angle to assist in determining how this relationship changes with the angle of attack. Thus, the table below was created.

Table 2: Lift to Drag Ratios for NACA 65-415 and NACA 64-206 at velocity of 17 m/s

Angle of Attack (degrees)	Lift to Drag Ratio		Proportion of Lift to Drag Ratio of NACA 65-415 to NACA 64-306
	Airspeed AS.57 Ambassador NACA 65-415	General Dynamics F-16 Fighting Falcon NACA 64-206	
0	4.915731421	4.913906006	1.000371479
5	12.79592646	16.20346785	0.7897029561
20	2.579829276	2.611506156	0.9878702641

The quantitative results of the simulations are quite intriguing. For the angle of attack of zero degrees the results seem to support the hypothesis that a passenger aircraft would have a greater focus on lift rather than drag when compared to a military aircraft. The lift to drag ratio of the NACA 65-415 airfoil belonging to the Airspeed Ambassador passenger aircraft has a larger lift to drag ratio compared to the NACA 64-206 airfoil belonging to the Fighting Falcon military aircraft as can be seen by the value of the proportion greater than one. In the five- and twenty-degree simulations however, the airfoil belonging to the military aircraft seems to have the larger lift to drag ratio as seen by the value of the proportion less than one.

A possible explanation for this discrepancy is that the aircraft spend most of their flight time at an angle of attack of approximately zero degrees which is why the lift and drag forces on the airfoil of the aircraft must be optimized for that angle. This theory would validate the fact that airfoils belonging to aircraft with the purpose of carrying heavy loads are optimized to have a higher lift to drag ratio than airfoils belonging to aircraft aimed at achieving high speeds.

As can be seen in the figures below for angle of attack equal to zero, the NACA 65-415 airfoil belonging to the passenger aircraft seems to have a slightly greener color gradient below, indicating a higher pressure below the airfoil, producing more lift, while the color gradient for the NACA 64-206, is bluer below the airfoil indicating a lower pressure underneath the wing.

Figure 7: Pressure Graph for NACA 65-415 at AoA 0

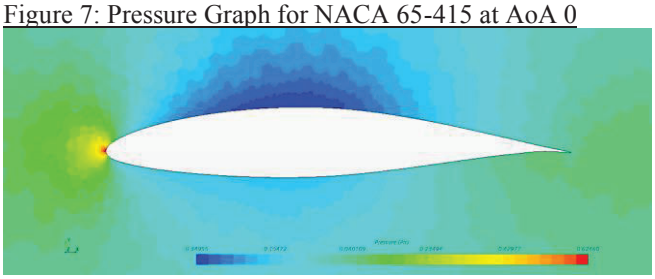
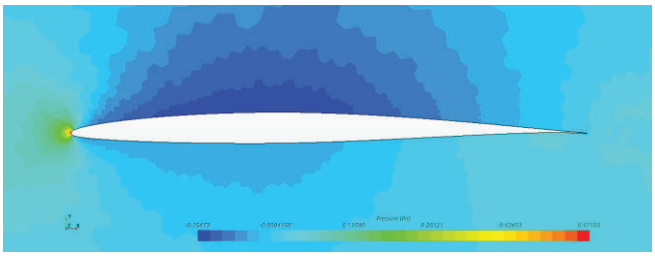


Figure 8: Pressure Graph for NACA 64-206 at AoA 0



V. Conclusion

Aircraft vary vastly in complexity, design, shape, and materials based on their purpose and the boundaries in which they are built. In this way the process that aircraft manufacturers have in designing new aircraft is a complex one involving algorithms, testing, and experimenting. When designing airfoils, the purpose of the aircraft plays a vital role in the way that the airfoil is optimized to produce the desired aerodynamic forces. This process can be made more cost effective using computational fluid dynamics to run simulations on possible designs for airfoils, thereby testing their usability in the flight industry before committing to build a real-life model.

Through the comparison of lift and drag coefficient graphs retrieved from an online database as well as simulations run on the airfoils, a valid conclusion can be drawn that the passenger aircraft is more geared towards maintaining a high lift force while the military aircraft has a bigger focus on minimizing the drag force. This conclusion has many implications in the way that airfoils are designed and gives more insight into what kinds of factors are taken into consideration when creating the airfoil of an aircraft. The creation of aircraft is a very sophisticated process involving many parameters and assumptions but as can be seen by the results of this experiment, the purpose of the aircraft has a large effect on the way the lift and drag forces are balanced on an airfoil.

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The Effect of Window Position and Ceiling Height on Cooling Load in Architectural Studio

Seyedehzahra Mirrahimi

***Abstract*—**This paper investigates the effect of variations in window and ceiling heights on cooling inside an architectural training studio with a full width window. For architectural training, students use the studio more often than they use ordinary classrooms.
Therefore, studio dimensions and size, and the window position, directly influence the cooling load. Energy for cooling is one of the most expensive costs in the studio because of the high activity levels of students during the warm season.
The methodology of analysis involves measuring energy changes in the Energy Plus <EP> software in Kish Island.
It was proved that the cooling energy in an architecture studio can be increased by changing window levels and ceiling heights to add a range of cooling energy.

***Keywords*—**Energy Plus; cooling energy; window position, studio classroom

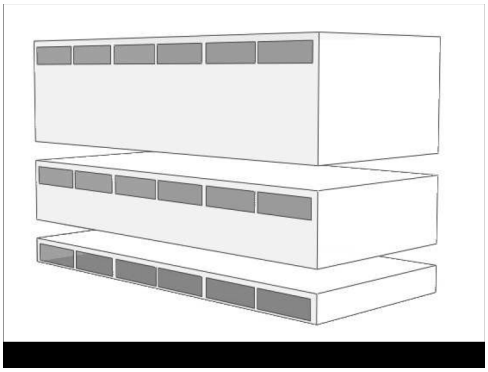
I. INTRODUCTION

Buildings all over the world comprise approximately 30-40% of the total use of energy and it is likely to be increased to 50% by 2050[1, 2]. Buildings also account for GHG emission exceeding 30%, which is responsible for climate change, global warming and also reduction of natural resources [3]. The housing sector is responsible for about a third of the world's overall energy use in the housing sector and the 33% of all the energy consumption is for the purpose of cooling, heating and air conditioning[4, 5]. In the developed nations, HVAC systems account for about 10–20% of the whole energy consumption in structures, and in the developing nations, this amount reaches to about 50% [6]. The contrast between studio and normal classroom has proved that in a formal classroom, only the students and teacher interact with each other whereas, in a studio, there exist a relationship among the students too [7]. Additionally, for the greater part, it is observed in studios that there is a better cooperation between students, and it draws out the best performance from them. Several experts have stated that the application of the studio architecture is an excellent mode of education [8].

In the school of architecture, a studio is meant for much more than just the usual classroom activities; as a result, the lighting is a very significant factor in the enhancement of the learning process [9].This study presents an enquiry into the determination of the measurements of the height of ceiling and the height of window heads with regards to the Iranian standards.

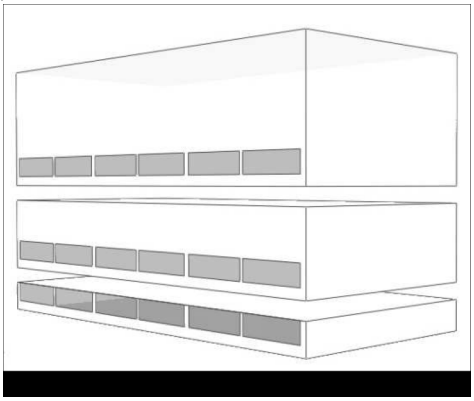
II. STUDIO SPACE CHARACTERIZES

Historically, the studios in the architectural school have a spacious and open design with abundant natural lighting, where every student is given a desk for drawing and building of models by hand [10]. Majority of the schools of architecture still employ the manual techniques for drawing even though software tools have been employed to aid the drawing and modelling since the decades of the 80s, which has not yet replaced the manual technique [11]. The natural lighting should be made available from the left hand side of the students [10]. The measurements of the desk used for drawing should be appropriate for paper of size A0 (92*127 cm); thus, every desk requires about 3.5 to 4.5 m2 per student and the height should be about 2.70 to 3.40 m [12]. The objective of this paper was to propose optimum cooling load with various ceiling heights for the studio (576 m) which has the capacity to house about 100 students. It is preferable to situate the studio on the lower floors in order to provide better approach to support services [13]. The building's orientation should be in accordance to the east-west axis to get the best position in which the south and the north face each other [14]. The path of the Sun can have a considerable influence on the luminance level [15]. The window head dimension must be stretched above the plane for more than 2.1 m [16]. Experts believe that the height of ceiling must be minimum 3 m for the smallest studios and generally at least 1/2 of the dimension of the breadth for all other than the largest studios [17]. In 1913, P J Waldram described that the ratio among the area of glazing to area of floor must be one tenth so as to get the maximum benefit of the day light [17].



III. METHODOLOGY

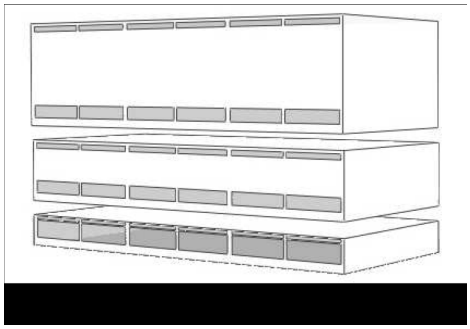
For this study, three prototypes of a studio for the architectural school were simulated using various heights for ceiling and window head in Iran (Yazd). The case study utilised for the purpose of this study was 16m depth, 36m width with various heights for ceiling and window head. The prototypes were situated in the ground floor. The windows in the south wall provided natural lighting in the studio. As displayed in Fig.1 (case study1), the height of the windows' head was fixed 2.1 m above the floor and the ratio of area of window to area of floor using which the simulations were executed was 10%; the various ceiling heights ranged from 2.4 m to 10 m. It is apparent from Fig.2 that the range of window head heights and ceiling heights rose from 2.4 m to 10 m as well as 0.2 m to 7.8 m correspondingly in Case Study 2. The rule of thumb for glazing area to floor, similar to Case Study1 and Case Study2, was 10%. Fig.3 demonstrates Case Study 3, where the ceiling heights ranged from 3 to 10 m and the glazing area to floor area ratio was higher than in the case of CS1 and CS2, roughly by 13%; it is because CS3 has windows with entire width wall



and with window head 0.3 m and 0.5 m below the ceiling.

IV. SIMULATION

After the study of the effects of variations in ceiling height and window levels, cooling loads were calculated by Energy Plus, a building energy simulation software developed by the US Department of Energy. Energy Plus estimates the building's thermal loads by using the heat balance technique. This technique considers all heat balances on indoor and outdoor surfaces and temporary heat conduction via building construction. It gives more accurate estimates compared to the weighting factor techniques, since it permits the changes in properties with time steps.



The walls of the base case model are composed of three layers: a wall tile of medium colour on a sand/cement plaster layer on the external side, a 150 mm thick layer of reinforced concrete as well as a 13 mm thick layer of gypsum plaster painted on the internal side. The total U-value of the exterior wall is 2.86 W/m2. The slab of the floor is 300 mm broad concrete. The ceiling surface is gypsum plastic of 13 mm thickness with a false ceiling of 25 cm. The characteristics of the different materials utilised in the construction of this building are given in Table 1 All the windows use a single panel of clear glass of 5 mm thickness with a 0.9 visible transmittance, and aluminium frames with an SHGC (solar heat gain coefficient) of 0.83 and with a U-value of 5.82 W/m2. At the time of simulation, the condition of Yazd, Iran is that it is the most proximate to the place of case studies and it is located at 22° altitude and 3.12° North and 101.55° East longitude. Table1 shows the simulation location in Yazd, Iran; it is the most proximate to the place of case studies and it is located at 32°0 North and 55°0 East longitude.

The highest number of individuals occupying the building during 8 a.m. to 8 p.m. on weekdays was considered to be 25 and, on the other hours of weekdays and on weekends, it was considered to be 5. The heat emanated by the students was estimated in accordance with their levels of activity and the

design of the indoor environment. The building in question is considered to be airtight with no windows open. For the purpose of the calculation of the infiltration load, the rate of mass flow was supposed to be equivalent to 0.2 ACH (air changes per hour)

Table 1
Characteristics of building materials used in base case model

Material	Density (kg/m^3)	Specific heat (J/kg K)	Thermal conductivity (W/m K)
Concrete	2400	653	2.16
Cement/sand plaster	1860	840	0.71
Gypsum plaster	1120	837	0.38

Related information to the computer simulation	
Date of simulation	July
Location	Yazd (Iran)
Latitude	32°0'N
Longitude	55°0'E

V. Results and Discussion

The results presented below show the influence of window position and ceiling height on the annual cooling energy consumption for a clear, double-glazed window in an architectural studio located in Yazd, Iran.

A. Case Study 1

As shown in Fig. 4 (case study 1), an increase in ceiling height causes an increase in cooling energy required for the studio. A wall with the maximum ceiling height consumed the most cooling energy, while a wall with the minimum ceiling height consumed the least cooling energy. A change in ceiling height from 2.4m to 10m will decrease the cooling energy in July.

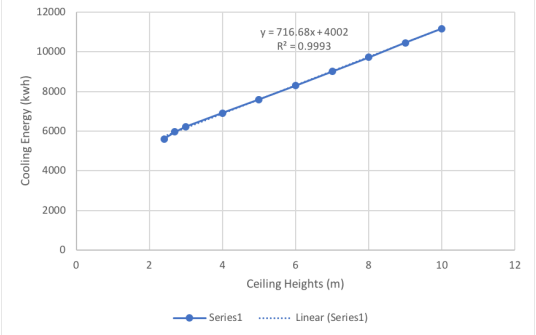


Fig. 4: Average illuminance ratio versus multiple ceiling and higher window highs

B. Case Study 2

It can be seen in Fig. 5 that the cooling load increases with increasing ceiling heights and window head heights;

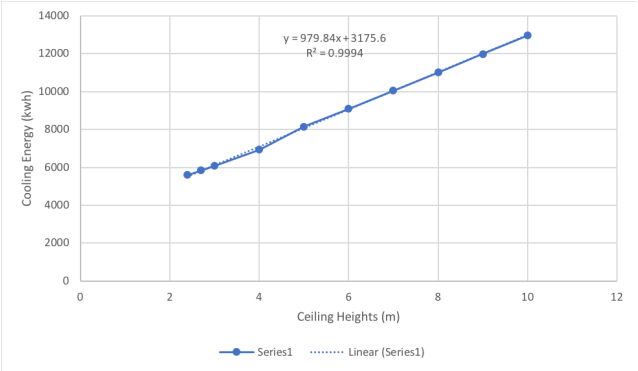


Fig. 5: Average illuminance ratio versus multiple ceiling and higher window highs

C. Case Study 3

The design of case study 3 was such that the ceiling heights increased from 3 m to 10 m; however, the window head heights remained the standard 2.1m from the floor. This positioning anchors the other window close to 0.3 m from the ceiling. The 0.5m window height remained the same in the experimental series (Fig.6).

According to Fig. 6, the result of simulation CS3 showed a model with increasing ceiling heights, putting the other window near the ceiling, with a better result when compared with CS1 and CS2.

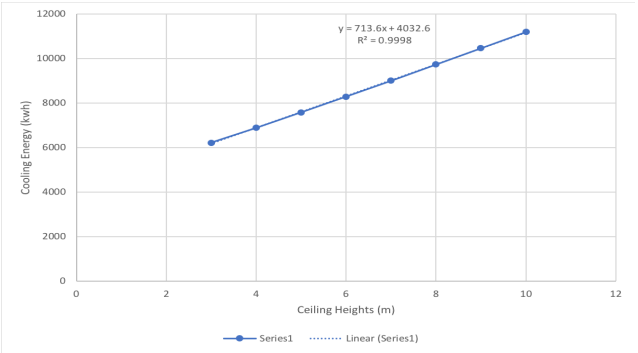


Fig. 6: Average illuminance ratio versus multiple ceiling and higher window highs

VI. CONCLUSION

As you can see the result in Cs1 min and max cooling energy is (5600kWh, 11174 kWh)

$$y = 716.68x + 4002$$

$$R^2 = 0.9993$$

and in Cs 2 min and max is (5600kWh,12967)

$$y = 979.84x + 3175.6$$

$$R^2 = 0.9994$$

and in Cs3 min and max is (6200kWh, 11195 kWh)

$$y = 713.6x + 4032.6$$

$$R^2 = 0.9998$$

The above demonstrates that the result of case study 2 differs from the average cooling energy requirements in case studies 1 and 3. In case studies 1and 3, the ceiling heights varied while the window head heights were fixed; in case study 3, the windows were positioned close to the ceiling.

The result of the analysis indicates that an increase in ceiling height will increase the requirement for cooling energy and that the case study Cs1 with windows fixed at head height offers the lowest cooling energy consumption.

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Basic Study on a Thermal Model for Evaluating The Environment of Infant Facilities

Xin Yuan, Yuji Ryu.

***Abstract*—**The indoor environment has a significant impact on occupants, and a suitable indoor thermal environment can improve the children's physical health and study efficiency during school hours. This study explored the thermal environment in infant facility classrooms for young children aged 5 and evaluated their thermal comfort. An infant facility in Kitakyushu, Japan, was selected for a case study to capture the young children's thermal comfort characteristics from October 12 to 13, 2021. Indoor temperatures measured by traditional fixed-point measurements could be insufficient to evaluate the indoor thermal environment, leading to misleading results. Thus, the operative temperature of each child through the thermal model is retrieved to grasp the actual thermal environment and thermal comfort characteristics of young children based on the sensible heat transfer from the skin to the environment, and the measured classroom indoor temperature, relative humidity, and pocket temperature of children's shorts. The statistical and comparative analysis of the results shows that: (1) There is applicability in evaluating the actual thermal environment surrounding children by wearing wearable sensors. (2) Children's behaviors are an essential cause of their intra-individual differences. (3) Due to children's different behaviors and positions, there are local temperature differences in children's thermal experiences. The findings contribute to improving the understanding of the actual thermal environment of children and provide valuable information for designers and governments to develop effective strategies for the indoor thermal environment considering the perspective of children.

***Keywords*—**Young children, thermal environment, thermal model, operative temperature, individual temperature differences.

I. Introduction

THE indoor environment has a significant impact on occupants' physical, mental, and work efficiency. Meanwhile, due to psychological and physical differences, children are more vulnerable to the influence of the surrounding environment than adults. Most Japanese infant facility classrooms serve multi-purposes, including classes, meals, activities, naps, etc. As the children spend most of the daytime in the classrooms, how to make and maintain a comfortable indoor environment for children becomes an important issue. So far, research on improving children's thermal environment has mostly been based on in-site measurements [1]. In studies based on field measurements, the measurements were mostly conducted in or at several fixed points in the classroom [2,3]. The sparsely distributed measurement points could not represent the temperature distribution in a room.

The wearable sensor has been deployed in many research methods. Sugimoto [4] proposed a wearable system to measure biological data, activity data, and location data in daily human life. The wearable sensors have recently been used to monitor physiological signals because of the advantages of minor interference with the measured object and no need for any cooperation with the measured object [5,6]. Therefore, to capture the actual situation of children, we used micro wearable sensors to measure children's surrounding environment.

In addition, several studies used the Predicted Mean Vote (PMV) and Predicted Percentage of Dissatisfied (PPD) as indices for thermal comfort evaluation [7–9]. According to ISO 7730 [8] and ASHRAE 55 [10], these indices can represent the thermal sensation of a group of people. However, it is only adaptive when people do the same activities and wear clothes with the same clothing insulation. Meanwhile, several studies focused on the uncertainties of the indices and concluded that air temperature and central radiant temperature might be the primary sources to propagate errors [11,12]. For this reason, the conclusions could be misleading when using PMV-PPD as the indices for evaluating children's indoor thermal comfort. Operative temperature is another widely used index to evaluate thermal comfort [13,14], which has higher accuracy than the PMV-PPD indices [12]. The operative temperature can be calculated by measuring the indoor air temperature and radiant temperature [15]. However, the indoor air temperature and radiant temperature are measured at fixed points, and the occupants usually keep still in a position. This is quite different from the actual living condition where the occupants have various activities and change positions. Hence, we established a thermal model to capture the thermal environment of the child's surroundings in the classroom through the operative temperature retrieved by the thermal model. We simultaneously wore the wristband sensor on the child's wrist and placed the mini-size wearable sensor the child's pants to measure the temperature in the pocket. The temperature measured in the pocket is used to create a thermal model to retrieve the operative temperature. Then we evaluated the indoor thermal comfort of children. The objectives were (1) to evaluate the surrounding thermal environment of children in the classroom by establishing a thermal model and (2) and comparing the results of traditional fixed-point indoor temperature measurements to evaluate thermal comfort from a child's perspective. The study contributes to improving the understanding of the actual thermal environment of young children. It provides valuable information for designers and governments to develop effective

X. Y. Faculty of Environmental Engineering, The University of Kitakyushu, Kitakyushu 808-0135, Japan (phone: 070-3853-1177; e-mail: uanin03@gmail.com).

Y. R. Faculty of Environmental Engineering, The University of Kitakyushu, Kitakyushu 808-0135, Japan (e-mail: ryu@kitakyu-u.ac.jp).

strategies for the indoor thermal environment considering the children's perspective.

II. METHODS

A. Measurement

The case study infant facility is in Kitakyushu city, Japan. Kitakyushu city, which is located at 130°52°N, 33.53°E. The average annual temperature of the city is about 16 °C, peaks in August at about 27-28 °C, and reaches its minimum in January at about 5-6 °C. Meanwhile, the city has a humid climate with annual precipitation ranging from 1600 to 2000 mm (www.jma.go.jp). The measurements were conducted from October 12 to 13, 2021. Temperature and humidity data recorders were installed in classrooms for children ages 0 to 5 to record the indoor temperature and humidity (Fig.1). Because the children could have damaged or played with the data recorders and minimized disruption to the children's class, we put the data recorders near the wall side. The temperature and humidity data recorder were placed 1.1m above the ground for measurement (Fig. 1 and Fig.2(a)). Considering the need for coordination in the measurement process, we selected children with the oldest age of 5 in the infant facility as the study subjects. We measured children by individualized measurements using a wearable sensor. Specifically, we put the wristband sensor on the child's wrist while putting the mini-sized wearable sensor in the 5-year-old's short pants pocket, and each measured child wears two temperature sensors (Fig.2 (b)). Table I shows the data recorder parameters used for measurement. We also observed and recorded the children's positions and behavior in the classroom during the measurement day. In addition, as shown in Fig. 2(b), children's shorts are unified.

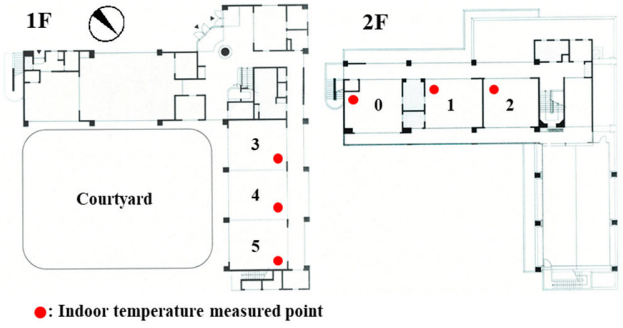
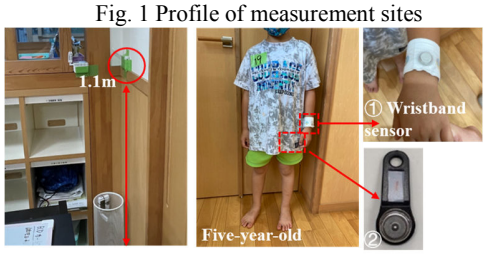


Fig. 1 Profile of measurement sites



(a) (b)

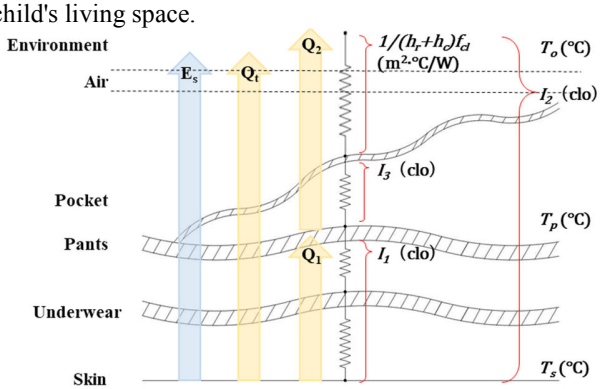
Fig. 2 Profile of measurement instruments. (a) Measured points and data recorder; (b) Clothing for children, the wristband sensor, and the mini-size wearable sensor.

TABLE I
PROFILE OF THE INSTRUMENT PARAMETERS

Instrument	Parameters	Accuracy	Resolution
Thermo Recorder TR-72 nw	Air temperature	±0.5 °C	0.1 °C
Thermo Recorder TR-72 nw	Relative humidity	±5% RH	0.1% RH
Thermochron Type-G	Wristband sensor and the temperature in the shorts pocket	±0.1 °C	0.5 °C

B. Establishment of a thermal model

As shown in Fig. 3, a thermal model was established in this study based on the sensible heat transfer from the skin to the environment [16]. The model retrieves the operative temperature T_o from the measured pocket temperature T_p and evaluates it as the horizontal temperature distribution in the child's living space.



Item	Description
T_o	Operative temperature (°C)
T_p	Pocket temperature (°C)
T_s	Skin temperature (°C)
f_{cl}	Ratio of body surface areas with clothes to body surface areas
h_c	Convection heat transfer coefficient
h_r	Radiative heat transfer coefficient
I	Thermal resistance coefficient (clo)
E_s	Evaporation loss (W/m²)
Q_t	Sensible heat transfer from skin to environment (W/m²)
Q_1	Sensible heat transfer from skin to pockets (W/m²)
Q_2	Sensible heat transfer from pockets to environment (W/m²)

Fig. 3 Sensible heat transfer in the thermal model (from child's skin to pocket to the environment)

Fig. 3 shows the sensible heat transfer from the skin to the clothing to the environment. Taking the pockets of the pants worn by the children as the boundary, we divided them into two parts: inside the pockets (Q_1) and outside the pockets (Q_2). The sensible heat transfer can be calculated through the following equations:

$$Q_t = (T_s - T_o)/0.155I_2 \quad (1)$$

$$Q_1 = (T_s - T_p)/0.155I_1 \quad (2)$$

$$Q_2 = (T_p - T_o)/\{0.155I_3 + 1/(h_c + h_r)f_{cl}\} \quad (3)$$

Where Q_t, Q_1 and Q_2 are the sensible heat transfer from skin to environment, from skin to pocket, and from pocket to environment (W/m²) respectively; T_s is the skin temperature (□); I (clo) is the thermal resistance of measured clothing. Meanwhile, the following formula is workable under steady-state:

$$Q_t = Q_1 = Q_2 \quad (4)$$

The heat loss of the right thigh Q_m (W/m²) could be divided into sensible heat loss Q_t (W/m²) and latent heat loss from the

skin surface E_s (W/m^2) (Eq. (5)) [17]. Where since the metabolic rate M (W/m^2) expresses the heat generated by humans as the heat value per unit surface area of the human body. In addition, ASHRAE 55-2013 [10] pointed out that the mechanical workload could be considered as 0 for most activities, especially when people are sitting. Hence, according to the description of heat loss from the skin surface in ISO 8996-2004 [18], when the mechanical workload is 0 and in a steady state, the metabolic rate M (W/m^2) is equal to the total heat loss Q_m (W/m^2) (Eq. (6)). Therefore, the heat loss Q_m (W/m^2) can be obtained by dividing the total heat generated by the human body W (W)by the body surface area S (cm^2) (Eq. (6)).

$$Q_t = Q_m - E_s \tag{5}$$

$$M = Q_m = \frac{W}{S} \tag{6}$$

$$W = Q_s \times S \tag{7}$$

The body surface areas also vary with age and nationality [19–21]. The surface area formula provided by Haycock has been widely used in infant, child, and adult samples while considering the child's ethnicity [20]. The formula was calculated as follows:

$$S = w^{0.5378} \times h^{0.3964} \times 0.024265 \tag{8}$$

Where S is the body surface areas (cm^2), w is the weight (kg), h is the height (cm). According to ISO 8996, children are between 4 and 5 years old, 1.2 (m) in height and 20 (kg) in weight [18].

Eguchi and Ryu [22]measured the sensible heat loss of every part of the Japanese body, with the thermal resistance of clothing is 0.56 (clo), in an experimental room (wind speed < 0.15 (m/s), indoor temperature = 28(°C)). The average sensible heat loss of the right thigh was found to be about 7% of the whole body. Whilst the account of the surface area of the right thigh to the total body of five-year-old children is about 15.9%, respectively [23]. Hence, the sensible heat loss could be estimated through Eq. (9):

$$Q_{rt} = \frac{W_{rt}}{S_{rt}} = \frac{W \times R_{wrt}}{S \times R_{srt}} \tag{9}$$

Where Q_{rt} is the per surface area sensible heat loss of the right thigh (W/m^2), W_{rt} and W are the sensible heat loss of the right thigh and the whole body (W), S_{rt} and S are the surface area of the right thigh and the whole body (m^2), R_{wrt} and R_{srt} are the account of the sensible heat loss and surface area of the right thigh to the whole body (%).

The metabolic rate of the human body is expressed using met. 1 met is the amount metabolized when sitting quietly in a chair, equivalent to 58.2 (W/m^2). Considering the thermal balance greatly affected by the physique differences of humans, the metabolic rate usually refers to the amount metabolized per body surface area. In a summary of the activity levels of 119 Korean children aged 4-6 years in the infant facility classroom based on the adult activity levels of ISO 7730-2005 and a child metabolic rate 1.2 times that of adults, H. Yun et al. concluded that children's activity levels in the classroom ranged from 1.96 met to 2.64 met, with a mean value of 1.37 met and a metabolic rate of 66.6 (W/m^2) [24]. Meanwhile, according to Tanabe et al. paper, the human body heat balance equation is expressed as Eq. 10 [17]. In addition, when the mechanical workload is 0, Q_{res} and E_s can be estimated through Eq. (11) and Eq. (12) [25].

$$Q_s = M - Q_{res} \tag{10}$$

$$Q_{res} = 1.7 \times 10^{-5} M(5867 - P_a) + 0.0014M(34 - T_a) \tag{11}$$

$$E_s = 3.05 \times 10^{-3}(5733 - 6.99(M - W) - P_a) + 0.42(M - W - 58.15) \tag{12}$$

The thermal resistance of clothing for children is calculated using Eq. (10) for calculating the thermal resistance of clothing derived from the 1984 McCullough and Jones study provided in ASHRAE 55. As the garments of the subject children in our measurements were uniformly made of the same material for short sleeves (0.07 clo) and shorts (0.08 clo)[26]. In addition, according to ASHRAE, we added an underwear thermal resistance of 0.03 clo for all samples[10].

$$I_{cl} = 0.835 \sum_i I_{clu,i} + 0.161 \tag{13}$$

Where I_{cl} (clo) is the thermal resistance of the entire garment and $I_{clu,i}$ (clo) is the thermal resistance of a single garment.

Then the operative temperature T_o could be retrieved combined with Eq. 3 and 4.

III. Verification of a Thermal Model

A. The Validation Experiment

To verify the accuracy of the thermal model, we conducted validation experiments on May 9, 2022. We calculated the operative temperature ($T_{o\text{-}g}$) from the measured indoor air temperature (T_a), wet bulb globe temperature (T_g), and wind speed (v) and compared the operative temperature (T_o) calculated with the thermal model (Fig. 4). The parameters of the instruments used in the experiment are shown in Table II. The experiment lasted for a total of 30 minutes (Table III) and measured 8 subjects. The subjects were pre-treated for 5 minutes to adapt to the current indoor thermal environment. The indoor temperature was maintained at a steady-state (Table II), and the experiment was conducted at the end of the 5-minute pre-treatment time. We measured indoor temperature and humidity (1 point), wet-bulb globe temperature (1 point), and wind speed (1 point) in the experiment. Meanwhile, the subjects wore a wearable sensor in the pocket of their shorts. The subject was seated in a chair during the experiment and maintained the work status, while we unified the subject's clothes to eliminate the error caused by the clothes (Fig.5 (a)). The data of the measured subjects were recorded in Table IV.

TABLE II
PROFILE OF THE INSTRUMENT PARAMETERS

Instrument	Parameters	Accuracy	Resolution
Thermo Recorder TR-72 nw	Air temperature	±0.5 °C	0.1 °C
Thermo Recorder TR-72 nw	Relative humidity	±5% RH	1% RH
Thermochron Type-G	Wristband sensor and the temperature in the shorts pocket	±0.5 °C	0.1 °C
Thermo Recorder TR-71 wf	Wet bulb globe temperature	±0.5 °C	0.1 °C
SIBATA thermal anemometer ISA-700	Wind speed	±0.1m/s	0.01 m/s

As shown in Fig. 6, there was an individual difference

between the measured subjects, resulting from the wearable sensor set in the pocket of the shorts and the measured temperature due to the influence of the skin temperature. Furthermore, through the validation experiment, the average operative temperature (T_{o_ave}) calculated by the 8 subjects based on the thermal model coincided with the results of the operative temperature ($T_{o\text{-}g}$) calculated from the measured T_g. This result verifies the trustworthiness of the model. Simultaneously, we consider that the thermal environment surrounding the measured subjects can be calculated through the thermal model established by wearing wearable sensors.

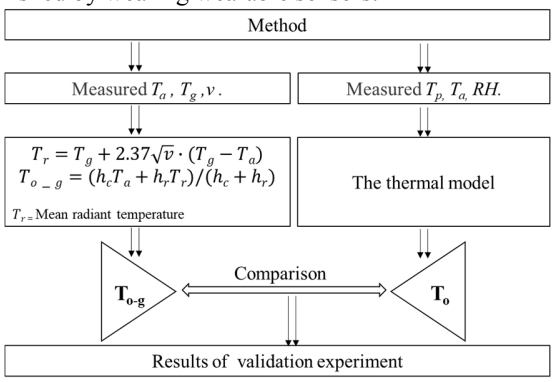
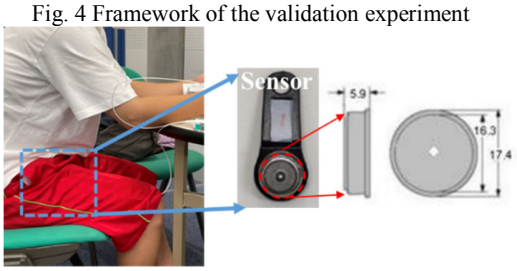


Fig. 4 Framework of the validation experiment



(a) (b)

Fig. 5 Measured subjects and dimensions of the wearable sensor. (a) Measured subjects, (b) dimensions of the wearable sensor (Source: KN Laboratories, Inc., Osaka, Japan)

TABLE III
SUMMARY OF THE EXPERIMENT AND MEASURED ENVIRONMENT PARAMETERS

Date	Subject	Duration	T_g (° C)	$T_{o\text{-}g}$ (° C)
9. May 2022	8 persons	30 mins	23.5±0.21	23.3±0.18

T_g = wet-bulb globe temperature (mean ± std.dev.), $T_{o\text{-}g}$ = operative temperature (mean±std.dev.).

TABLE IV
SUMMARY OF THE MEASURED SUBJECTS AND OPERATIVE TEMPERATURE BY THE THERMAL MODEL

Measured subjects	Body surface areas (cm^2)	T_o (° C)
Sub-1	1.55	23.2±1.00
Sub-2	1.46	23.0±1.12
Sub-3	1.8	22.3±0.60
Sub-4	1.86	23.7±0.86
Sub-5	1.69	22.1±1.04
Sub-6	1.34	23.0±0.65
Sub-7	1.5	24.5±0.73
Sub-8	2.21	22.2±0.85
Average	1.68	23.4±0.16

T_o=operative temperature (mean±std.dev.).

IV. RESULT AND DISCUSSION

A. Result of measurement

Due to the effects of COVID-19, the classroom was always ventilated except for rainfall, and the air conditioning system continuously operated when children were in the classroom. Fig. 7 shows the outdoor temperature (T_{out}), and rainfall on a typical measurement day.

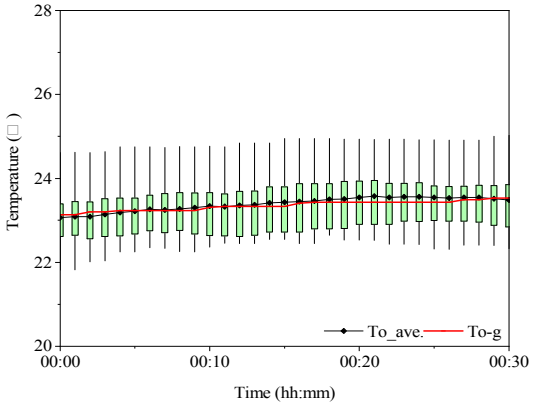


Fig. 6 Results of temperature comparison for validation experiments

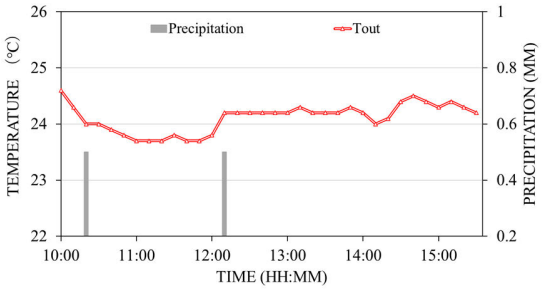


Fig. 7 Weather and classroom air temperature on a typical measurement day

1. Results based on traditional measurement

Based on the government standard, the comfortable temperature zone for children is 25°C to 28°C [27–29]. As shown in Fig.8, the classroom temperature for 5-year-olds was lower than in other classrooms, with a 5.9% failure rate for 2-year-olds and a 34.4 % failure rate for 5-year-olds. All other classrooms were within the zone of comfortable indoor temperatures set by the government.

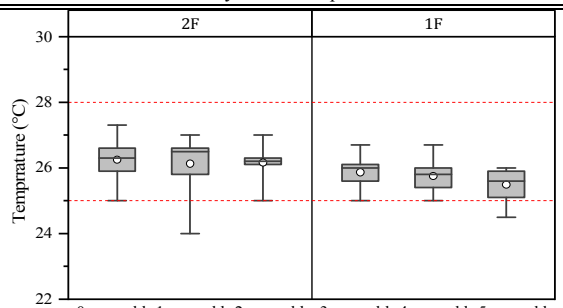
2. Results based on wearing wearable sensor measurements

Table V shows a summary of typical measurement days for 5-year-old children. A total of 6 5-year-old children were measured from 10:00 to 15:30. As shown in Fig. 9, the measured wristband sensor (T_w) and pocket temperature (T_p) for the 6 subjects indicate inter and intraindividual temperature differences. This could be due to the influence of skin temperature resulting in the temperature difference. In addition, air penetration in pockets or wristbands and different levels of contact between the sensor and the measured object could also be the reason.

TABLE V

SUMMARY OF TYPICAL MEASUREMENT DAY

Date	Cooling	Ventilation	Measurement Object	Measurement time
12 Oct. 2021	24° C	Always	6 persons	10:00~15:30



	0-year-old	1-year-old	2-year-old	3-year-old	4-year-old	5-year-old
Mean	26.25	26.13	26.16	25.87	25.75	25.49
Max	27.3	27	27	26.7	26.7	26
Min	25	24	25	25	25	24.5

Fig. 8 Indoor temperature of children's classroom for children aged 1 to 5.

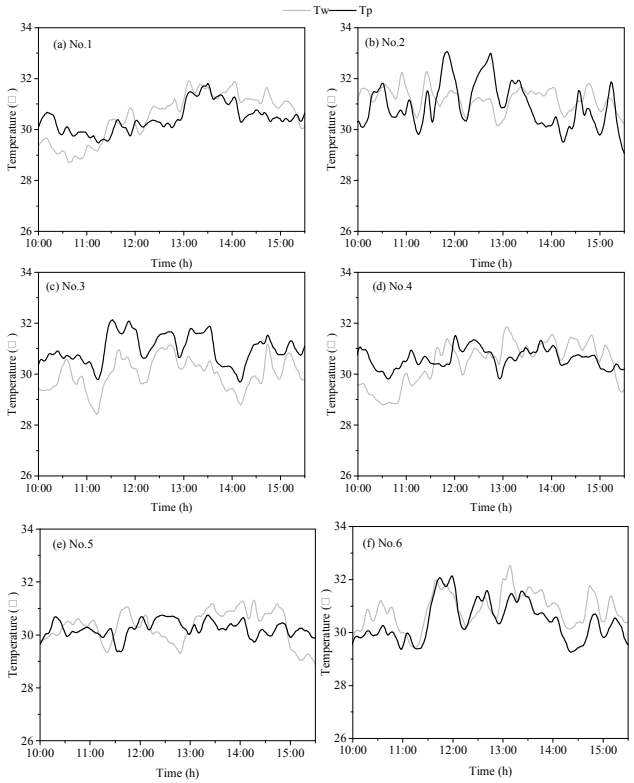
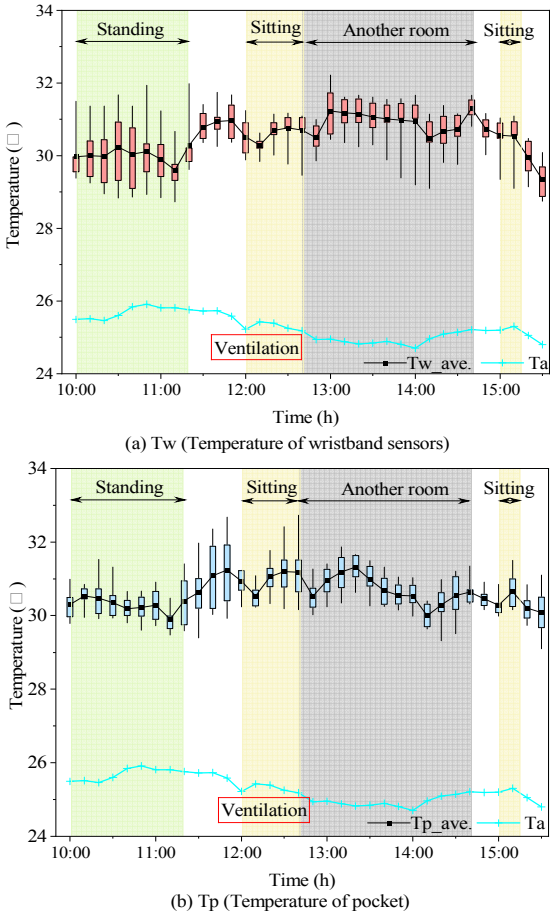


Fig. 9 Comparison between the wristband sensor and the pocket temperature measurement for each subject

As shown in Fig. 10(a) and Fig. 10(b), the indoor temperature (T_a) decreases by 0.5°C at 12:00 due to ventilation and rainfall. Simultaneously, T_w (temperature of wristband sensor) and T_p (temperature of pocket) also gradually decreased at 12:00 and decreased by 0.5°C after 10 minutes (12:10). This indicates that although the sensors we used are sensitive to changes in the surrounding thermal environment, the degree of sensitivity could be slightly delayed due to the influence of the thermal resistance of the wristband and pants pocket.

The inter-individual temperature difference between T_w and T_p is variable. The most significant inter-individual differences were observed for T_w when the children were in a standing position (10:00~11:20) (Fig. 10(a)) and smaller when they were in a seated position (12:00~12:40). Meanwhile, the inter-individual differences for T_p were more minor than for T_w, especially when the children were in a standing position (10:00~11:20) (Fig. 10(b)). This could be because the difference in the thermal resistance of the wristband and the pocket of the clothing while the child is standing and pockets for breath penetration leads to a reduced skin temperature influence on the sensors.



(a) Tw (Temperature of wristband sensors)

(b) Tp (Temperature of pocket)

Fig. 10 Temperature variation of T_w, T_p for the 6 subjects on a typical measurement day.

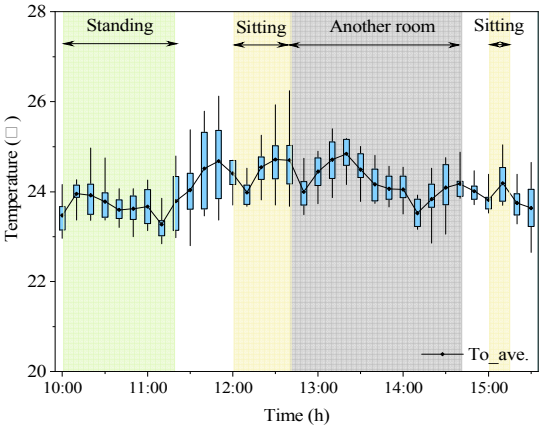


Fig. 11. Characteristics of typical diurnal temperature variations

B. Evaluation of children's thermal environment

The operative temperature variation for the 5-year-old children is shown in Fig. 11. The periods not marked in Fig. 11 are the periods when children go to the bathroom or are not in the classroom. 10:00 ~ 11:20 is when the children are standing, 12:00 ~ 12:40 and 15:00 ~ 15:15 are when the children are sitting, and it can be seen that the surrounding temperature is higher when the children are sitting. This could be due to the effect of heat from between bodies as the children gather at their desks. We consider this result to represent the thermal experience of children with local temperature differences. This could lead to the lower-than-expected thermal comfort of children.

V. CONCLUSION

In this paper, we evaluated the indoor thermal environment of an infant facility classroom in Kitakyushu, Japan, from the perspective of child occupants based on measurement data in summer. Due to the variability of children's locations, indoor temperatures measured by traditional fixed-point measurements could be insufficient for evaluating the indoor thermal environment. We propose a measurement method in which children wear wearable sensors and establish a thermal model to retrieve the operative temperature of each child in the classroom and evaluate the actual thermal environment of 5-year-old children. The method proposed in this paper indicates that: (1) There is applicability in evaluating the actual thermal environment surrounding children by wearing wearable sensors.

(2) The inter-individual temperature difference varies with the child's behavior. The inter-individual differences for the temperature inside the shorts' pocket were smaller than for the wristband sensor temperature, especially when the children were in a standing position. (3) Due to the children's different behaviors and positions, there are local temperature differences in children's thermal experiences. The findings improve the understanding of the actual thermal environment of young children and provide valuable information for designers and governments to develop effective strategies for the indoor thermal environment considering children's perspectives.

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Identification and Characterization of in Vivo, in Vitro and Reactive Metabolites of Zorifertinib Using Liquid Chromatography Lon Trap Mass Spectrometry

Adnan A. Kadi, Nasser S. Al-Shakliah, Haitham Al-Rabiah

***Abstract*—** Zorifertinib is a novel, potent, oral, a small molecule used to treat non-small cell lung cancer (NSCLC). zorifertinib is an Epidermal Growth Factor Receptor (EGFR) inhibitor and has good blood–brain barrier permeability for (NSCLC) patients with EGFR mutations. zorifertinibis currently at phase II/III clinical trials. The current research reports the characterization and identification of in vitro, in vivo and reactive intermediates of zorifertinib. Prediction of susceptible sites of metabolism and reactivity pathways (cyanide and GSH) of zorifertinib were performed by the Xenosite web predictor tool. In-vitro metabolites of zorifertinib were performed by incubation with rat liver microsomes (RLMs) and isolated perfused rat liver hepatocytes. Extraction of zorifertinib and it's in vitro metabolites from the incubation mixtures were done by protein precipitation. In vivo metabolism was done by giving a single oral dose of zorifertinib(10 mg/Kg) to Sprague Dawely rats in metabolic cages by using oral gavage. Urine was gathered and filtered at specific time intervals (0, 6, 12, 18, 24, 48, 72,96and 120 hr) from zorifertinib dosing. A similar volume of ACN was added to each collected urine sample. Both layers (organic and aqueous) were injected into liquid chromatography ion trap mass spectrometry(LC-IT-MS) to detect vivozorifertinib metabolites. N-methyl piperizine ring and quinazoline group of zorifertinib undergoe metabolism forming iminium and electro deficient conjugated system respectively, which are very reactive toward nucleophilic macromolecules. Incubation of zorifertinib with RLMs in the presence of 1.0 mM KCN and 1.0 Mm glutathione were made to check reactive metabolites as it is often responsible for toxicities associated with this drug. For in vitro metabolites there were nine in vitro phase I metabolites, four in vitro phase II metabolites, eleven reactive metabolites(three cyano adducts, five GSH conjugates metabolites, and three methoxy metabolites of zorifertinib were detected by LC-IT-MS. For in vivo metabolites, there were eight in vivo phase I, tenin vivo phase II metabolitesofzorifertinib were detected by LC-IT-MS. In vitro and in vivo phase I metabolic pathways wereN- demthylation, O-demethylation, hydroxylation, reduction, defluorination, and dechlorination. In vivo phase II metabolic reaction was direct conjugation of zorifertinib with glucuronic acid and sulphate.

***Keywords*—** in vivo metabolites, in vitro metabolites, cyano adducts,GSH conjugate.

Nasser Al-Shakliah is with the King Saud University, Saudi Arabia (e-mail: nalshakliah@ksu.edu.sa).

Principal Component Analysis in Drug-Excipient Interactions

Farzad Khajavi*

***Abstract*—** Studies about the interaction between active pharmaceutical ingredients (API) and excipients are so important in the pre-formulation stage of development of all dosage forms. Analytical techniques such as differential scanning calorimetry (DSC), Thermal gravimetry (TG), and Furrier transform infrared spectroscopy (FTIR) are commonly used tools for investigation regarding compatibility and incompatibility of APIs with excipients. Sometimes the interpretation of data obtained from these techniques is difficult because of severe overlapping of API spectrum with excipients in their mixtures. Principal component analysis (PCA) as a powerful factor analytical method is used in these situations to resolve data matrices acquired from these analytical techniques. Binary mixtures of API and interested excipients are considered and produced. Peaks of FTIR, DSC, or TG of pure API and excipient and their mixtures at different mole ratios will construct the rows of the data matrix. By applying PCA on the data matrix, the number of principal components (PCs) is determined so that it contains the total variance of the data matrix. By plotting PCs or factors obtained from the score of the matrix in two-dimensional spaces if the pure API and its mixture with the excipient at the high amount of API and the 1:1mixture form a separate cluster and the other cluster comprise of the pure excipient and its blend with the API at the high amount of excipient. This confirms the existence of compatibility between API and the interested excipient. Otherwise, the incompatibility will overcome a mixture of API and excipient.

***Keywords*—** API, Compatibility, DSC, TG, Interactions.

I. Introduction

In a dose shape, an API comes in coordinate contact with other components (excipients) of the formulation that encourage the administration and release of an active substance as well as keep it safe from the environment [1,2]. Although excipients are pharmacologically inert, they can interact with the drug in the dosage form, there by affecting the physical stability of the drug product, such as sensory properties, slowed dissolution rates, or chemical properties that cause drug degradation [3, 4]. Excipients need to be carefully selected to form a robust and effective dosage form to facilitate administration, improve patient compliance, promote drug release and bioavailability, and extend shelf life [5, 6]. Therefore, the compatibility detection of API and excipients or other active ingredients is considered one of the mandatory factors and is at the forefront of research in pharmaceutical science and technology. In addition, under the prototype of drug development quality design, it is expected that the physical and chemical interactions in the dosage form will be fully understood and encouraged by the U.S. Food and Drug Administration and various regulatory agencies around the world. The emergence of thermal analysis methods in the initial steps of pre-formulation research has greatly facilitated the early prediction, monitoring and characterization of API incompatibility, thereby avoiding expensive material waste and significantly reducing the time required to achieve the correct product formulation of the API [7, 8].

Regularly utilized analytical techniques for investigation the compatibility comprises thermal methods such as differential scanning calorimetry, thermogravimetric analysis [9–10], differential thermal analysis, isothermal microcalorimetry [11,12], hot stage microscopy [13] and other analytical methods like powder X-ray diffraction [14,15], Fourier transform infrared spectroscopy [16], scanning electron microscopy [17] and high performance liquid chromatography [18].

Sometimes interpretation of data obtained from the mentioned analytical techniques is difficult because of overlapping of the peaks of APIs with excipients. In this situation, factor analysis method can be a powerful method to process and resolve data in a better and more precise way.

Factor analysis (FA) is fitting a set of latent variable models and methods to data. One of the FA methods is principal component analysis (PCA). The purpose of PCA is finding the subs pace in the space of the variables where data has the most variance. The primary variables, generally correlated, are linearly transformed into a fewer number of uncorrelated variables namely principal components (PCs). PCA obeys the following:

$X = T_A \cdot P_A + E_A$

Where X is a N×M matrix of data, T_A is the N×A scores matrix including the projection of the objects in the A PCs sub-space, P_A is the M×A loadings matrix comprising the linear combination of the variables indicated in each of the PCs, and EA is the N×M matrix of residuals [19].

PCA can be utilized to recognize the relationships among variables of high variance. As shown by Jackson [20], the understanding of the data set under analysis will be useful [21]. In this review PCA is used as a factor analytical method to interpret the data matrixes of mixture of APIs with excipients and it is really helpful to predict drug-excipient interactions.

II. Case Studies

Study about interaction between Theophylline and some excipients such as Arabic gum, glucose, sorbitol and sucrose showed incompatibility using factor analysis method on DSC data [22]. In this experiment, binary mixtures of theophylline

*Research and development section, Dr. Abidi Pharmaceutical Company, Tehran, Iran (phone/fax: +98-21-44504787; email:farzadchemistry@gmail.com, f.khajavi@abidipharma.com).

with excipients were prepared at 9:1, 7:3,1:1, 3:7 and 1:9 molar or mass ratios (the first number of the ratio shows the content of theophylline in the mixtures). In FA calculations, the variables were DSC parameters such as enthalpies, onset temperatures, peak temperatures, peak heights and peak widths. The samples were considered as theophylline, excipients and their mixtures at ratios of 9:1, 7:3, 1:1, 3:7and 1:9. Figures 1-6 show the DSC curves of theophylline with excipients at different ratios.

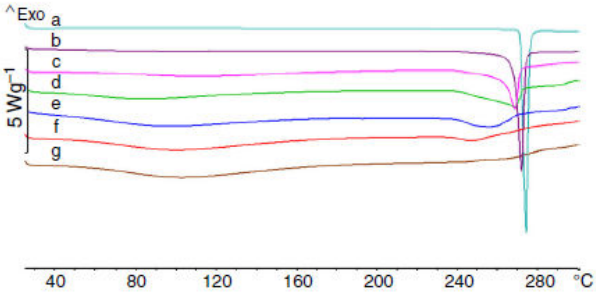

Fig. 1. DSC curves of **a** theophylline, **A**rabic gum and their mixtures at API/excipient ratios **b** 9:1, **c** 7:3, **d** 1:1, **e** 3:7, **f** 1:9

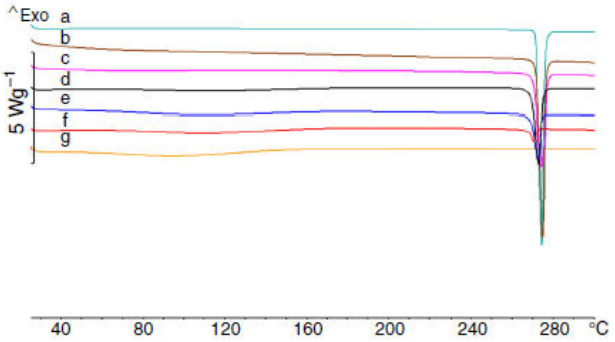

Fig. 2. DSC curves of **a** theophylline, **g** microcrystalline cellulose and their mixtures at API/excipient ratios **b** 9:1, **c** 7:3, **d** 1:1, **e** 3:7, **f** 1:9

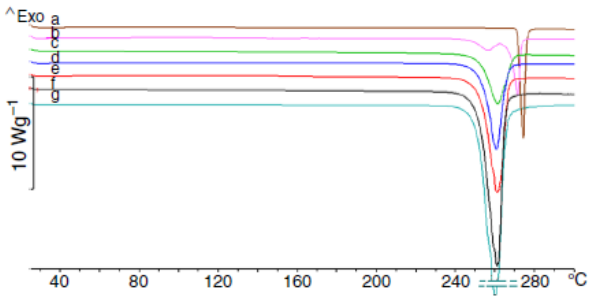

Fig. 3. DSC curves of **a** theophylline, glicocol and their mixtures at API/excipient ratios **b** 9:1, **c** 7:3, **d** 1:1, **e** 3:7, **f** 1:9

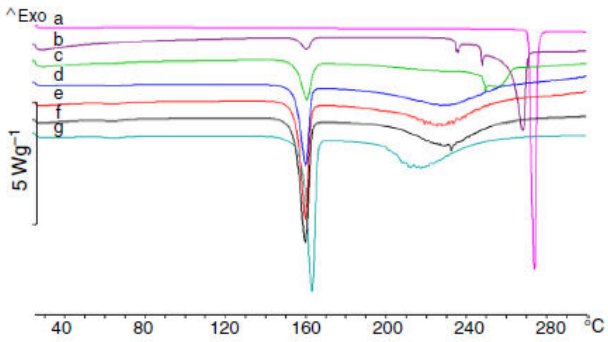

Fig. 4. DSC curves of **a** theophylline, **g** glucose and their mixtures at API/excipient ratios **b** 9:1, **c** 7:3, **d** 1:1, **e** 3:7, **f** 1:9

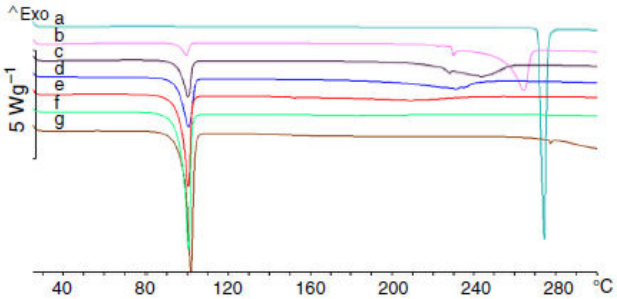

Fig. 5. DSC curves of **a** theophylline, **g** sorbitol and their mixtures at API/excipient ratios **b** 9:1, **c** 7:3, **d** 1:1, **e** 3:7, **f** 1:9

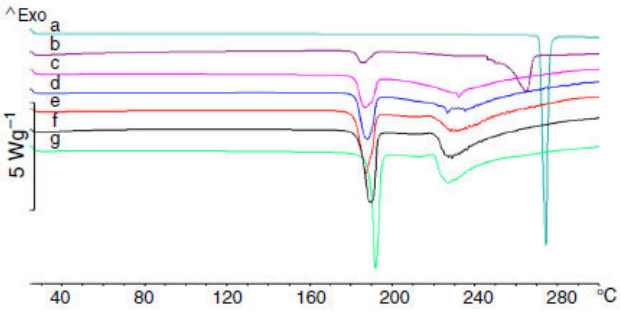

Fig. 6. DSC curves of **a** theophylline, **g** sucrose and their mixtures at API/excipient ratios **b** 9:1, **c** 7:3, **d** 1:1, **e** 3:7, **f** 1:9

Sometimes it is difficult to predict compatibility or incompatibility between mixture ingredients in the DSC data, e.g., theophylline mixtures with glicocol orarabic gum. In these situations, factor analysis methods such as principal component analysis (PCA) are a solution to determine compatibility. The results of FA can be seen on a two-dimensional score plot. The localization of both ingredients and their blends on the FA plot demonstrates compatibility or incompatibility. If the API with mixtures at most amount and the 1:1 blend form a separate cluster and the other cluster comprises of excipient with blends with its most amount; this indicates that compatibility between ingredients is obvious. The score plot of theophylline with

microcrystalline cellulose and sorbitol are shown in Fig 7 and Fig 8, respectively.

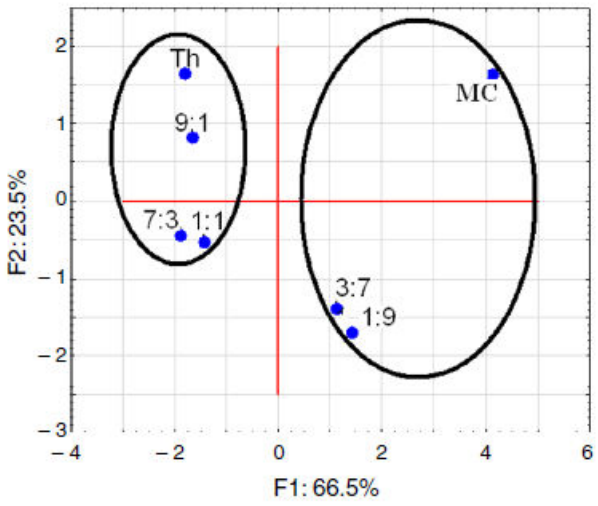

Fig. 7. FA score scatter plot for DSC data: theophylline (Th), microcrystalline cellulose (MC) and their mixtures at the ratios:9:1, 7:3, 1:1, 3:7, 1:9

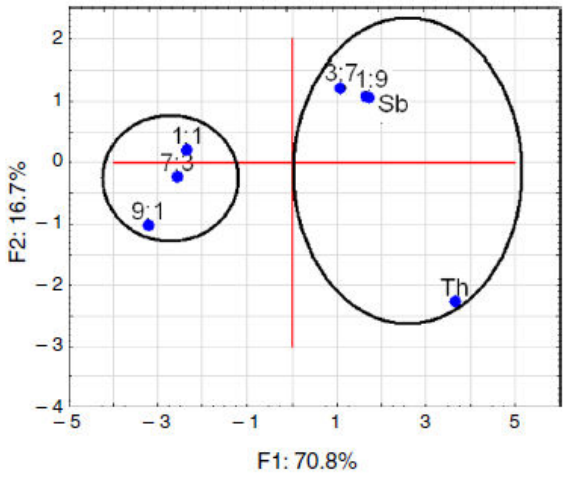

Fig. 8. FA score scatter plot for DSC data: theophylline (Th), sorbitol(Sb) and their mixtures at the ratios: 9:1, 7:3, 1:1, 3:7, 1:9

According to these score plots, theophylline is compatible with microcrystalline cellulose and is incompatible with sorbitol. Table 1. Shows that which excipient is compatible with theophylline.

Table 1. Results obtained using FA for interpretation of the DSC data for theophylline mixtures.

Matrices	Theophylline mixtures	Results of DSC supported by FA
1	Arabic gum	Incompatibility
2	Microcrystalline cellulose	Compatibility
3	Glicocol	Compatibility
4	Glucose	Incompatibility
5	Sorbitol	Incompatibility
6	Sucrose	Incompatibility

In another study the compatibility of hydrocortisone as an API with excipients such as mannitol, starch, lactose, methylcellulose, β-cyclodextrin, meglumine, chitosan, magnesium stearate and polyvinylpyrrolidone was investigated. PCA and cluster analysis methods were applied on the matrixes of thermal gravimetric data. Hydrocortisone was incompatible with β-cyclodextrin and magnesium stearate. The results were confirmed by other methods like DSC, IR and X-ray powder diffraction [23]. Fig. 9 and Fig.10 represent TG traces of hydrocortisone with chitosan and magnesium stearate at different mole ratios, respectively.

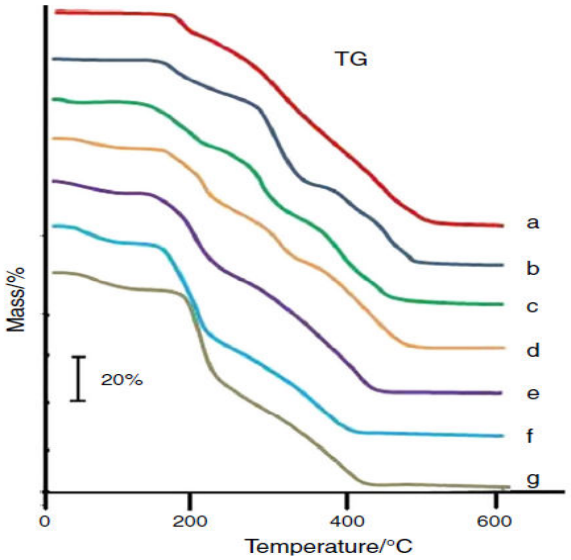

Fig. 9. TG traces of: (a) hydrocortisone, (g) chitosan at drug/excipient ratios: (b) 9:1, (c) 7:3, (d) 1:1, (e) 3:7, (f) 1:9

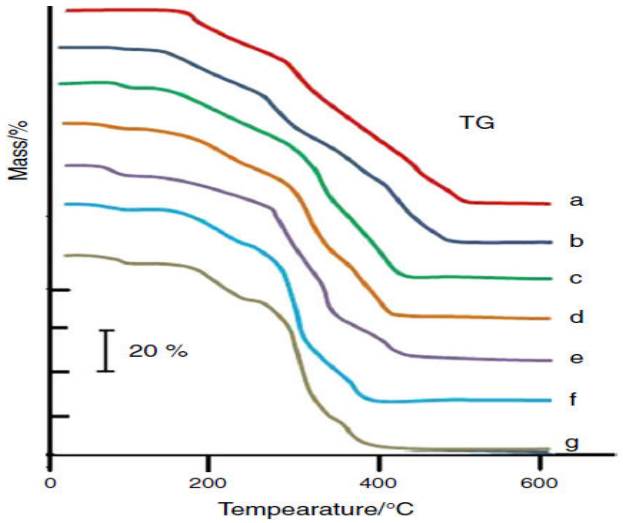

Fig 10. TG traces of: (a) hydrocortisone, (g) magnesium stearate and their mixtures at drug/excipient ratios: (b) 9:1, (c) 7:3, (d) 1:1, (e) 3:7, (f) 1:9

By applying PCA on data matrixes from Fig 8 and Fig 9, PC2 versus PC1 was graphed. Fig 11a and Fig 11b show two dimensional score plot of hydrocortisone with chitosan and magnesium stearate, respectively.

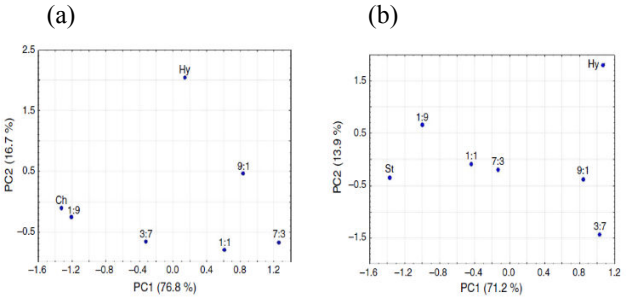

Fig. 11a PCA score biplot for the first two principal components for hydrocortisone (Hy), chitosan (Ch) and their mixtures at drug/excipient ratios: 9:1, 7:3, 1:1, 3:7, 1:9 and b PCA score biplot for the first two principal components for hydrocortisone (Hy), magnesium stearate (St) and their mixtures at drug/excipient ratios: 9:1, 7:3, 1:1, 3:7, 1:9

Fig. 11a shows that two partitioned clusters were formed. One comprises chitosan and a blend with its high content, whereas the other includes hydrocortisone and its blend with a high amount of API. This classification indicates hydrocortisone and chitosan are compatible. Distribution of points in the score plot of Fig 11b shows that hydrocortisone and its mixture with the high amount of API (9:1) are not close to each other. Also Mg stearate and its blend with the high amount of excipient (1:9) are not in the same group. Therefore, hydrocortisone and Mg stearate are incompatible. The same method was used for the other excipients. Table 2 shows the results of PCA on data matrixes obtained from different excipients with hydrocortisone at different ratios.

Table 2. Results obtained by using multivariate statistical techniques as supporting tools for interpretation of the TG curves of mixtures with hydrocortisone

Matrices	Excipient	PCA	CA
1	Mannitol	+	+
2	Lactose	+	+
3	Starch	+	+
4	Methylcellulose	+	+
5	ß-cyclodextrin	-	-
6	Meglumine	+	+
7	Chitosan	+	+
8	PVP-30	+	+
9	Magnesium stearate	-	-

+, compatibility; -, incompatibility

III. Conclusion

In this review a simple, fast and precise method was used to investigate the compatibility of API with excipients. The method was based on application of principal component analysis as a powerful chemometric method on data matrices obtained from DSC, TG and FTIR analytical techniques. By plotting score points, the compatibility is confirmed if the API and its mixture with the excipient at the high amount of API put in one group and the excipient and its mixture with API at the high amount of excipient placed in another group. This method helps the formulation scientists to select appropriate excipients with lowest possibility of interaction with API.

Acknowledgment

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Synthesis and Characterization of PVDF, FG, PTFE, and PES Membrane Distillation Modified with Silver Nanoparticles

Lopez. J, Mehrvar. M, Quinones. E, Suarez. A, Romero. C.

***Abstract*—**The Silver Nanoparticles (AgNP) are used as deliver of heat on surface of Membrane Distillation in order to fight against Thermal Polarization and improving the Desalination Process. In this study AgNP were deposited by dip coating process over PVDF, FG hydrophilic and PTFE hydrophobic commercial membranes as substrate. Membranes were characterized by SEM, EDS, contact angle, Pore size distribution and using a UV lamp and a thermal camera were measured the performance of heat deliver. The presence of AgNP 50 – 150 nm, and the increase in absorption of energy over membrane were verified.

***Keywords*—**Silver Nanoparticles, Membrane Distillation, Plasmon effect, heat deliver.

Lopez, J. Author is with Universidad Nacional de Colombia, Chemistry Dept. Bogota Campus, (phone: +1 416 5200949; e-mail: jalopezne@ unal.edu.co).

Mehrvar, M., Author is with Ryerson University, Chemical Engineering Dept. Toronto, Canada. (e-mail: mmehrvar@ryerson.ca).

Quinones, E. Author is with Universidad de Cartagena, Civil Engineering Dept, Cartagena, Colombia (e-mail: equinonesb@unicartagena.edu.co).

Carmen, C. Author is with Universidad Nacional de Colombia, Chemistry Dept. Bogota Campus, (e-mail: cmromeroi@ unal.edu.co)

Research on the Effects and the Solution on Earthquake

Ashique Khetani, Mishlin Meghani

***Abstract*—** In the following paper we check out the effects of earthquake and the solutions researched by the authors in recent years. We will also glance on the effects which are present in these days and try to focus on them. So, the main effects caused of earthquakes are ground shaking, ground rupture, landslides, tsunamis and many more. Till date we can see if there is any solution that is seismic motion parameter. Which is used to predict the ground motion and to save from future earthquakes. We will give a brief glance on this device, which was invented by John Milne and his associates in Japan.

***Keywords*—** effects, solutions, device, parameter.

Mishlin Meghani is with the Anurag University, India (e-mail: mishlineghani@gmail.com).

Clicking Based Graphical Password Scheme Resistant to Spyware

Bandar Alahmadi

Abstract—The fact that people tend to remember pictures better than texts, motivates researchers to develop Graphical Passwords as an alternative of textual password. Graphical passwords as such were introduced as a possible alternative to traditional text passwords, in which users prove their identity by clicking on pictures rather than typing alphanumerical text. In this paper, we present a scheme for graphical password that is resistant to shoulder surfing attack and spyware attack. The proposed scheme introduces a clicking technique to chosen images. First, the users choose set of images, the images are then included in a grid where users can click in the cells around each image, the location of the click and the number of clicks are saved. As a result, the proposed scheme can be safe from shoulder surface and spyware attack.

***Keywords*—**Security, password, authentication, attack, applications.

I. Introduction

A picture is worth a thousand words, this confirms the fact that people tend to understand and remember pictures better than the texts; a psychological study supports such assumption [1]. Mainly, this is the basic idea that motivates some researchers to develop graphical passwords.

Recently, having a secure password has been an important issue. This is because of the big advances that have taken place in the use of computers in many applications such as that of data transfer, sharing data and logins to emails, the internet or bank accounts. The problem is that users tend to choose passwords that can be easy to remember and recall, like their names and date of birth, and they use those passwords for every account they have. This makes breaking into that particular password very easy on the part of the hacker who can use list of the words in dictionary and try to figure out them, and he/she can attack more than one account.

According to Alsuliman and El Saddik [2], an experiment was conducted by Klein who examined 15,000 accounts that had "alphanumerical passwords", in which he could guess 25% of passwords using a small dictionary, in the first 15 minutes he could guess 368 passwords, and in the week he could guess 21% of the passwords. Klein conducted his experiment in 1990, and at the time, computer technology and processing were not as advanced as it is now. Therefore, users have the challenge of choosing the password that is easy to remember and one that is difficult to be guessed, which is difficult to be applied in textual password. Thus, an alternative solution to the textual password has been introduced, in the form of a graphical password based on the use of graphics instead of texts. When a user creates an account, they can choose some pictures as their password; thus, instead of using words or numbers to access their account, a user can click on the pictures that they chose. These pictures are their password.

Even though most of graphical password techniques are more secure than textual passwords, they are vulnerable to some password attacks. In this paper, we present a graphical password scheme that is resistant to most of password attacks, especially to shoulder surfing attack.

This paper is organized as follows: First we will give the background of some common password attacks and then we will go through some of previous works on the graphical password, after that, we will explain our method and finally we will analyze the proposed method and show how it is secure.

II. Previous Work

A. Passface

Passface is one of the recognition-based mechanisms and the main objective here is to ensure that the user will be able to login to the system based on some object that has been presented to them. This was a system that was first developed by Real User Corporation [8].

The goal was to give users a number of faces from a selected database and the users will choose four faces that will then act as their password in the near future. During the authentication level, the users will be asked for their username credentials, then, they will be presented with nine faces where the goal is to select the particular face that they had previously selected as the password for themselves. This will be repeated four times until the users choose their four faces password. The user will only be provided with the authentication to the system when they selected the right faces. However, the passface method is vulnerable to shoulder surfing attack and guessing attack because the users tend to choose the faces that are easier to remember.

B. Jansen Technique

This system aimed and was designed to be used for mobile systems such as that of a cell phone rather than a regular computer terminal. This system takes a given image and breaks it down into a 30 thumbnail images. Then when the user registers, he/she chooses several of the thumbnail images. The sequence of his/her choices is the user's password. Then, in the authentication process, the user would choose his/her thumbnail images in sequence [9], [10].

Bandar Alahmadi is with the Ministry of Education, Saudi Arabia (e-mail: balahmadi@hotmail.com).

This technique is vulnerable to shoulder surfing attack because the attacker can know which thumbnail images the user clicked.

C. ImagePass Technique

This is yet another type of a recognition-based system that is being used today. The main aspect of the imagePass [11] is sort of similar to the one presented in passface. What often happens is that the person will be given a number of images in a 4x3 grid which contains the user's images and other fake images, and the user will then have to click and select the images in the right order and sequence. Only after that step has been accomplished would they then be given access to that particular system. The problem of this technique is that the attacker can know the password by shoulder surfing attack in which the attacker can see the password over the shoulder of the user in authentication phase. This attack can happen when the attacker is physically exist with the user.

D. PassPoint Technique

Like the other types of techniques that have been talked about, Passpoint is also one that is becoming more usable. This was one of the techniques put forth by Wiedenbeck [12]. Instead of having many images, here the user will be given only one image, in which they then choose a place on that image by clicking on it. The system will then compute a tolerance amount based on the selected pixels by the user. Later on during the actual authentication process, the user will be asked again to click within the limits of that tolerance level that was earlier computed for them and upon having the right type of sequence would they then be given access to the system authentication. The main advantage of using such system is that it has a large password space as an image can have many places that the user can select. As with the previous techniques mentioned, this method is vulnerable to shoulder surfing attack.

III. Method

A. Existing System

1. Shoulder Surfing

As the name suggests, this is the type of hacking mechanism where the potential hacker will try to learn a person's password by simply looking over the user's shoulder when they log in [3].

There are a number of places that are more prone to shoulder surfing, these included crowded cafes and restaurants as well as places like ATM machines. In such places, it is important that users be very vigilant and careful about one's surroundings [4].

2. Brute Force Search

One of the mechanisms that a potential hacker might resort to is that of the use of the brute force method. In this case, an attacker will first generate some type of an algorithm that will then be used to come up with a number of combinations of words to detect the correct user password. Mainly, text-based passwords often have up to 94^n space in them (such that 94 is the number of characters and n is the length) [5]. Thus, the attacker can successfully generate that many combinations for the text password to break it. Therefore, to solve this problem the users usually are encouraged to use longer password and more challenging passwords.

In essence, the practical advice that is given to users is that their password should have different combinations of letters, numbers and symbols, so that it is not easily able to be hacked by brute force attacks. Graphical passwords techniques proved that they have larger password space than that of the text-based passwords [4]-[6] and so have good resistance to this kind of attack.

3. Dictionary Attacks

Dictionary attack is the mechanism where a potential attacker will first utilize a number of words from the dictionary to check if a user has used them as a password. What often happens in this case is that the attacker will end up resorting to the use of some type of brute force methodology to carry out their attack [7].

By the same token, one also needs to take into account that graphical passwords are often based on the use of mouse input instead of keyboard input, such types of attacks would be very hard to carry out against graphical password [4].

4. Spyware

One of the key tools that the hackers tend to use from time to time is known as the spyware. Here, the hacker will try to first install the spyware on the user's computer and then record the data that are being received and sent. In this case, mouse movements will also be recorded. Also, all the changes in the user computers including the password change and the data will be sent to the hacker without user knowledge [6].

Again, what one comes to see is that a text based password might be easier to hack by spyware tool comparing to the graphical based password. This is because graphical passwords are often based on movements of the mouse which are, even if recorded, inputs that are often hard to track and identify.

5. Guessing

As the name suggest, in this type of attack the potential hacker will simply try to guess the password of a user. The hacker might guess the passwords based on the users' private information such as their date of birth, house number, phone number and so forth [4]. So when it comes to guessing, it is more important than ever to ensure that users do not choose a weak text based password that is very easy to be guessed.

From the previous analysis, we can conclude that breaking graphical passwords using traditional passwords attacks is more difficult than for text-based passwords. Moreover, just few of graphical password techniques are considered to be resistant to shoulder surfing attacks. Therefore, developing a new technique is needed to overcome these kinds of attacks. The proposed method in this study is designed to be resistant to shoulder surfing attack.

The proposed scheme is designed to solve the problems of other graphical password schemes, such as shoulder surface attack. The idea of clicking graphical passwords is borrowed from chess. In chess, every piece must move in particular steps and directions. However, in clicking a graphical password, the user will choose images (which will work chess piecese) and

choose how every image will move (clicking on the cell around the image). The user will choose M images on the registration phase and only N images will be shown on the authentication phase.

There are two phases: Registration and authentication.

B. Clicking Graphical Password

1. Registration Phase

The user will be asked to enter their user name, and then choose the number (M) of images that will form a password; the user will choose how many random images (N) of the chosen images appear in the authentication phase.

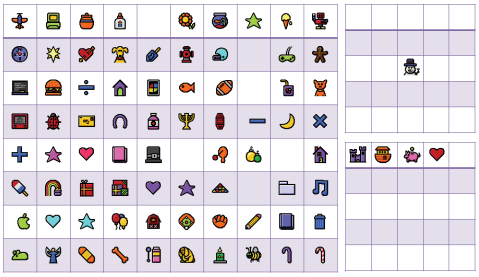

Fig. 1 Registration phase

As can be seen in Fig. 1, there are a lot of images in the left side, and on the right side, there is a grid and a table that shows the user's choices. The user chooses any images from the left side, which are then placed in the grid on the right side. Then, the user clicks on the cells around the selected image. The user decides on the number of clicks they want to include in the password. The selected images are then inserted into another grid and ordered based on their priority (lower right grid in Fig. 1). The image that the user chooses first has a higher priority than those selected next, and so on. Therefore, during the authentication phase, the user would choose images in the order of their priority.

2. Authentication Phase

After entering the user name, the user would be required to enter a graphical password. A very large grid with a lot of images will be shown (Fig. 2), not all images in the grid are part of the user password; only N of user's images that they choose during registration will be shown on that grid. The user will then select the images and should include the clicking that is corresponding with each image that they chose during registration. The clicking of each image could be on the image itself or on the cells around the image even if the cell contains another image. The user first should click on the image that has a higher priority and then click the corresponding clicking with that image, and so on for the N images.

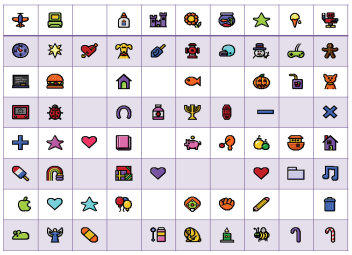

Fig. 2 Authentication phase

3. Implementation

There are three tables in the database. The first table (images) consists of the images. The second table (User) stores the user name, the number of images (M), and the length of the password (N). The third table (imageUser) stores the user ID and the corresponding images. The last table (Moves) stores the clicks and the location of those clicks for each selected image. Fig. 3 shows the relationship between these tables. As it can be seen, "user table" link the "clicks table" and the "user image table", such that each user has images and clicks corresponds with the image. Image table links the user image with the click table, such that each image has clicks corresponding with.

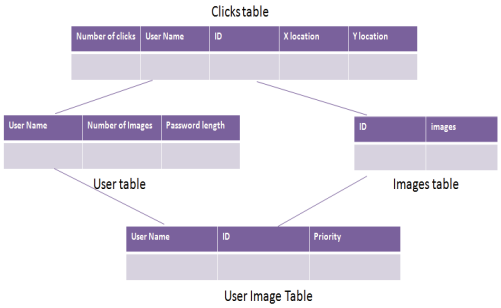

Fig. 3 Database

IV. Analysis

The idea of raising the security is not to make the password impossibly broken, but to make this procedure as difficult as possible. One problem that was not solved by other graphical password schemes was the shoulder surfing attack. In such an attack, the user's authentication session can be observed, a potential hacker can learn a password by simply observing which images the user chose. However, in the clicking graphical password, it is hard to know the password even if there was a observing, and this happens because of two reasons.

First, besides choosing the images, the user can include clicking with each image. Therefore, even if there was a shoulder surface attack, the hacker may know the images that the user chose, but it is still difficult to know how many clicks that the user inserts in each cell. Moreover, when the user clicks on the cells around the image, they may click on a cell that already has an image, so if a hacker was observing, they may think that this image is one of the password images.

The second reason that makes breaking such passwords difficult is that each time the user enters the system there will be different images representing their password; this is because

the user has M images as a password and only N random images are shown every time. Moreover, these N images have different priorities, and the user needs to choose the images according to their priority. Therefore, a hacker would need to closely observe the user has selected, as well as their order of priority, and this is not easy problem, because it is difficult to have a lot of observing. Clicking the password, the observer can easily remember the password later.

TABLE I
SECURITY ANALYSIS OF TEXTUAL PASSWORD AND MAJOR GRAPHICAL PASSWORD TECHNIQUES AGAINST COMMON PASSWORD ATTACKS

Techniques		Common Passwords Attacks				
		Shoulder surfing	Brute force	Dictionary	Spyware	Guessing
Textual Passwords		✓	✓	✓	✓	✓
Graphical Passwords	PassFace	✓	✓	✓	×	✓
	Jansen	✓	✓	×	×	-
	ImagePass	✓	-	-	×	-
	PassPoint	✓	×	-	×	×
	Proposed Method	×	×	×	×	×

In Table I, we evaluate the security of some major graphical password techniques against the most common attacks as well as the security of the proposed method. We can see that the method is not vulnerable to the most common password attacks.

The proposed scheme solves a very important problem which is shoulder surfing attack. However, there are some drawbacks which may be solved in future work.

The graphical password is used to solve the problem of forgetting passwords and gives the user more freedom to choose a complicated password instead of one that is easy and vulnerable to attack. However, in the proposed graphical password scheme, a user would still need to remember the number of clicks and the position of those clicks, which is an aspect of this method that can be considered a difficult to remember.

However, it should be considered that the users have a freedom of choosing how many clicking around their images depending on how the important is the security of that application, and they still can make it not complicated by including only one click. It will be still difficult to hacker to break such password because the hacker still cannot differentiate between clicks and choosing images as clicking can be over other image. However, users can make their password more secure by including more clicks on their images to make it more difficult for a hacker to break.

V. CONCLUSION

Graphical password is a technique in which the password is looked at from different perspective. The password has always been known as a text which consists of words, numbers, and/or symbols, but not pictures. However, instead of using texture, in graphical password, the user can have pictures as a password. As users can remember the pictures better than words, it is easier for the users to create a password that is easy to remember and hard to be guessed.

Many graphical password schemas have been proposed, but most of them did not solve the problem of shoulder surfing attack. Therefore, if there was a recording in the user computer, the attacker can easily observe the authentication process and he/she can know the password. observing is much easier in the graphical password as the password can be easy to remember, so if there was someone who observes the user when he/she the authentication sessions in order to determine the M images

The proposed graphical password tries to solve this problem by including clicks in the chosen password pictures. The users can choose their pictures and include image clicks in the registration phase. Each one of the chosen pictures has a priority that the users should remember in order to choose the picture in order in the authentication phase. In the authentication phase, a lot of pictures will appear and only some random of the user pictures will be there. The users should choose their pictures in order of their priorities. Therefore, proposed graphical password is hard to be attacked as the users choose many pictures and only some pictures of chosen pictures appear in the authentication process

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Automatic Detection of Suicidal Behaviours Using an RGB-D Camera: Azure Kinect

[1]Maha Jazouli

[1] Cilex, Language Technology Research Center, CANADA
Email: [1]maha.jazouli@cilex.ca

Abstract: Suicide is one of the most important causes of death in the prison environment, both in Canada and internationally. Rates of attempts of suicide and self-harm have been on the rise in recent years, with hangings being the most frequent method resorted to. The objective of this article is to propose a method to automatically detect in real time suicidal behaviors. We present a gesture recognition system that consists of three modules: model-based movement tracking, feature extraction, and gesture recognition using machine learning algorithms (MLA). Our proposed system gives us satisfactory results. This smart video surveillance system can help assist staff responsible for the safety and health of inmates by alerting them when suicidal behavior is detected, which helps reduce mortality rates and save lives.

Keywords: suicide detection, kinect azure, RGB-D camera, SVM, gesture recognition.

1. INTRODUCTION

Suicide attempts are one of the main problems faced by correctional services worldwide. Even beyond the prison environment, such attempts represent a growing concern. Every year, a total of about 25 million attempts are recorded according to the Center for Disease Control and Prevention, the World Health Organization [1]. To address this problem, various technologies have been proposed to detect indicators that can be used for prevention.

The main objective of this article is to design and develop an intelligent system for the monitoring of life signs and behavioral patterns of prison inmates with built-in detection capability for attempts of suicide and self-harm.

Methodically, the paper is divided into five sections. Firstly, we will review the previous work on automatic recognition of gestures using RGB-camera. While proposed solutions for implementing our method appear in Section III, and experiments results aimed at evaluating the efficiency and the robustness of our system will be the focus of Section IV. We conclude the paper in Section V.

2. RELATED WORKS

The medical sector offers more and more technical solutions based on the digital acquisition of video sequences. The clinical psychology area is focused on the detection and analysis of human behavior through computer vision.

Recognizing behaviors and predicting people's activities from video are major concerns in the field of computer vision. Dang et al. [2] present an interesting survey on human activity recognition (HAR) methods, which are divided into two groups: sensor-based HAR and vision-based HAR. Furthermore, activity recognition systems are more and more interested in activity recognition based on skeletal data. Ashwini and Amutha [3] propose an activity recognition system using a Kinect sensor. The general contribution of their work is in recognizing human activities using Kinect and machine learning algorithms. The proposed method is tested on the most popular KARD (Kinect activity recognition dataset) and an SVM (support vector machine) classifier is used to classify the dataset. The Microsoft Kinect sensor has become very popular for its effortless operation and low cost.

In this work, our goal is to set up an intelligent video surveillance system that can help detect in real time the suicidal behavior of prisoners. Some technologies have been developed to detect suicides based on artificial intelligence. The use of machine learning can help reduce the incidence of death by suicide. On the one hand, most recent work is interested in the detection of suicide prevention based on a patient's psychological record [4]-[8]. On the other hand, studies have been done on the detection of suicidal behaviour based on sensors. In the literature, we find few works that address the issue of recognizing suicidal behavior in real time.

Graichen et al. [9] was one of the first groups to propose a monitoring system capable of identifying suicide attempts. The authors proposed a wall-mounted system that could continuously track the heart rate, respiration, and movements of the inmates with alarm functionality. The proposed system consisted of an off-the-shelf Doppler radar used for home security and modified to detect chest movements. Convulsions and a slowing rate of the heart were proposed to be indicative of asphyxiation. However, the system was not automated and therefore required user intervention for operation, which was claimed to have 86% precision.

Lee et al. [10] propose a system to detect and prevent hanging attempts. Their approach is based on a 3D camera being used to identify the behavior. By using a random forest classifier, their system can detect hanging suicide attempts with more than 95% accuracy.

Chiranjeevi and Elangovan [11] present a system based on a deep learning concept with the help of self-organized mapping, which is used to extract features after videos are captured from surveillance cameras. This proposed system will provide more efficient results in predicting hanging attempts when compared to the traditional methods.

Bouachir et al. [12],[13] present a system for detecting suicide attempts by hanging in prisons. Their approach is based on modelling suicidal actions through pose and motion features. They propose a computer vision system using depth images provided by an RGB-D camera (Kinect V2) to identify the 3D locations of joints. Their system presents a binary classification on a single observation of "suicide" or "unsuspected" behavior based on an LDA (Linear Discriminant Analysis) classifier [14],[15].

Main de Boissière [16] presents, in his thesis work, a study on behaviors and potentially deadly events in prison using video analysis. He proposes a method of human activity recognition by artificial intelligence based on a deep learning architecture, combining infrared video with 3D pose data. He evaluates the performances of his model on the NTU RGB+D and PKU-MMD datasets.

We can summarize that, suicidal behaviors system can be divided into three stages: (i) monitoring and gesture detection (ii) gesture feature extraction. (iii) gesture classification. In this article, were interested to automatically detect five suicidal behaviors: hand to neck standing, hand to neck sitting, self-cut standing, self-cut sitting, standing on chair with hand to neck) in real time by proposing a method that gives good results.

3. PROPOSED APPROACH

The objective of this work is to recognize and monitor the behavior of self-stimulation observed by imprisoned person. Our system presents new methodology to automatically detect five suicidal behaviors: hand to neck sitting, hand to neck standing, self-cut sitting, self-cut standing, standing on a chair. We propose to automatically detect suicide in real-time using the azure Kinect sensor.

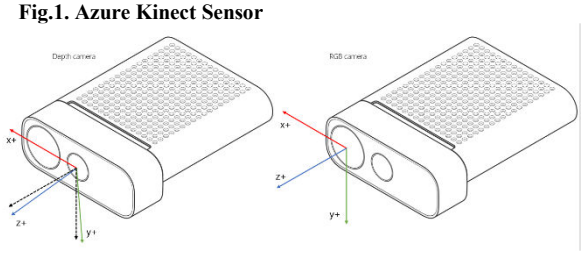
We present a gesture recognition system, which consists of three modules: model-based gesture tracking, feature extraction, and gesture recognition using machine learning algorithms (Fig.3). The first one uses three azure Kinect sensor, the second one chooses points of interest from the 3D skeleton to characterize the gestures, and the last one proposes different machine learning algorithms (MLA) for classification of data.

The proposed project aims to combine parameters from three different sensors of the kinect azure camera, in order to detect and recognize suicidal gestures.

3.1. Extraction features

In order to acquire motion data, in this research, we use 3D skeleton model information generated from azure Kinect sensor Fig. 1. The position and orientation of each joint form its own joint coordinate system. All joint coordinate systems are absolute coordinate systems relative to the depth camera 3D coordinate system.

Fig.1. Azure Kinect Sensor



The raw data taken from the Azure Kinect sensor corresponds to the X, Y and Z coordinates of the joints. The azure kinect SDK provides us with a set of APIs that allow easy access to the skeleton joints. The SDK supports the tracking of up to 32 joint points. Each gesture is characterized by a sequence of joints movements (Fig.2) [17],[18].

We have built our own dataset because there are no publicly available datasets for suicidal gestures. It consists of ten individuals imitated suicidal gestures: hand to neck sitting, hand to neck standing, self-cut sitting, self-cut standing, standing on a chair. Each person was asked to make each gesture 10 times. This gives us a database of 500 gestures. Data has been divided as follow: 70% for the learning phase and 30% for the test.

Table 1 The desired output vector for each of the 5 classes.

Class	Denomination	Desired outputs
1	hand to neck sitting	(1, 0, 0, 0,0)
2	hand to neck standing	(0, 1, 0, 0,0)
3	self-cut sitting	(0, 0, 1, 0, 0)
4	self-cut standing	(0, 0, 0, 1, 0)
5	standing on a chair	(0, 0, 0, 0, 1)

Fig.2. Points tracked by the Azure Kinect sensor.

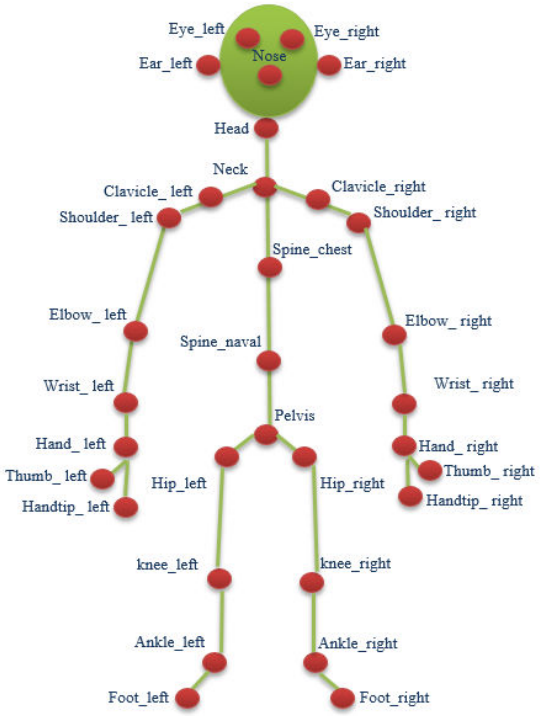
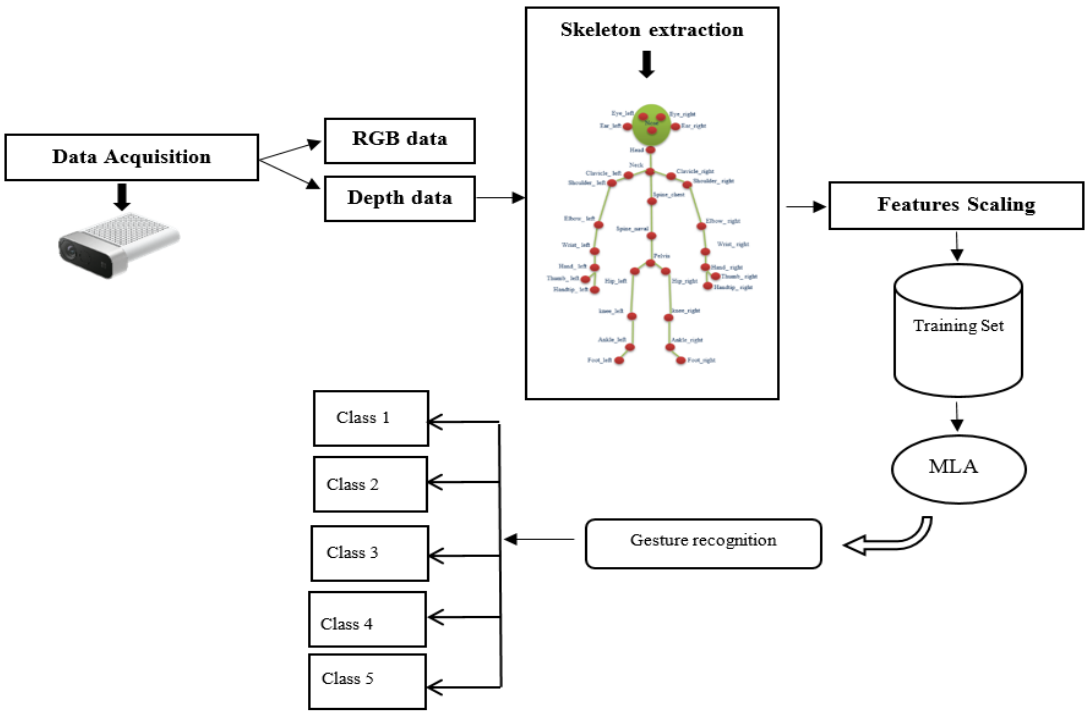


Fig. 3. Global architecture of our system.



3.2. Machine learning for gesture recognition

We have tested our system with several machine learning algorithms: Adaboost (Adaptive Boosting), SVM (support vector machine), and DT (Decision Trees). The experimental results show that our system can achieve above 93.9% recognition rate. The best results are obtained by the SVM algorithm (Table 2).

The figure below (Fig.4.) presents the obtained recognition rates in real time using SVM algorithm to classify each gesture: hand to neck sitting, hand to neck standing, self-cut sitting, self-cut standing, standing on a chair.

Fig. 4. Classification rates in real time using SVM algorithm to classify each gesture.

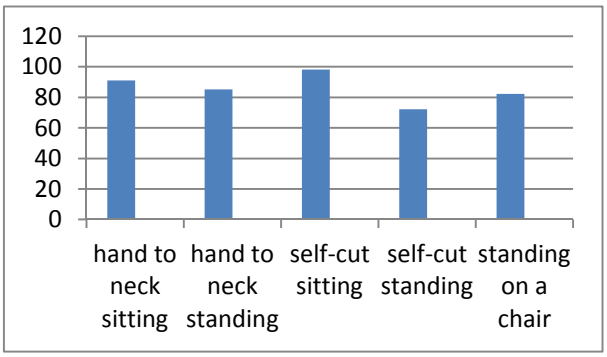


Table 2 Classification rates for five suicidal gestures of different MLA.

	Adaboost	SVM	DT
Rate of recognition	85.8%	93.9%	80.4%

Table 3 Confusion matrix using SVM

algorithm.

Class	1	2	3	4	5	Error Rate
1	30 20.0%	0 0.0%	3 2.0%	0 0.0%	0 0.0%	90.90% 9.1%
2	0 0.0%	32 21.33%	0 0.0%	1 0.66%	1 0.66%	94.11% 5.89%
3	3 2.0%	0 0.0%	24 16.0%	0 0.0%	0 0.0%	88.88% 11.12%
4	0 0.0%	1 0.66%	0 0.0%	33 22.0%	0 0.0%	97.05% 2.95%
5	0 0.0%	0 0.0%	0 0.0%	0 0.0%	22 14.66%	100% 0.0%
Error Rate	90.90% 9.1%	96.96% 3.04%	88.88% 11.12%	97.05% 2.95%	95.65% 4.35%	93.9% 2.5%

CONCLUSIONS

In this paper, we have proposed an approach to detect in real time the suicidal behaviors using three Kinect azure sensor and MLA algorithms. The system recognizes in real time five suicidal gesture: hand to neck sitting, hand to neck standing, self-cut sitting, self-cut standing, standing on a chair. The system detects 93.9% of the suicidal gestures, which are satisfactory results compared to literature.

For future work, it is important to recognize that the detection rate of false positives and false negatives is critical to ensuring system reliability and performance. In particular, the goal of achieving a low or zero rate for false negatives is paramount for the safety of inmates as well as the uptake of the system by potential users. Also, we consider that is necessary to build a bigger database with different ages and ethnicities of people and we need an exhaustive analysis of suicidal gestures.

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Factor Neural Document Model for Processing Transcription Factors

Liang Li
Vinolake LLC.
Mission Viejo, USA
liangli23348@gmail.com

Robin Wang
Dept. of Computer Science
University of California at Ivivine
San Diego, USA
luobinwang@uci.edu

Jing Zhang
Dept. of Computer Science
University of California at Irivine
Irivine, USA
jingz31@uci.edu

***Abstract*— Factor-NVDM, deep generative models, is described in this paper, including the strengths of Variational Autoencoders (VAEs) and generative adversarial networks (GANs) to sample from disentangled representations without sacrificing data generation quality. This model have achieved remarkable successes in generating and manipulating high dimensional biological Chip-seq TFs documents. VAEs excel at learning disentangled document representations, while GANs excel at generating realistic weights on genes distribution. Here, we systematically assess disentanglement and generation performance and find that these strengths and weaknesses of VAEs and GANs apply to process Transcription Factor data in a similar way. Factor-NVDM allows us to manipulate semantically distinct aspects of cellular identity and analysis genes responses to interference.**

Keywords*— *Variational Autoencoders (VAEs), Generative adversarial networks (GANs), Disentangled representations, t-SNE, Transaction Factor, Genes

I. INTRODUCTION

The two most widely used types of deep generative models are variational autoencoders (VAEs) and generative adversarial networks (GANs). The state-of-the-art deep learning techniques, such as generative models can generate realistic data, documents and images from low-dimensional latent variables [1]. The generated data, and documents are often nearly indistinguishable from real data, and data generating performance is rapidly improving.

VAEs use a Bayesian approach to estimate the posterior distribution of a probabilistic encoder network, based on a combination of reconstruction error and the prior probability of the encoded distribution.

The representation on low-dimensional latent space of big data can be constructed with the major features and statistic characters of raw big data. And, some critical features of big data are determined smartly from samples of latent topics distribution.

In contrast, the GAN framework consists of a two-player game between a generator network and a discriminator network [2]. GANs and VAEs possess complementary strengths and weaknesses: GANs generate much better samples than VAEs, but VAE training is much more stable and learns more useful "disentangled" latent representations [3].

A new deep learning model is named as Factor Neural Document Model (Factor-NVDM), and its unsupervised training procedure are proposed. Neural Document Model (NVDM) is one deep learning platform of VAE, innovated by Yishu Mao [4].

In this paper, we systematically assess the disentanglement and generation performance of deep generative models on Chip-seq Transcription Factor (TF) data. These data are the measured expression of genes for each Transcription Factor. The function of TFs is to regulate—turn on and off—genes in order to make sure that they are expressed in the right cell at the right time and in the right amount throughout the life of the cell and the organism.

We show that the complementary strengths and weaknesses of VAEs and GANs apply to TFs data. And Factor-NVDM model combines the strengths of VAEs and GANs to sample from disentangled representations without sacrificing data generation quality.

We employ Factor-NVDM and other methods on simulated Chip-seq data and provide quantitative comparisons through several disentanglement metrics.

II. FACTOR-NVDM FRAMWORKS

A. Factor-NVDM Architecure

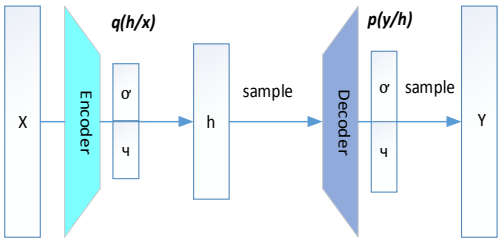

*Figure 1 Variational Autoencoder (**VAE**) neural architecture*

VAE inherits autoencoder architecture, but make strong assumptions concerning the distribution of latent variables. Autoencoder maps big data x on multiple hyperplanes to limited topics on principal hyperplanes. The valued features are abstracted easy from these topics. Thus, rather than building an encoder which outputs a single value to describe each latent state attribute, VAE encoder describes a probability distribution $q(h/x)$ for each latent attribute.

Neural Document Model (NVDM), one remark model of VAE architecture, contributed advantages of (1) simple, expressive, and efficient when training with the SGVB algorithm; (2) suitable for both unsupervised and supervised learning tasks; and (3) capable of generalizing to incorporate any type of neural network. In general, NVDMs learn semantically disentangled representations, but may generated samples of distribution are 'blurry".

Here, innovative Factor-NVDM architecture is drawn on **Error! Reference source not found.**. Factor-NVDM adopts NVDM model as core VAE processing platform. The critical part is to add Generative Adversarial Networks (including one discriminator and as one generator (VAE decoder)), which is objective with a penalty that encourages the marginal distribution of representations to be factorial without substantially affecting the quality of reconstructions on decoder [5] .

The Discriminator architecture of Factor-NVDM is drawn on Figure 3. The basic core is still MLP architecture. The activation is Leaky_relu( ) function The discriminator receives the real samples of topic distribution and permuted samples from latent space.

B. Deep Learing procedure for Factor-NVDM platform

Deep-learning procedure is in two stages:

- First, training a VAE core to learn a disentangled representation.
- Second, adopting the VAE encoder's latent representation $\boldsymbol{h}$ for each cell x as a given code and train a conditional GAN using the ($\boldsymbol{h}$, $\boldsymbol{x}$) pairs.

After training, generate high-quality samples from the VAE's disentangled representation. Importantly, the training is no less stable than training VAE and GAN separately, and the GAN generation quality is not compromised by a regularization term encouraging disentanglement. The detail data processing is as:

- The data X are formatted as document and are input on encoder. Let $\boldsymbol{X} = \{\boldsymbol{x}^{(i)}\}_{i=1}^{N}$ denote a dataset consisting of N documents.

- We assume each input document $\boldsymbol{x}$ is generated from a conditional distribution with K underlying independent features, so we designed an unsupervised generative model aims to learn a continuous latent representation $\boldsymbol{h} \in \mathbb{R}^K$ to capture these invariant properties.

- The encoder is one nonlinear Multilayer Perceptron (MLP) Network. The outputs from the trained MLP are called Topics of the document $\boldsymbol{X}$.

- On latent layer, one elated topic distribution $q_\varphi(\boldsymbol{h}|\boldsymbol{x})$ is generated, which denoted as a probabilistic encoder that extract the stochastic latent variables from input documents.

- The decoder is one Multilayer Perceptron (MLP) Network too. The output of decoder is one distribution sample array $\boldsymbol{y}$, which approach original data x array statistically. The statistics is indicated as one post distribution$p_\theta(\boldsymbol{y}|\boldsymbol{h}) = \prod_{j=1}^{M} p_\theta(y_j|\boldsymbol{h})$.

- Encoder and decoder are parameterized by φ and θ accordingly. φ is the coefficients of encoder; and θ is the coefficient of decoder.

- During the training procedure, the latent continuous variable $\boldsymbol{h}$ can be sampled from distribution $q_\varphi(\boldsymbol{h}|\boldsymbol{x}) = \mathcal{N}(\boldsymbol{h}|\boldsymbol{\mu}(\boldsymbol{x}), \boldsymbol{\sigma}^2(\boldsymbol{x}))$, where the mean and variance are produced by the encoder. Encoder takes each input document $\boldsymbol{x}$ produces its own parameters $\boldsymbol{\mu}$ and $\boldsymbol{\sigma}$ that are used to sample a latent representation $\boldsymbol{h}$ from the conditional probability $q_\varphi(\boldsymbol{h}|\boldsymbol{x})$. The parameterized latent semantics $\boldsymbol{h}$ allows us to apply backpropagation and optimized the lower bound $\mathcal{L}$ w.r.t. φ and θ.

- Having access to samples from both distributions allows us to minimize their KL divergence using the *density-ratio trick* [6] which involves training a discriminator to approximate the density ratio that arises in the KL term.

C. Object and Totoal_correction

The leaning procedure of Factor-NVDM is distinguished on its *object and Loss* functions. One *Total_Correction* item is added to original object of training NVDM as:

$$Object\ of\ Factor\ NVDM = Object\ of\ NVDM + Total\_Correction \quad (1)$$

Total_correction is for assessing the accuracy of latent space arithmetic for a particular held-out cell type/perturbation combination.

1

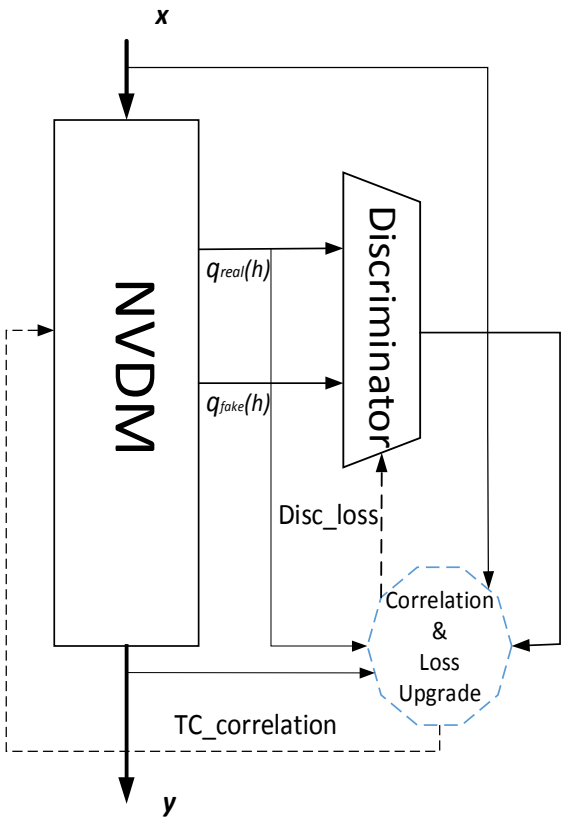

Figure 2 Architecture of Factor NVDM

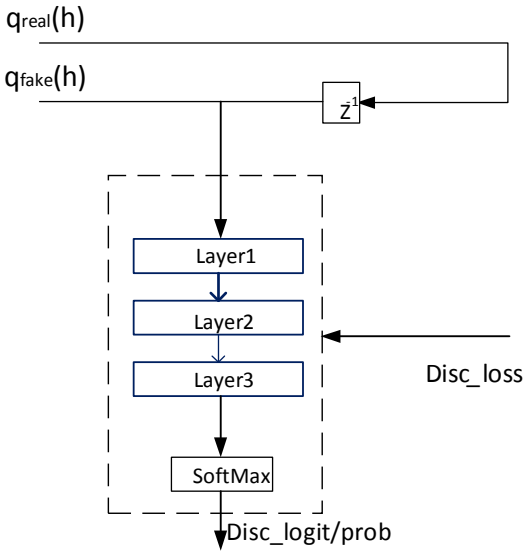

Figure 3 Discriminator Architecture

Total_correction is original from the difference of two cross entropies, $\Delta E = E\{q_{Fake}(h), p(h)\} - E\{q_{Real}(h), p(h)\}$, which are the entropies of the latent embedding for the held-out data, and for the latent values predicted by latent space. Here q_{Fake} is calculated by latent space arithmetic and q_{Real} is calculated using the encoder.

The quantity then gives a measure of how accurately latent space arithmetic predicts the latent values for the held-out data. Such as, if ΔE is positive, then the latent space prediction is less concentrated (and thus more uncertain) than the encoding of the real data.

In general, object of NVDM is defined as:

$$\pounds = \pounds_1 + \pounds_2 = \ddot{E}q_\varphi(h|x)[\sum_{j=1}^{N} log p_\vartheta(y|h)] - DKL[q_\varphi(h|X)||p(h)] \quad (2)$$

And, ***object of Factor-NVDM*** is formatted as:

$$\pounds = \pounds_1 + \pounds_2 + TC = \ddot{E}q_\varphi(h|x)[\sum_{j=1}^{N} log p_\vartheta(y|h)] - DKL[q_\varphi(h|X)||p(h)] + (-\gamma D_{KL}[q(\boldsymbol{h})\|\bar{q}(\boldsymbol{h})]) \quad (3)$$

Where: $\bar{\boldsymbol{q}}(\boldsymbol{h}) = \prod_{j=1}^{d} q(h_j)$, d is the dimension number of topic space.

The detail calculation, using the *density-ratio trick* [6], is as:

- *TC (Total_Correction)* is inference from above *(4)* as:

$$TC = \varphi \times \mathrm{E}(\sum_1^d (logit_t - logit_f) \quad (4)$$

where $logit_t$ = *output of discriminator on one end,* and $logit_f$ = *output of discriminator on other end*

- And *loss of discriminator* is also set as:

$$disc_{loss} = 0.5 \times (\mathrm{E}(\sum_{i=1}^{d} log(Dis_{real}(i))) + \mathrm{E}(\sum_{i=1}^{d} log(Dis_{permuted}(i))) \quad (5)$$

where $Dis_{real}(i)$ is sample of output distribution sample from discriminator for real topics and *$Dis_{prtmuyrf}$ (i)* is sample of output distribution sample fromdiscriminator for permuted topics

This *disc_loss* is applied to optimize discriminator in training procedure.

The summary of training discriminator is as:

Input: Chiq-seq data X

- Obtain disentangled representations ***h*** by training VAE.
- Utilize the representations ***h*** as codes.
- Train a conditional GAN using the codes.

Result: a generator network that produces high-quality samples from a disentangled representation

Factor NVDM could be design as one popular alternative to β-VAE with InfoGAN, which is based on the Generative Adversarial Net (GAN) framework for generative modelling.

InfoGAN learns disentangled representations by rewarding the mutual information between the observations and a subset of latent.

III. VALIDATION OF FACTOR-NVDM MODEL

A. *Data pre-processing and performance validation of Factor-NVDM*

The source data for validation is an amount of genome Transcription Factors (TF) experience documents from ChIP-seq experiments. TFs are proteins involved in the process of converting or transcribing DNA into RNA. And Transcription Factors help turn specific genes "on" or "off" by binding to nearby DNA.

Same as paper [4], the data file with 863 ChIP-seq experimental results for 387 TFs from the ENCODE portal for model training due to their high-quality control and consensus peak calling. In addition, we included ChIP-Atlas data collections with more than 6000 ChIP-seq experimental results to test the model. The number of target genes included in this dataset ranges from hundreds to thousands, and the TFs with the greatest availability among different cell lines include CTCF, EP300, MYC and REST. From each ChIP-seq experiment, the regulatory target genes of specific TFs are defined as those with ChIP-seq peaks in proximal regions (62500 bp) of their transcription start site.

For training Factor-NVDM, one TF under a specific condition (cell line or tissue) is as a 'document', with the TFs' target genes as 'words' and latent functional subgroups as gene 'topics' comprised these words. Figure 4 is a group of schematic diagrams of Transcription Factor pre-processing and encoded on latent space.

Figure 4 (a) described the TFs Data pre-processing. The test experience is organized in document matrix. Each TF (T1,…..,Tn) is as one document and linked to activated/non-activated genes in binary [0 , 1].

The training data matrix to a corpus including all of the regulatory networks inferred from 863 chromatin immunoprecipitation-sequencing (ChIP-seq) assays of the ENCODE dataset. Figure 4(b) describes the document matrix encoded on Factor-NVDM one by one.

Figure 4 (c) presents the desired topic distribution of each TF (T1,…..,Tn) on latent low-dimension space.

Here is one training example. The Factor-NVDF architecture is set as:

- NVDM Architecture: Hidden Neuron number: 1000; Batch Size: 64; latent level size: 50; Activation Function: tanh( ).

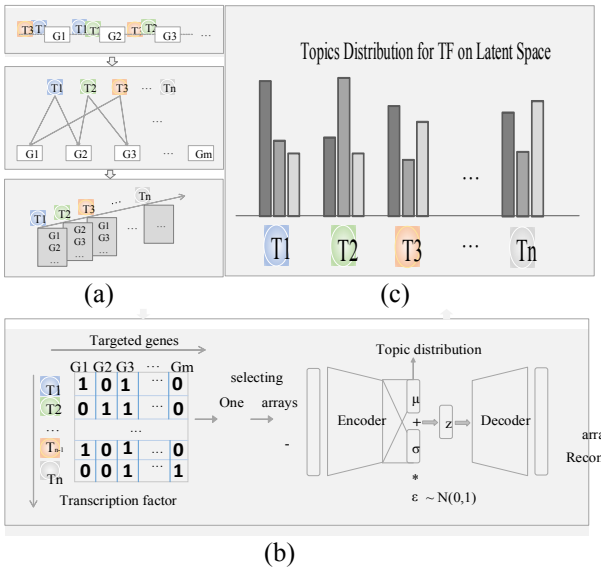

Figure 4 TF Data pro-processing and Encoding

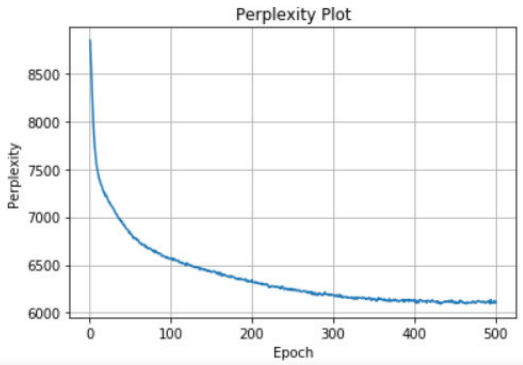

Figure 5 Convergent Plot in Factor-NVDM Training

- Discriminator architecture: 4-layer MLP layer (30 nodes per layer). The activation function is Leaky_relu( ).

An unsupervised learning is implemented,

- Source Data: edge_allencode.mat.txt, mentioned in last section (Data Pre-processing). Formatted as Raw data file: Vocab_size: 9000.

- Learning rate: Factor-NVDM: $5*10^{-5}$, and Discrimination: $1*10^{-5}$.

Figure 5 is the training divergence plot under above conditions. Factor-NVDM shows an excellent divergence in unsupervised training.

For different architectures (such as layers, hidden nodes and nonlinear activation function), and more, the training divergence plots and stability may be different. Especially, choosing suitable coefficients of GAN and learning rate could avoid the overfitting of Factor-NVDM training.

A nearly optimal discriminator is crucial for maximizing this mutual information, and we meet it by training the discriminator 30 times for every generator update. Second, the adversarial loss allows the decoder (GAN generator) to capture complex, multi-modal distributional structure that cannot be modeled by the factorized Gaussian distribution of the NVDM decoder.

B. Comparion of RCTC regission on various platforms

One serial of computing testing are organized to verify the effectiveness of topics on latent space, mapped by Factor-NVDM. Here, one Raw-data Correlation – Topic Correlation (RCTC) regression is one testing forum.

$$E[x \cdot x^T] \propto E[h \cdot h^T]$$

And, linear RCTC regression by Factor-NVDM are compared to ones with NMF clustering, K-means clustering, famous Latent Dirichlet Allocation (LDA) model, and original NVDM platform.

In these tests, six groups of 50 topics are mapped by NMF, K-means, LDA, NVDM and Factor-NVDM algorithm from same TFs data individually. Calculate the correlation of topics and ones of raw data, formed in last section. The raw data is still edge_allencode.mat.txt, in last section.

These NVDM, NME, K-means and LDA processing are adopted from scikit-learn project [7].

Figure 6 scatter pots show the correlation of topics from Factor-NVDM vs. correlation of raw data (grey block) and ones of K-means (red), NMF (blue), LDA (green) and NVDM (pink).

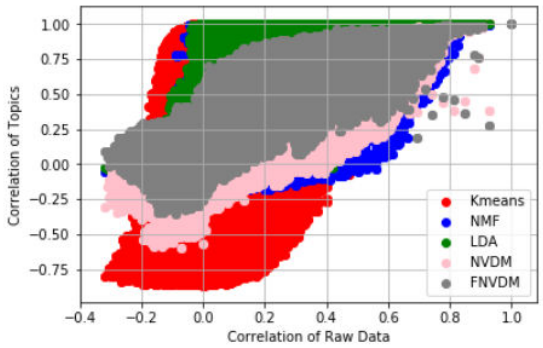

Figure 6 Linear Regression of Correlations

Table 1 lists the slope and R^2 score of RCTC regression for each platforms. In principle, for the same data set, higher R-squared values represent smaller differences between the observed data and the fitted values.

R^2 score from RCTC regression of Factor-NVDM is highest. It means the diversity on Factor-NVDM latent space to ones on raw data space is smallest.

And, by Factor-NVDM, the slope coefficient is 1.05. It indicates the correlation of topics and correlation of raw data kept excellent linearity.

Table 1 R^2 Scores and Slopes of RCTC regression on various models

Model	slope	R^2 score
K-means	0.7414	2.75%
LDA	1.8	43%
NMF	0.648	48%
VAE (NVDM)	1.11	58%
Factor NVDM	1.05	64%

C. Clustering on latent space

Here, one project of clustering TFs is implemented and compare the clustering TFs from raw data directly to the ones from topic samples obtained from Factor-NVDM

Figure 7 (up) shows clustering pots for five TFs (CTCF, ETH2, POLR2A and POLR2APHOSPOSS with raw TF data directly on T-distributed stochastic neighbor embedding (T-SNE).

Figure 7 (down) is T-distributed stochastic neighbor embedding (T-SNE) of the 50-dimensional representation demonstrated the topics from FNVDM to preserve similar clusters on T-SNE for these five TF (CTCF, ETH2, POLR2A and POLR2APHOSPOSS).

Figure 7 shows, even on latent space, the mapping topics by Factor-NVDM could be easy to keep the similar clustering characteristics implemented on raw data.

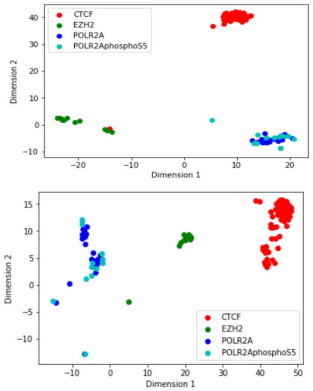

Figure 7 Clustering of TFs (up) from raw TFs data, (down) ones from topics on latent space

IV. DISCUSSION

The Factor-NVDM platform provides an alternative to the current disentanglement learning literature, which focuses on learning disentangled representations through improved VAE-based or GAN-based methods, but rarely by combining them.

Factor-NVDM effectively achieves our goal of sampling from a disentangled representation without compromising generation quality. In fact, such a combination of VAE and GAN approach is conceptually simple, there are several underlying reasons why it performs so well, and recognizing these led us to pursue this approach. This supports our hypothesis that accuracy of the latent space arithmetic influences Factor-NVDM performance.

Our works provide fundamental evaluations of disentanglement performances of Factor-NVDM models on Chip-seq TFs data.

We apply Factor-NVDM platform to analysis Chip-seq TFs documents and observe network rewiring score of TFs pairs and clustering TFs on latent space that helps us to determine whether a TF undergoes functional alternation across different cell lines.

For future work, we are going to apply Factor-NVDM platform to analysis Chip-seq TFs documents and observe network rewiring score of TFs pairs and clustering TFs on latent space that helps us to determine whether a TF undergoes functional alternation across different cell lines. Additionally, there are many other biological settings in which predicting unseen combinations of latent variables may be helpful, such as genes activation analysis or disease diagnose.

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A Hybrib Fingerprint Matching System with Minutiae-Based and Image-Based Methods

[1]Adekunle Adebola Olayinka, [1]OGUNSINA Foluso Fisayo ,[2]Ayo Femi Emmanuel and [3]ETESE, Oghenefego Anthony

[1]Department of Computer Science, Adeyemi College of Education Ondo, Nigeria.
[2]Department of Computer Science, Olabisi Onabanjo University Ago Iwoye, Nigeria.
[3]Physical and Computer Sciences Department McPherson University,Seriki Sotayo,Nigeria.
[1]adekunleao@aceondo.edu.ng
[2]ogunsinaff@aceondo.edu.ng
[3]Jazelogin@hotmail.com

ABSTRACT
The use of fingerprints for identity authentication is a popular mode of biometric authentication in modern society. Its use stems from the fact that no two fingerprints are exactly the same, therefore unique features from each fingerprints are extracted and used for matching purposes, where match accuracy is key. Fingerprint matching is performed mainly in two ways, using minutia-based and image-based techniques. Each technique has its own drawbacks, the minutia approach faces issues with fake minutiae in the image which leads to false or non matches and the image based techniques face high computational time which leads to slow processing. This research proposes a hybrid approach using both matching techniques, combining template matching to find the reference minutia in query image with minutia matching for obtaining match score. The template matching uses Speeded-Up Robust Features (SURF) algorithm for reference template selection and Zero Normalized Cross-Correlation (ZNCC) for locating the template. Selecting and using reference template images locates the reference minutia in the query image more accurately due to the small space and number of minutiae to scan and compare, rather than scanning the whole image, which involves several other minutiae similar to the reference minutia and is prone to errors. In the template matching, the rotation factor of the query to the enrolled fingerprint is obtained and used to rotate the query image. Experiments on a database of 20 fingerprints have shown that the ZNCC takes ~179s to find the template but the minutia extraction and matching are fast processes, the SURF algorithm selects poor templates, which lead to false matches and non-matches. A False Acceptance Rate (FAR) of 0.14 and False Rejection Rate (FRR) of 0.54 for the robust minutiae match was obtained. Results have shown that this approach is neither feasible for real time use in terms of time consumption and accuracy, and a better model of this approach using core detection has been stated which will improve the accuracy of this algorithm.

Keywords*: finger print authentication; minutiae-based method; image-based method; template matching*

Introduction

In this technologically driven century, reliable personal authentication is key to human computer interaction. Experts over the years have been researching into how to create a more robust and secure means of personal authentication. One mode of authentication that has been given a warm welcome by all and sundry is biometric authentication. Biometric authentication is a security process that uses the unique biological characteristics of an individual to verify whom he claim to be. A typical biometric authentication system compares physical or behavioral traits to authentic stored data in a database, and

if there is a match, authentication is confirmed. Biometric authentication system can be grouped as shown in figure 1:

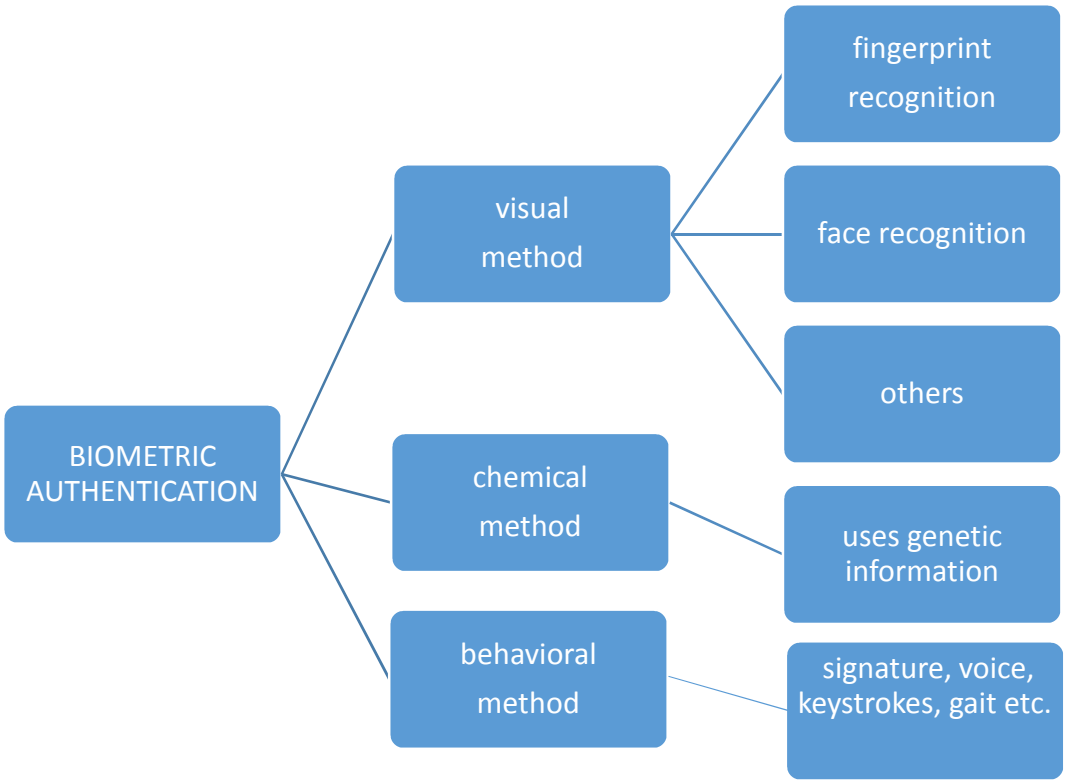


Figure 1: Biometric authentication methods (Source: field work, 2021)

Chemical biometric system uses genetic material to identify a person, Visual biometric system uses an individual physical characteristics such as retina scan, iris recognition, fingerprint, hand geometry, facial recognition for authentication and behavioral biometric system uses individuals' behavioral characteristics for authentication. The common and widely implemented biometric authentication method is the visual method. In fact fingerprint recognition dated as far back as 6000 B.C.E where in ancient Babylon, they were used on clay tablets in business transactions. (biometric technology application manual, 2008)

Fingerprint Biometric Authentication

According to Britannica (online), a fingerprint is an impression made by the papillary ridges on the ends of the fingers and thumbs. The permanence and Individuality of fingerprints is one major reason why it is used widely in biometric authentication. Komarinsiki (2004) says that automated identity authentication using fingerprint recognition is an effective solution to the problem of weak and frequently reuse passwords.

There are basically 4 steps to fingerprint recognition: image acquisition, image enhancement, feature extraction and pattern recognition. Image acquisition has to do with acquiring fingerprint images with the help of scanners. The captured images maybe blurred or contain noises which may affect the performance of fingerprint recognition system. This leads to the second step of image enhancement, at this phase image enhancement algorithm is used to recover the true ridge/valley structures in corrupted images and to remove noise from the image. In feature extraction, global and local structures are

extracted from the image and converted into more useful formats. The last step, pattern recognition is done by comparing fingerprints against a database.

Approaches to Fingerprint Matching

Two popular approaches to fingerprint matching are either minutiae-based or correlation-based, of which minutiae-based techniques attempt to match the fingerprint by aligning two sets of minutiae points and determine the total number of matched minutiae, while correlation-based techniques compare the global pattern of ridges and valleys to see if the two fingerprints align (Ross, Jain & Reisman, 2002). According to Ross *et al.* (2002), the performance of minutiae-based fingerprint systems is better than correlation-based techniques when it comes to fingerprint matching.

Fingerprint systems that employ the procedure of using only one type of fingerprint matching technique, which could be variants of minutiae-based techniques or correlation-based techniques, are susceptible to the errors that arise due to the lingering disadvantages of these systems when used in isolation. For example, some of the disadvantages of a minutiae-based matching system is the location and direction errors of minutiae during the extraction process, and the presence of fake minutiae after extraction (Ng *et al*., 2004), which could lead to wrong judgments based on incorrect information. Correlation-based techniques also have a drawback due to the large computational effort it takes to match the fingerprints (Lindoso *et al*., 2007), which makes it unsuitable for use in a real time system as performance and speed of the system will be poor, especially when the system is used as an identification type of authentication system that consists of a large database of fingerprints which are to be searched one by one for the identity of a person, which is common in law enforcement agencies.

The combination of these two approaches into one approach to be used in a fingerprint verification system will help deal with the accuracy deficiency each of these approaches face when supplied with fingerprint images that have bad characteristics or features that could influence the decision of the system wrongly. Increased accuracy in fingerprint matching will help a fingerprint verification system truthfully and quickly tell when an individual is posing as who he/she is not.

Purpose of the Study

The main objective of this research is to design and implement a fingerprint-matching algorithm that is a hybrid of minutia-based and image-based methods of matching. Specifically, the study seeks to:

i. Study and review existing literature and models on minutia-based and image-based matching algorithms.
ii. Design a fingerprint-matching algorithm that is a hybrid of the two approaches.
iii. Implement and evaluate performance of the designed hybrid-matching algorithm.
iv. Review evaluation carried out on the implementation of the proposed fingerprint system.

Fingerprint Matching

Fingerprint matching is the process of extracting certain distinctive features from the images of two fingerprint and using expertly crafted reliable methods, to match these features to take a decision based on the identicality of these samples, on whether the two samples are a match or not. Fingerprints consist of ridges, which are the dark lines that are present in the fingerprint area, and valleys, which are the lighter lines in-between two ridges (Bharti *et al*., 2015). Automatic fingerprint matching usually depends on the comparison between ridge characteristics and their relationship to make a person identification (Lee, 1991).

These ridges found on the finger surface sometimes forms patterns which are distinctive in terms of location and orientation. These patterns are called minutiae, and they are one of the major components involved in the matching of fingerprint samples.

There are two main approaches to matching fingerprints. The first is the minutiae-based approach, which makes use of minutiae features and their properties such as the type, orientation and location.

While the second is the correlation-based approach, which makes use of direct gray-level information from the fingerprint image, containing richer, more discriminatory information than the minutiae features, and works by selecting characteristic templates in the primary image, using template matching to find those templates in the secondary image, after which the templates' positions in both images are compared to determine whether the fingerprints match (Bazen *et al*., 2000).

Minutiae

Minutiae are essentially terminations and bifurcations of the ridge lines that constitute a fingerprint pattern (Maio & Maltoni, 1997). The work of fingerprint minutiae matching can be divided into two parts: minutiae extraction, which involves obtaining the minutiae features from the fingerprint and is further broken down into fingerprint image enhancement and purification (Maio & Maltoni, 1997), and minutiae matching, which involves the comparison of individual minutiae gotten from both fingerprint samples, to determine whether the two fingerprint samples are a match. Minutiae extraction is the process of removing unique features from fingerprints, formed by the joining/halting of ridge lines on the finger, that are invariable to different fingerprint images.

Though these minutiae features can be extracted from the gray-scale image of the fingerprint, the gray-scale fingerprint images are known to be highly unstable for this extraction, hence, most fingerprint classification and recognition systems make use of a feature extraction stage for identifying salient features (Maltoni, Maio, Jain & Prabhakar, 2009). One of the main problems of extracting features from a fingerprint is the presence of noise in the fingerprint image (Ratha *et al*., 1996), which could lead to false extraction of minutiae or even worse, no extraction at all, meaning the image is damage beyond recovery by enhanced image processing techniques. Therefore, several image enhancement techniques have been proposed in literature to enhance the quality of the fingerprint image, achieving reduction of noise and the enhancement of the ridge definition against the valleys, to reduce the extraction of spurious minutiae that eventually leads to false matching in the matching stage (Bansal *et al*., 2011). Figure 2 shows the flow of a minutiae extraction process.

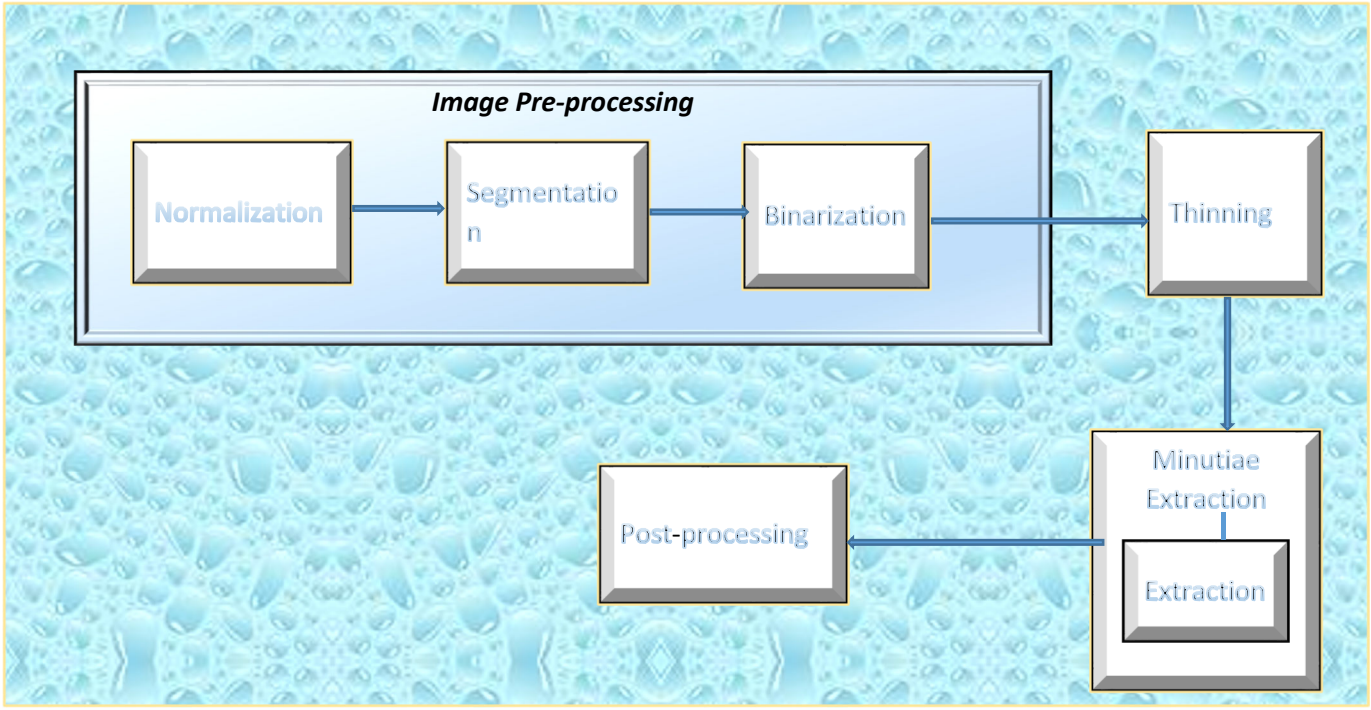


Figure 2: The flow of minutiae extraction process

mediate steps on the input image, and finally
Several techniques for the removal of noise
erprint image have been developed.

Hong *et al*. (1998) proposed a fingerprint enhancement algorithm which divides the fingerprint image into non-overlapping blocks of size $w \times w$ to determine the local ridge orientation of each block and also the frequency of the ridge and valley structures normal to the direction of the local ridge orientation, which can adaptively improve the clarity of the ridge lines in comparison to the valleys structures. Vaikole *et al*. (2009) views the fingerprint images as a flow pattern with definite texture. The image is divide into equal sized blocks and processed independently. The maximum variance is calculated for each block using a gray level projection perpendicular to the local ridge orientation. The ridges of the fingerprint image are thinned and morphological operations such as using a morphological filter are applied to enhance the image.

Choi *et al.* (2000) used a method called Magnify-Shrink (MS) smoothing algorithm, which uses a closing method, and processes the widening of the image followed by the noise removal. This method assigns the maximum and minimum value instead of the mean value, which effectively removes the noise in a local area, and the appearance of the ridges, and valleys are more, clearly discriminated leading to an enhanced image.

Binarization

Binarization is the process of converting gray-images to its same representation in black and white using a threshold gray value that if any pixel is higher than it is considered background and turned to white, while any pixel lower than the threshold is considered foreground and turned to black. High quality binary images can give off more number of characteristic features as compared to original image, because of the noise present in the original image (Garg, 2013).

The two categories of binary thresholding techniques used for binarizing images in literature are:

- Global Thresholding: Which is when the goal is computing a single threshold value for the entire image, of which this choice of value can be gotten by analyzing the histogram of the image;

- Adaptive Local Thresholding: due to the complexity in selecting a global threshold for the image, analysis of the intensities of gray levels within a window over an image is used, so that for each window a local threshold can be determined (Carneiro *et al*., 2014).

Thinning

Thinning of fingerprints refers to the process of reducing the thickness of the fingerprint ridges to be one pixel wide with minimum losses in shape, and this process is important to identify the exact pattern of the fingerprint (Al-Ani, 2013).

Golabi *et al*. (2012) proposed a thinning algorithm that makes use of four box of matrices. Each box includes three 3×3 matrices and one 4×4 matrix. Each of the four matrices perform thinning in different directions, for example, the diagonal matrices, which consists of four 3×3 matrices that are sued to thin diagonal lines. If any two pixels lie adjacent to each other at an angle of 45 degrees, and a third pixel connects these two at an angle of 90 degrees, then the third pixel will be deleted (turned to white), to preserve continuity of the image. There are also the vertical, horizontal and final matrix versions of the four box of matrices, and the first two mentioned thin vertically, right to left and horizontally, down to up, respectively. The last one (final matrix), just keeps on thinning to ensure there are no spurious minutiae or noise in the fingerprint image.

Minutiae Points Extraction

Typically, each minutia is described by four parameters which are: the coordinates of the minutiae point, x and y, the minutiae direction obtained from the local ridge orientation, θ, and the type of minutiae point, whether ridge ending or bifurcation, t (Więcław, 2009).

Crossing Number (CN) algorithm is a minutiae extraction algorithm used to define the minutiae points in a fingerprint image. The concept of crossing number is a widely used concept in the extraction of minutiae points and Rutovitz definition of crossing number for a pixel is given by $C_n(P) = \left(\frac{1}{2}\right)\sum_{i=1}^{8}|P_i - P_{i+1}|$ (Kaur *et al*., 2008).

Post-Processing

The post processing stage of the minutiae extraction process is performed after the minutiae has been extracted. After the extraction of minutiae using an extraction algorithm, based on the quality of the image after thinning, several spurious minutiae are also detected and need to be removed to ensure proper matching goes on. A post-processing stage filters out all the undesired features points based on their structural characteristics. Akram *et al*. (2008) designed a post-processing algorithm that eliminates false minutiae based on the structure they form. These structures include, spurs, bridges and ladders, which are eliminated by the use of a *w*×*w* window around the candidate bifurcation which is placed in the center of the window, and movement is done in the direction of connected branches of the bifurcation. All the neighboring pixels, which have value of one in the thinned image, are said to be connected to the candidate minutiae. If an end point of any traveled branch is detected within the window, eliminate that ending point and the candidate bifurcation, which occurred due to spurs. If a bifurcation of any traveled branch is detected on the boundary of the window, eliminate that bifurcation and the candidate bifurcation, which occurred due to bridge. If two bifurcations are detected along traveled branches within or on the boundary of the window, eliminate that bifurcations and the candidate bifurcation, which occurred due to ladders. If one bifurcation is detected along two traveled branches within or on the boundary of the window, eliminate that bifurcation and the candidate bifurcation, which occurred due to holes/islands. If another ridge ending is detected within the window, eliminate that ending and the candidate ending which occurred due to short ridges.

Minutiae Matching

Minutiae matching essentially consists of finding the best alignment between a subset of the minutiae in the template image stored in the database and a subset of minutiae of the query image fingerprint, through a geometric transformation (Więcław, 2009).

Luo *et al*. (2000) proposed a fingerprint-matching algorithm that firstly aligns the template image with the query image using two corresponding pair of minutia points, which are used as references to align the image. If the two points can be taken as corresponding minutia pairs, that is the associated ridges of T (template minutiae) and Q (query minutiae) are similar to each other to a certain degree, and the minutia types are the same for the two minutiae, the rotation angle will be set to a value between 0^o and 360^o else the value is set to 400. The template and query minutiae are represented in the polar coordinate system as symbolic strings by concatenating each minutia in the increasing order of radial angles, the resulting strings are matched, and the maximum value of the matching is used as the final matching score. If the matching score is above the threshold, then the fingerprint match else the two fingerprints are not the same.

Jie *et al*. (2006) proposed an algorithm based on the principle that if two fingerprints come from the same source, the position and directions of their corresponding minutiae points should be close. Unlike Luo *et al*. (2000) approach to obtaining a reference point from the fingerprint images using the similarity of the minutiae linked ridges, which has to reach a predefined level before the pair of minutiae from the two images are fit to be used as reference minutiae.

Correlation-Based Matching

In correlation-based matching, the fingerprint image itself or a section of the fingerprint image is used as a template image and the pixel intensity values at each and every point of the template are compared

with the intensity value of the query image (Singla, 2013). It makes use of template matching technique in which, a small unique section of the stored fingerprint is captured, moved around the query fingerprint pixel by pixel in search of a location of best fit. Template matching is a high-level computer vision approach that distinguishes the part on an image that match a predefined layout (Jayanthi & Indu, 2016).

According to Singla (2013), Bazen *et al*. (2000) proposed a three-step correlation based fingerprint verification system. In the first step, the small sized template is searched for and selected from the stored fingerprint image. The second step uses template matching to locate where the selected reference template matches best in the query fingerprint image and the third step then compares the template position in both fingerprint images to certify the genuineness of the query fingerprint. The advantage of this method is that the correlation is done locally instead of globally, therefore non-uniform deformation of the fingerprint will not affect the decision taken, but the method is computationally intensive and cannot deal with rotations greater than 10 degrees.

Cavusoglu & Gorgunoglu (2007) proposed a correlation-matching algorithm that is a five-step procedure, which involves segmentation of the image, determination of ridge orientation, reference point detection, normalization of the images and the correlation-matching algorithm. The core of the fingerprint is chosen as the reference point for the procedure. Cavusoglu & Gorgunoglu (2007) correlation algorithm takes care of some of the problems faced by normal correlation based matching systems, such as the non-linear distortions, different pressures or different skin conditions which causes deformation on the fingerprint, which are eliminated by the use of the mean value of a 3×3 mask of pixels, instead of taking the gray-scale intensity of each pixel and normalization operation. A window of w×w size is drawn around the reference point and then by shifting the reference point, the differential sum of the square (SSD) of the digital signatures of both images for the different placements are calculated. The best matching point for the images is where the SSD is minimum and the coordinate value of this point is saved. For each rotation with incremental steps of 1 degree, the correlation value is computed and the mean of the set of values is found. The maximum value within the set of correlated values is used to determine the matching score of the images. This method performs better than the minutiae-based approach when it comes to low quality images and it also stores less data as compared to other correlation matching systems that store the whole fingerprint image in the database

Methodology

Due to the drawbacks involved in using only one type of fingerprint matching technique, either minutiae-based or correlation-based techniques, such as minutia-based algorithms inaccuracy in matching low quality fingerprint images and correlation-based algorithms which are computationally intensive, hybrid systems which use both of the systems in their approach have been researched and developed. Nandakumar & Jain (2004) developed a hybrid system that makes use of both minutiae features and correlation techniques for matching fingerprints. Their system uses the minutia features extracted from the stored fingerprint to align the query fingerprint according to the minutiae local orientation obtained from the extraction stage, but the after alignment the minutiae are not used again and template matching is employed to make a decision on whether the two fingerprint images are the same. Bringing these unused minutiae features into the matching process alongside template matching will improve the accuracy of the fingerprint matching.

The proposed algorithm in this project is based mainly on Nandakumar & Jain (2004) algorithm for fingerprint matching. They use the extracted minutiae features of both the stored and query fingerprint images to align the two fingerprints so their orientation match. They make use of the minutiae to align the fingerprint by using points on the ridge associated with the minutia and Procrustes analysis (Dryden, 2003), to get a good estimate of the rotation and displacement from a pair of possibly corresponding

ridges. The proposed algorithm suggests a replacement of this method of fingerprint alignment with template matching and correlation technique as used in (Seow *et al*., 2002).
After the extraction of the minutiae in the stored image, windows of w × w size will be selected around each minutiae and those windows will be treated as a template image. Unlike some correlation techniques that involves using each of the templates, matched against the enrollment fingerprint image to determine which template is the most unique (that is, a template image that fits as well as possible at its location but as badly as possible at other locations in the image (Bazen *et al*., 2000), we will use the SURF algorithm to determine the most unique template by extracting the SURF features of each template and selecting the template that has the most SURF features as the most unique template, and the chosen template will serve as a reference template image for that fingerprint and is stored in the file system.

The Euclidean distance from the minutiae inside the chosen reference template image, is then also used as a reference minutiae point, and is stored. All the minutia points are then converted to polar coordinates using the reference minutia as the center point and the local ridge direction as the reference line. The angle that a straight line, from the reference minutiae point to each of the other minutiae points, forms with the local ridge direction is computed and stored; they are used in the matching procedure to increase the accuracy of matching. Alongside storing the Euclidean distance and angle of reference minutia to each of the other minutiae points, the type of each minutiae point is also stored.

When supplied with a fingerprint (query fingerprint) to be matched, the reference template image of the stored fingerprint image is retrieved, the template image is searched for using Zero Normalized Cross Correlation (ZNCC) at different rotations of the image between 10 and -10 degrees, and the query fingerprint image is aligned in this process using the template image. The template image is first searched for in the query fingerprint using correlation methods, and if the template is not found then the image is rotated by one degree and the process of searching is repeated on the query image. This search continues, rotating one degree in a direction until the template image has been found in the query fingerprint, or the query fingerprint image has been rotated by a certain magnitude of degrees, which in this algorithm has been chosen to be ten degrees east and west (that is 10 and -10 degrees), and in the case of the template not being found, the two images are concluded not to match. If the template image is found in the query fingerprint, then the processes for minutiae extraction is carried out on the rotated form in which the template was found. Using template matching for query image alignment and reference template search reduces the time taken to compare fingerprints, because the extraction stage, which involves several processes, will not be performed if the reference point has not been found, and the two fingerprints are concluded not to be a match.

On the completion of the minutiae extraction in the query fingerprint image, the reference minutiae point in the reference template image is then used for the matching. The data of the Euclidean distance and angle, of reference minutiae from each other minutia, which was obtained in the fingerprint enrollment procedure, is retrieved from the database and straight lines are drawn in the query image originating from the reference minutiae, using the distance and angle. Where a line stops, a bounding box is created around that point to search for minutia in that region, and if a minutia is found in the region and the minutia is the same type as the minutiae that is at the end of that line in the stored fingerprint, and the minutia distance and angle is less than the threshold for distance and angle matching, then that minutia is considered a matching minutia.

If two minutiae are located in the bounding box region then the minutia closest to the center of the bounding box, which is the same type as the minutia in the stored fingerprint, then that minutia is the matching minutia. All minutia extracted from the query fingerprint image, after the extraction phase, are stored in a list. When a match is found, the matching minutia is removed from the list and put in another list.

When all the lines have been drawn and minutiae that match in each bounding box created at the termination of each line have been stored, then the matching score is computed, and if the score is higher than the threshold then the two fingerprints match, else if the score is below the threshold, the two fingerprints do not match. The bounding box is used to deal with possible deformations that may occur in the extraction of minutiae, such as minutia moving away from their original point in the enrollment image. The distance and angle of each minutia from the reference minutia point is used to increase minutia matching accuracy.

Proposed Algorithm

The proposed algorithm is based on the works of Seow *et al*. (2002), Nandakumar & Jain (2004) and Bazen *et al*. (2000). It is broken down into two phases, which are the fingerprint enrollment and the matching phases, which comprise of several sub-leveled processes.

Fingerprint Enrollment

In this phase, the features that are used in the matching are extracted from the stored fingerprint image, this is also known as the enrollment process. This phase is broken down into two sub-levels, which are minutiae extraction and reference template and minutia selection, which is joined with computing Euclidean distance and angle calculation.

Stage A

The algorithm for the first part of the enrollment which involves extracting the minutiae features is show below:

i. Obtain fingerprint image: The fingerprint to have features extracted is obtained.
ii. Normalize Image: The fingerprint sample obtained is normalized so it has a pre-specified mean and variance (Hong *et al*., 1998), which makes it easier to deal with.
iii. Segment Image: This involves the separation of the image foreground (parts that contain the fingerprint ridges and valleys) from the background (parts outside of the fingerprint) of the obtained acquired fingerprint image as done in (Akram *et al*., 2008).
iv. Binarize Image: The fingerprint will be converted from gray-scale to binary (black and white) using adaptive binarization as implemented in the imbinarize built-in function of MATLAB.
v. Thin Image: The binary fingerprint ridges will be reduced to a one-pixel wide ridge for proper extraction of minutiae. This will be done using the bwmorph built-in function of MATLAB.
vi. Extract Minutiae: The minutiae features are extracted from the thinned fingerprint image using the standard Crossing Number (CN) algorithm as specified in (Chaudhari, Patnaik, and Patil (2014).
vii. Remove Spurious Minutiae: Invalid minutiae detected in the extraction stage will be removed here and the fingerprint will be rid of bad structures such as holes, spikes etc. This will be done using the post processing technique in Akram *et al*.(2008).
viii. Estimate orientation field of the fingerprint as done in Murmu and Otti, (2009).
ix. Move on to stage B.

Stage B

The algorithm for the second part of the enrollment which involves the reference template and minutia selection is shown below:

i. Create a window of 71 × 71 pixels around each minutiae point as template images.
ii. Obtain SURF features from each template.
iii. Select template that has the most SURF points as the most-unique template.
iv. Locate minutia in the template image and select as the reference minutia point.
v. Compute Euclidean distance of reference minutia to each detected minutiae point.
vi. Calculate the angle that each minutiae point makes with the reference minutiae point according to the local ridge orientation of the minutiae gotten from the extraction phase.

vii. Store the reference template, reference minutia data, the distance and angle from reference minutia to each minutia, and each minutia type.
viii. End enrollment phase

Fingerprint Matching

This phase compares features of a fingerprint supplied to features of one already stored in the database. This stage is divided into two decisive levels, the reference template search level, which if not found ends the process, and if found moves on to the minutiae matching level.

Stage A

The algorithm for the reference template search is:

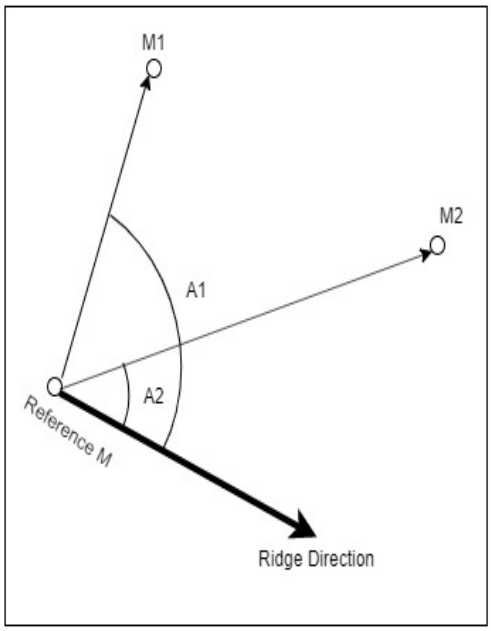
i. The query fingerprint image is acquired.
ii. The reference template of the stored fingerprint is retrieved from the database.
iii. The query image is searched through using the template image and Zero Normalized Cross Correlation, using a rotation threshold of 10 to -10 degrees.
iv. If template is found in the query image, go to step 6, else rotate the fingerprint by one degree and repeat step 2 until template image is found or the rotation threshold has been exhausted.
v. If template image still isn't found after rotating the image by 10 degrees clockwise and anti-clockwise, it is concluded that the two images are not the same, and the matching ends else move on to step 6.
vi. Maintain rotation on query image and move on to stage B.
vii. End stage.

Stage B

The algorithm for the minutiae matching is:

i. Locate reference minutia point in the area where the template image fit.
ii. If reference minutia cannot be found the matching ends and fingerprint are considered different, else proceed to step 3.
iii. Extract minutiae from query fingerprint using approach A in feature extraction phase.
iv. Store all detected minutia points in a list (i).
v. Use the data (Euclidean distance and angle) provided in the extraction phase to draw lines on the query fingerprint using exact measurement.
vi. Create a bounding box of n × n at the point where each line stops.
vii. Taking one line as an example, search for minutia that is of the same type as that at the end of the line in the stored image, and is closest to the center of the bounding box if there are two or more minutiae present in the box.
viii. If minutia found meets requirement in (7), store minutia in a different list (ii) and remove from list that contains all minutiae points, and increase matching score by 1.
ix. Repeat steps 6 to 8 for each minutiae distance and angle data.
x. If matching score is above threshold, fingerprints are a match else, fingerprints are concluded to be different.

Figure 3 shows the diagrammatic representation of the calculation of Euclidean distance from the reference minutia to other minutia M1 and M2, calculating the angle they forms with the ridge direction of the reference minutia, and this will be done for all the minutiae present in the fingerprint.
Figure 4 shows an overview of the proposed fingerprint matching system, while Figures 5 to 8 depict the internal flow of the fingerprint system, in each phase of the enrollment and matching processes.



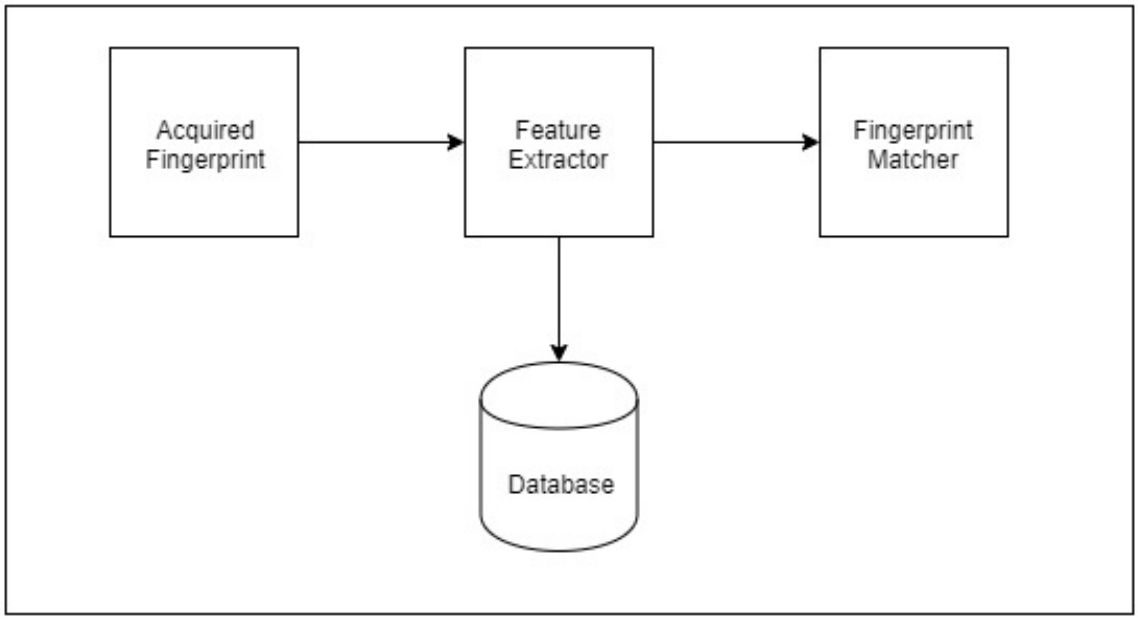


Figure 4: An overview of the proposed fingerprint matching system

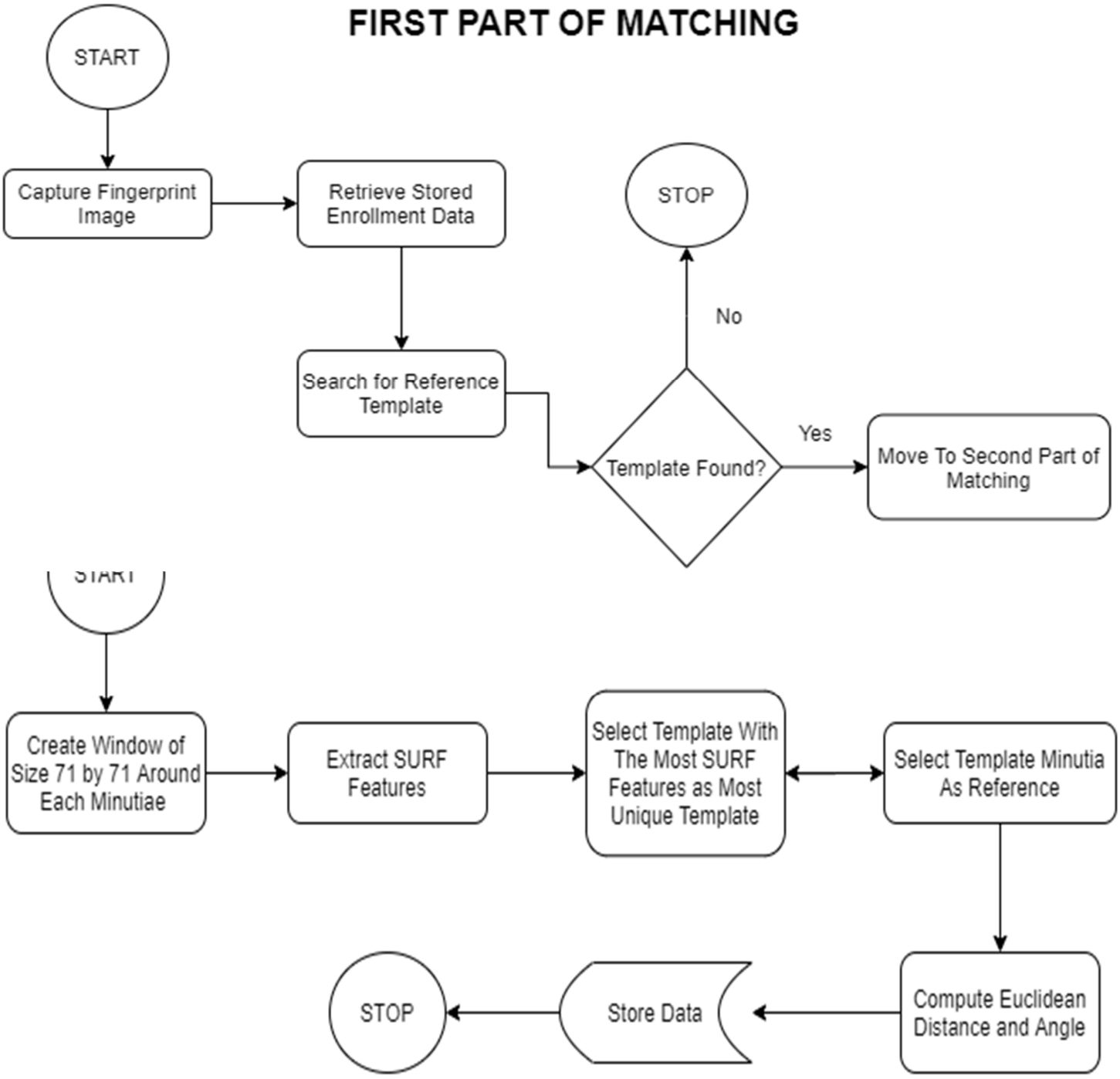


Figure 6: Phase II of fingerprint enrolment

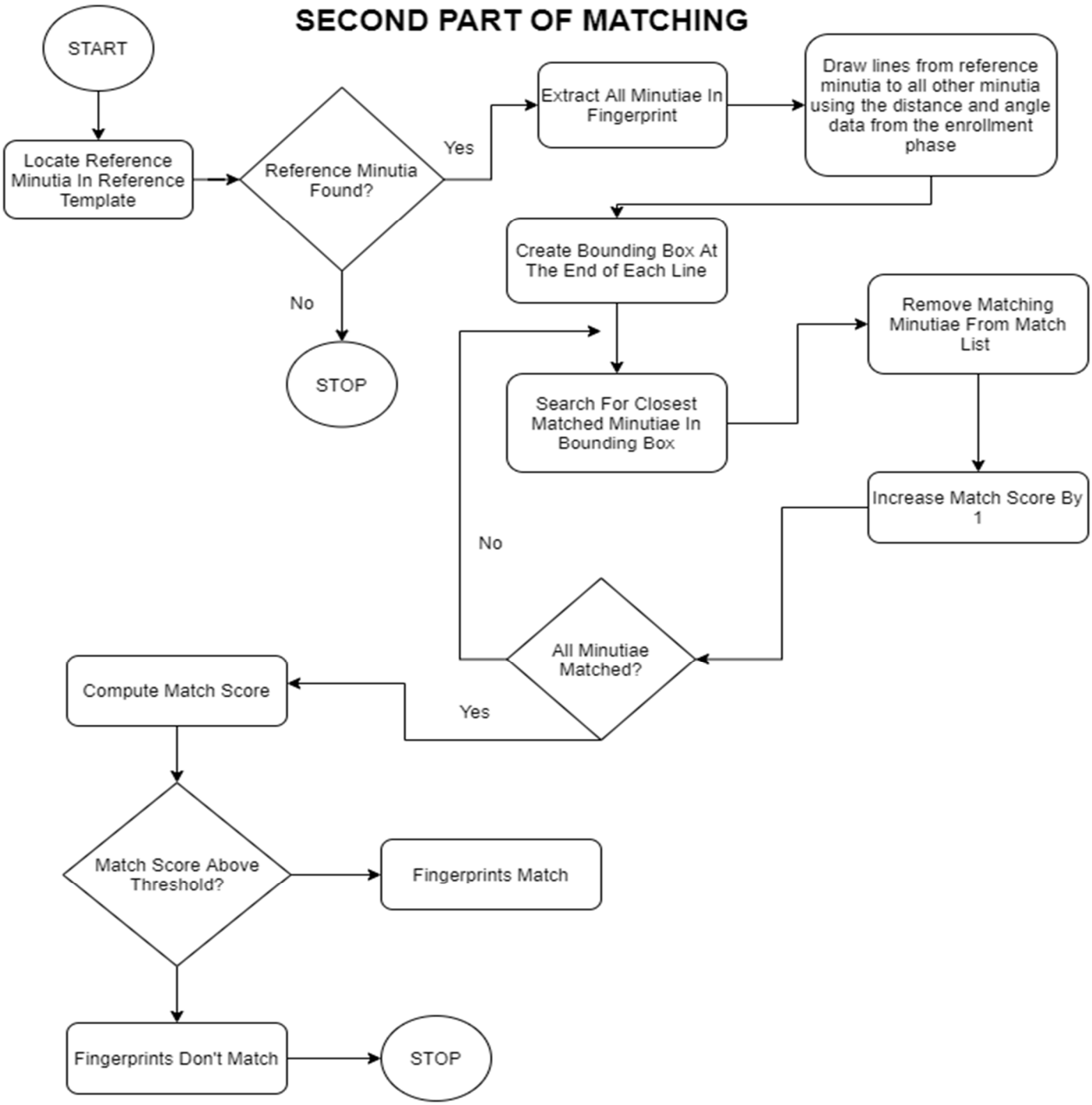


Figure 8: Phase II of fingerprint matching

Implementation

The proposed algorithm was carried out on a database of fingerprints gotten from the FVC 2002 DB1 database, which has 10 fingers with 8 imprints per finger, making 80 fingerprints, but only 20 out of the 80 fingerprints were selected because of the high time complexity of the algorithm. Groups of 5 fingerprints were made to consist of the same fingers, and 4 groups in total were created making 20 fingerprints. 100 trials were conducted for the False Rejection Rate (FRR) test, which is the rate at which the correct fingerprint is rejected, and this was done by matching each fingerprint in a group against all the other fingerprints in the same group and this was done for all the groups individually. 500 trials were carried out for the False Acceptance Rate (FAR) test, which is the rate at which an incorrect fingerprint is accepted into a system, it was conducted by using a fingerprint from a group to match all the other fingerprints in the other groups, and this was done for all the fingerprints in the database. The fingerprints also had varying conditions, where some of them where deformed by occurrences such as rotation, scale, translation and partial occlusion, but none selected had cuts in them. The implementation was carried out using MATLAB on a windows 10 operating system, using the Image Processing Toolbox of MATLAB.

Enrollment Phase

In this phase, one fingerprint is chosen as the enrollment fingerprint, and the enrollment algorithm is applied to it, which starts with the conversion of the fingerprint to gray scale using the mat2gray function of MATLAB. The fingerprint's histogram was initially equalized using MATLAB's histeq function but it darkened some areas of the fingerprint where there initially was high concentration of darker gray values, which is where the ridges are very thick, thereby introducing more noise into the fingerprint, so the equalization process was discarded and the gray image was used instead for the next stage.

The next stage of the preprocessing involved the segmentation of the fingerprint, separating the foreground, where the actual print is, from the background, which is the area surrounding the fingerprint. This was done to reduce the number of spurious minutiae that will be extracted from the fingerprint. The technique involves using the computed range image over blocks of size 16 by 16 to highlight the ridges and applying adaptive thresholding to binarize the fingerprint. A morphological closing operation is then carried out using a disc shaped structuring element of radius 6 which transforms the fingerprint into foreground and another morphological opening operation is carried out to remove the holes created by the closing operation and the foreground is then extracted. Contour smoothing is then carried out on the roughly segmented binary image in the Fourier transform domain to create a smoother outline of the segmentation as in (Fahmy, & Thabet, 2013). The result of this is shown in Figure 9.

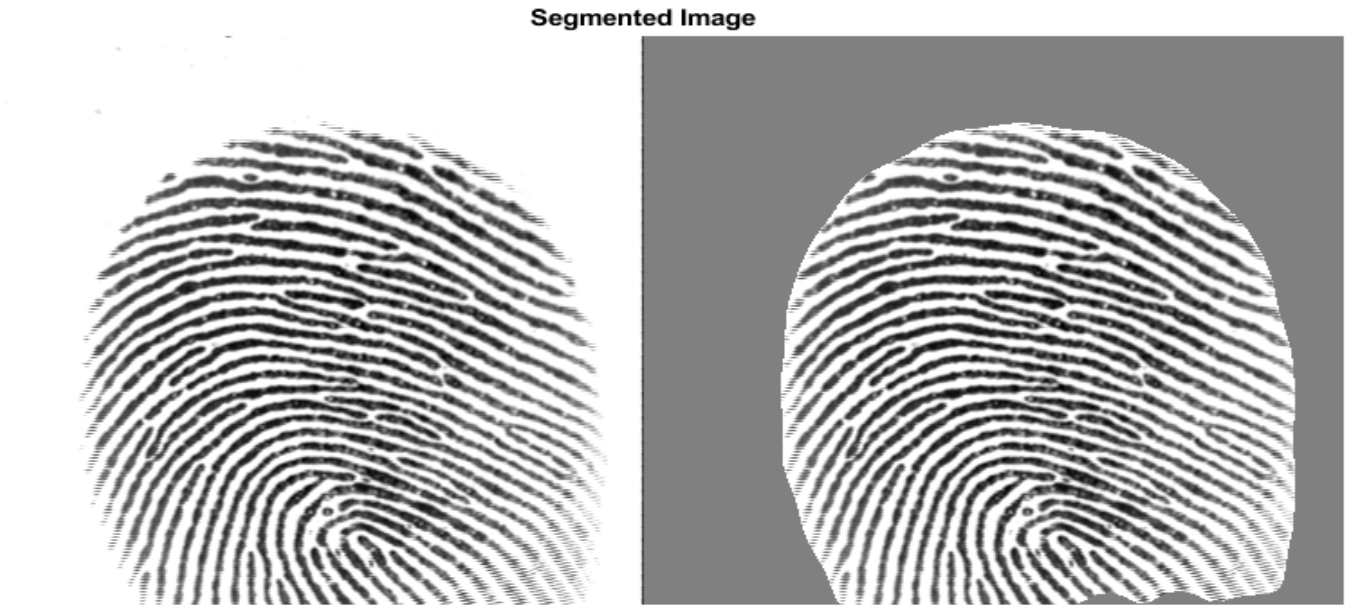


Figure 9: Grey fingerprint image versus segmented fingerprint image

After the segmentation process, the segmented fingerprint is then binarized using adaptive binarization technique, which is changing the fingerprint image from containing gray pixels to containing only black and white pixels, where a pixel value of 0 is black and that of 1 is white. This is achieved using the inbuilt function of MATLAB, the imbinarize function, which can perform both global and adaptive thresholding, but the adaptive thresholding is the use case here because of the illumination gradients which are strong, making global thresholding methods such as Otsu binarization technique not to work, but adaptive techniques works better. The binarized image is then thinned to reduce the ridges to be 1 pixel wide, and this is achieved through using the bwmorph inbuilt function of MATLAB. The results are shown in Figure 10.

The minutiae is then extracted from the thinned image using Rutovitz crossing number algorithm and the ridge endings and ridge bifurcations locations are then identified and collected into lists (Virdaus, Mallak, Lee, Ha & Kang, 2017). This approach to extracting the minutiae returned valid minutiae with several invalid ones which if used will lead to error in the minutia matching process, and to avoid these matching errors the minutiae were processed to separate the real ones from the fake ones. This was achieved by applying a series of heuristic rules to remove the fake minutiae, which form structures such as holes, spikes, bridges etc.

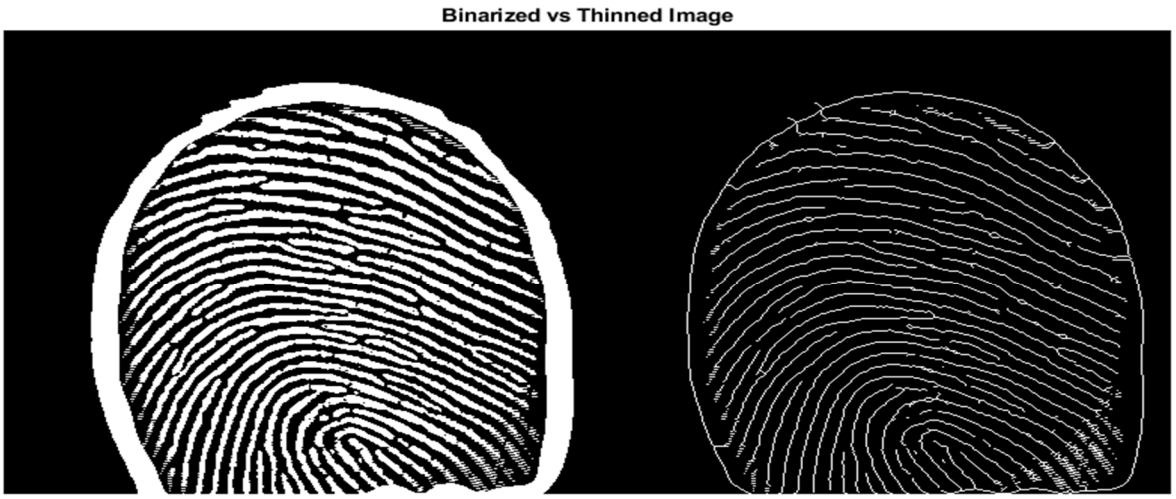


Figure 10: Binarized versus Thinned image

The spurious minutiae algorithm involves calculating the average inter-ridge distance and calculating the distance between two ridge endings, two ridge bifurcations and between an ending and a bifurcation, and if the distance of each of them is smaller than the average inter ridge distance then the two minutia points are removed. (Cao & Wang, 2017). The results of the minutiae extraction and spurious minutiae removal is shown in Figure 11.

After the minutia extraction and spurious minutiae removal, the next step in the enrollment phase is to estimate the orientation of the fingerprint ridges to know the direction of each minutiae, which is one of the parameters for the matching process. The estimation was done according to the average block direction algorithm proposed by Murmu & Otti, (2009), which provided very good results for the estimation.

A block size of 13 was chosen as it seemed to be the best fit for the number of orientations gotten after the estimation, and the estimation was done for ridge endings using the normal image, while for ridge bifurcations using the inverted image because for bifurcations we need the angle of the valley between the two ridges that make up the bifurcation, hence the inverted image was the best approach to get the angle of the bifurcations. The result of the orientation estimation are shown in Figure 12.

The second part of the enrollment process gathers the template images surrounding each minutia in a box of size 71 by 71, using each minutiae as the center point of each template and the most unique template is determined from the collection of templates and used as the reference template which is to be located on an image for matching, and the minutia at the center of that image is also used as a reference minutia.

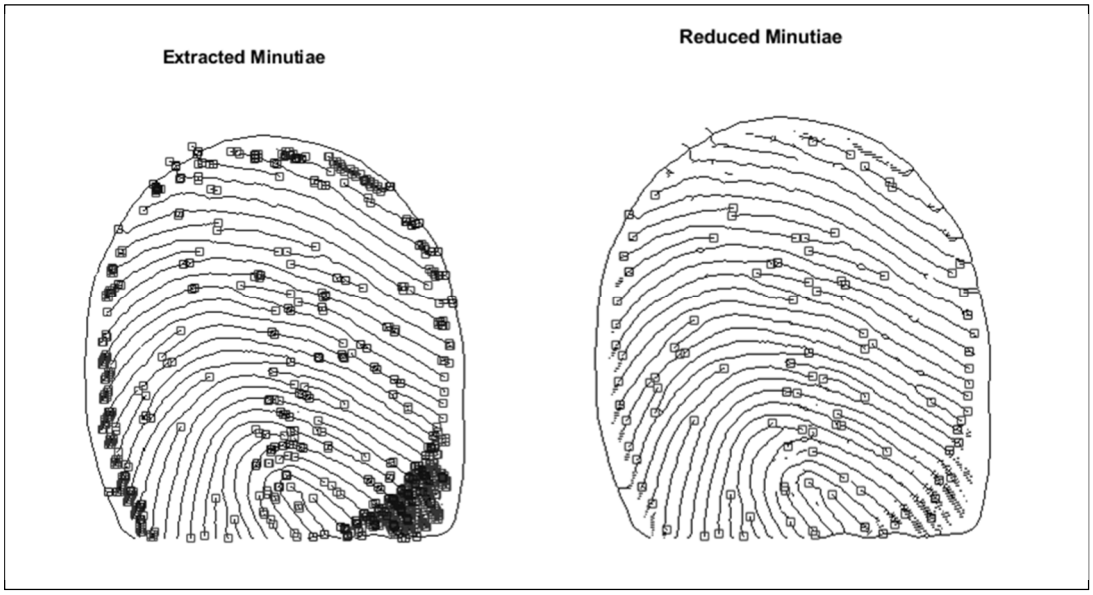


Figure 11: Results of the minutiae extraction and spurious minutiae removal

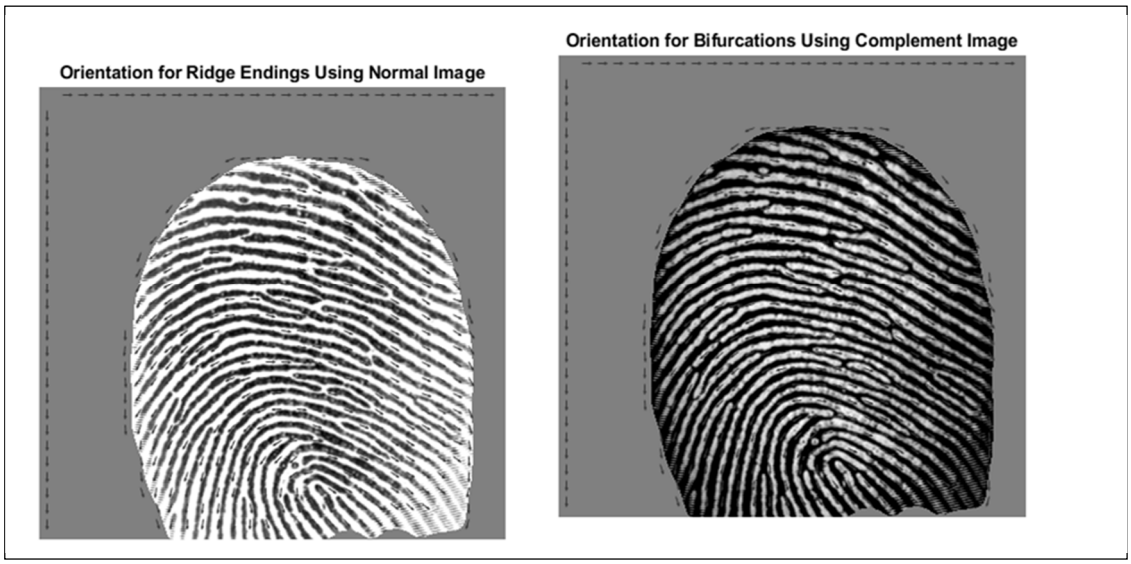


Figure 12: Orientation map of ridge endings and bifurcations

Minutia that are not able to satisfy the window size, that is, minutia whose window goes out of the borders of the fingerprint image are not regarded, only in the reference selection process but are still used for the minutiae matching.

The SURF algorithm, which is well known for extracting interest points from images, was employed in this algorithm to extract SURF interest point features from each template selected and the template with the most features is selected as a unique template, which is used as the reference template. If there are two or more templates having the same number of features, which is the maximum number of features overall, then the templates are put into an array and a random number from 1 to the size of the array is chosen using the rand function of MATLAB, that number is used as an index in the array to select a random template from the list of templates having the same number of features as the reference template. This approach is used as an alternative approach as specified in Bazen *et al.* (2000), where it is suggested to use a correlation approach to selecting templates by using ratio of least fit, sliding a template round its image and calculating it's correlation at every point of the image, which is done for all the templates and the template that fits the worst at every other location as compared to its original

location is selected as the most unique, but due to the high time complexity of a correlation match, coupled with the use of correlation in the matching stage, it seemed inappropriate to use this approach in the enrollment stage as it would only raise the time complexity of the algorithm overall. The SURF algorithm was a better alternative to the correlation approach.

After the selection of the reference template, this eventually leads to us selecting the minutia in the reference template as the reference minutia and the other minutiae in the fingerprint are converted to polar coordinates using this reference minutia as the center. The Euclidean distance between each minutiae and the reference minutiae is computed and recorded, the angle each minutiae forms with the reference minutia's ridge direction is computed and recorded for each minutiae in the fingerprint. The type of minutia for each minutia is also stored using 1 for ridge endings and 3 for ridge bifurcations, which is to be used in the matching stage of the algorithm. The template location and a template image is shown in Figure 13.

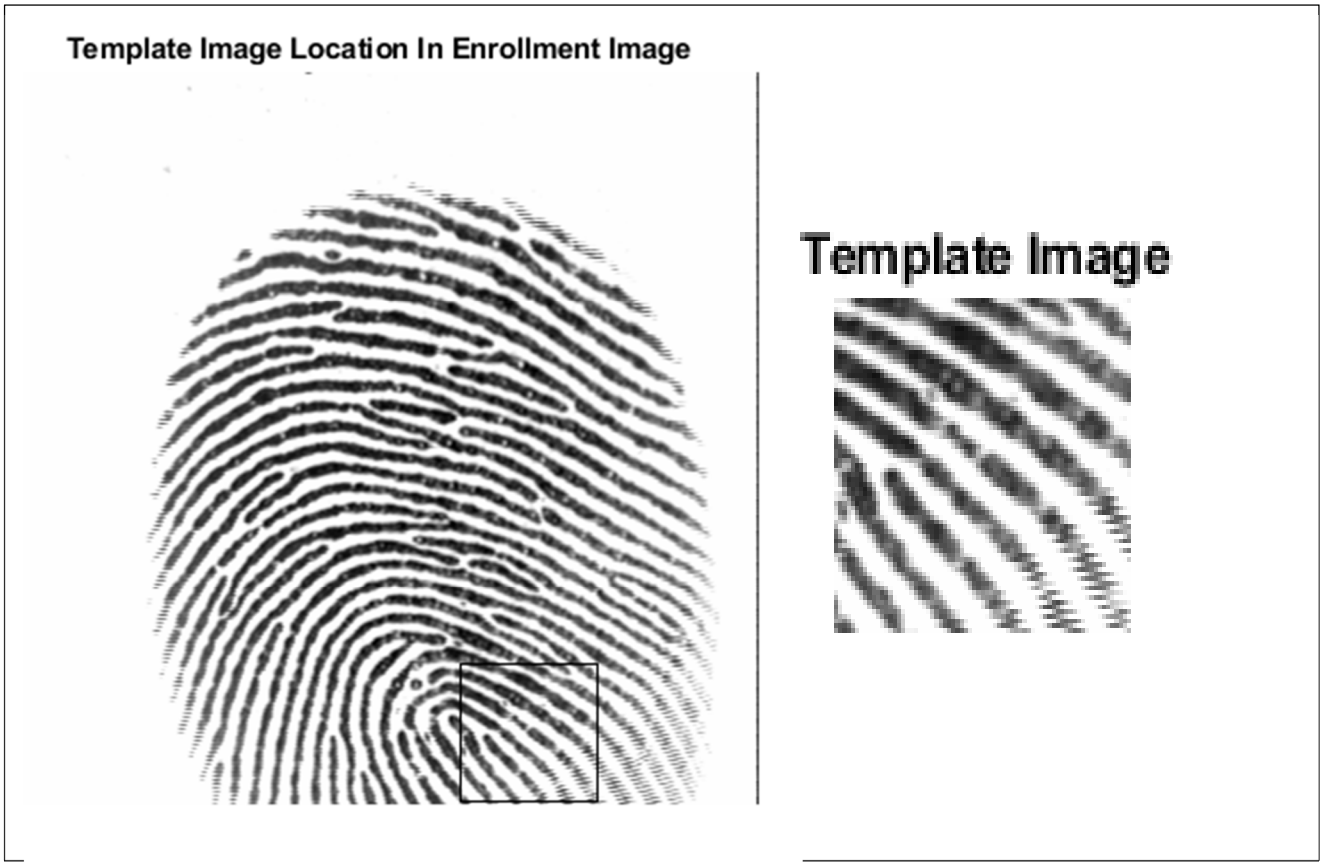


Figure 13: Template image location on fingerprint (left) with the template image (right).

Matching Phase

In the matching phase, the fingerprint to be matched is first acquired and the image is firstly converted to a gray format. The template matching process is carried out with the use of Zero Normalized Cross Correlation (ZNCC), which was chosen over the traditional Normalized Cross Correlation (NCC) after comparison in template location, as the ZNCC outperformed the NCC, while taking the same time to complete. The ZNCC part of the matching algorithm is very time consuming and is the part that takes the most time while the matching process is on, due to the way the algorithm is set up.

The template image from the enrollment phase is retrieved and is located in the query fingerprint; query is what the fingerprint to be matched is termed as in this paper. The template image is slid round the

query fingerprint, the ZNCC value at all positions are obtained and the location where the correlation is at its peak is obtained and. The query fingerprint is rotated between -10 and 10 degrees, in increments of 1 degree, and the ZNCC value at all positions of the rotation of the query fingerprint is obtained and the rotation position where the ZNCC value is at its maximum is selected as the rotation factor, which is used to correct the alignment of the query fingerprint in respect to the alignment of the enrollment fingerprint. A threshold for the ZNCC is employed and set to 0.4, and if the final ZNCC value does not exceed this threshold or is not equal to it, the template is said to not be found in the query image and the fingerprints are also said to not match, and the matching process ends with a non-match.

If the ZNCC value exceed the threshold then the location of the template is stored and the matching process continues on to the preprocessing, minutia extraction, spurious minutiae removal and orientation estimation stage which is similar to how it was done in the enrollment stage, with the exception that the minutia and the ridge orientation computed are rotated using the rotation factor obtained from the ZNCC template location process so as to match the enrollment image's alignment. Once the minutiae data, which are the minutia location, type and angle, are computed, the next step is to locate the reference minutia, which is obtained by searching the template window of 71 by 71 in the query image, where the template was located. The window is searched and any minutia that is of the same type as the reference minutia of the enrollment image, and whose difference in angle between it and the reference minutia angle is smaller than a threshold set at 20, are selected and stored as reference minutiae, which are to be used for the matching process.

For each reference minutia located in the template, the other minutiae are converted to polar coordinates using that reference minutia as the center. The lines which connects other minutiae to the reference minutia are reconstructed using the distance and angle data of the reference minutia to other minutiae points gotten from the enrollment image, a bounding box of size 31 by 31 is drawn at the end of each line and the minutia in the bounding box which is closest to the original minutia at the end of that line in the enrollment image is chosen as a match and removed from the list of minutia to be matched. The comparison of minutia in the box and the original one at that location is highlighted below.

The distance between that reference minutia and each of the other minutia in the query image is computed, the angle other minutiae form with the reference minutia direction in the query image is also computed and a threshold of 30 is used for the difference between the distance of the reference minutia and other minutiae in the enrollment image vs the distance in the query image, a threshold of 10 is used for the difference in angle between other minutiae and the reference minutia in the enrollment image vs the query image, and the minutia with the smallest difference in both distance and angle is chosen as the matching minutia. These thresholds are used to ascertain whether the minutia in the query image matches the minutia at that location in the enrollment image.

The match score is computed for that reference minutia, which is the number of matched query minutiae divided by the total number of enrollment minutiae. This process is repeated for each of the reference minutiae that are found in the reference minutia's location process and the reference minutia with the highest matching score is chosen as the final reference minutia, and the match score of the chosen reference minutia is chosen as the final match score of the matching process. A match score threshold of 60 is used, and if the final match score of the matching process is greater than or equal to the threshold then the fingerprints are said to match, else the fingerprints are concluded to not match.

Performance Analysis

The fingerprint matching process is a very sensitive one, especially as its purpose, which is authentication, is also sensitive. In a minutiae based approach, one has to be very careful to gather only the real valid minutiae and discard other minutiae that arise from deformations of the fingerprint, such

as the presence of noise and other artifacts that arise either at the capturing stage due to inappropriate capturing of the fingerprint or at the pre-processing stage of the fingerprint.

Discussion

Spurious minutiae, if allowed into the matching process could be a recipe for wrong matching, thereby allowing false individuals into the system and rejecting the real individuals. In addition, upon the alignment of the query fingerprint to the enrollment fingerprint, if the fingerprint image is first rotated before the minutiae are extracted, there will be more spurious minutiae found because of the rotation of the fingerprint, which involves the shifting of the image pixels, and introduces some artifacts, which may be interpreted as either minutia ending or bifurcation. The rotation also cause the fingerprint to be larger than it is originally, and the new size depends on the magnitude of rotation. This increase in size leads to the fingerprint minutiae points shifting away and increasing in distance, which makes it harder to locate them as when it was the original size.

In the implementation, a scale factor was computed using the largest original minutia coordinate, which is when the image was not rotated, divided by the largest minutia coordinate, when the image has been rotated, to increase the size of the bounding box for locating the reference minutia. This was done to combat the scale, translation and rotation problems the algorithm faced in locating the reference minutia. The original distance of the other minutiae to the reference minutia, when the image was not rotated, is what was used for the matching rather than the scaled distance. The rotation of the minutiae points also introduced a negative coordinate problem, where some of the minutia coordinates fell out of the bounds of the fingerprint image, so a translation was applied to the coordinates by locating the highest negative coordinate and adding the value to itself and all other coordinates on its axis. This process was achieved by obtaining the rotation factor from the ZNCC operation, rotating the minutia using a rotation matrix with the rotation factor obtained, and applying the necessary calculations to ensure the minutia angles and coordinates are non-negative. Increasing the template window by the calculated scale factor and locating the reference minutia is performed after this and once the reference minutia is found, the distance and angle is computed using the original minutia locations and the rotation is added to the angles while keeping the distance the same. The matching carries on using the procured minutia points and data.

Figure 14 shows the fingerprint minutiae extraction when the fingerprint image is rotated by the rotation factor obtained from the ZNCC template matching process. There are more invalid minutiae present in this approach, and after the spurious minutiae removal, we are left with very little minutiae to continue the matching, and in this case, the matching fails, even though the template was found.

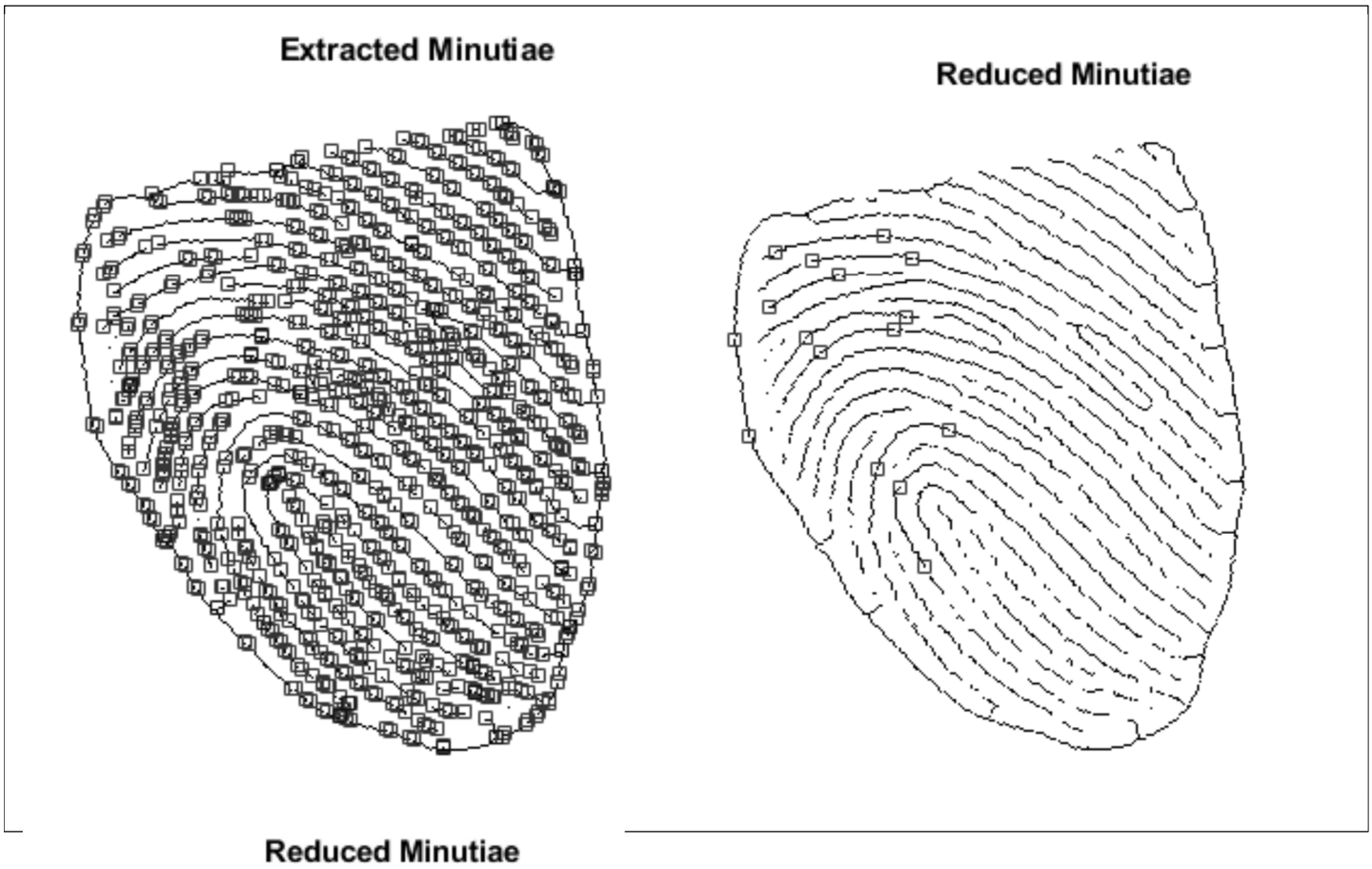


Figure 14: Rotation of the image before minutiae extraction and spurious minutia

in its original captured state, we can get all the correct
ıtrix to the minutia coordinates we can retain the all the
s minutiae removal.

results shows that it can identify fingerprints from the
ent fingers using the template matching and minutiae
cks to its performance as some invalid fingerprints also
prints.

process as it requires a lot of processing to find out the
\t its core, if the template image that is being found in
ed or is too distorted due to reasons such as poor finger
ts due to injuries, low variation of high intensity pixels
ss becomes highly difficult and of very low accuracy.
the section of the enrollment image where the template
image, in this condition, the template image cannot be
nds the matching process with a non-match conclusion
me finger.

Results

The False Acceptance Rate (FAR) is the rate at which invalid fingerprints are accepted by the fingerprint matching system, while the False Rejection Rate (FRR) is the rate at which valid fingerprints are rejected by the system. The FAR is calculated by dividing the number of accepted invalid fingerprints

by the total number of invalid fingerprint trials while the FRR is calculated by dividing the number of rejections of valid fingerprints by the total number of valid fingerprint trials. These metrics are suitable for measuring the accuracy of the fingerprint system and are used to test other fingerprint systems.

For the tests, four approaches to minutiae matching were tested; the first approach performed minutiae matching using all minutiae in the list to test against a single minutia from the enrollment image and the closest minutia to it was selected as the match and removed from the list, this was repeated for the rest of the enrollment minutia till the enrollment minutiae list was exhausted, and the match score was computed with a threshold of 0.5. This process was also repeated for all the reference minutiae points found during the reference template and minutia search, that were similar to the reference minutia based on angle difference and type of minutia. The reference minutia that had the best match was selected, as the first approach called the simple best match, while the second approach was to get average all the match scores gotten from all the reference minutiae found which was called the average simple match.

The third approach was using the proposed matching algorithm where we use a bounding box at the end of each line to capture minutia that should be at that location and find the best matching minutia out of all in the bounding box. Like the previous matching approach, this was also repeated for all minutiae found during the reference template and minutia search. The reference minutia with the highest match score was selected as the robust best match, which is the third approach, and an averaging of all the robust match scores was taken as the average robust match, which is the fourth approach to the minutiae matching. The FAR and FRR results of the four types of matching were compared at a threshold of 0.5 for the simple and robust best match approaches, and at 0.3 for the average simple and robust matches. The threshold of the average matches was reduced as compared the normal threshold due to the averaging operation carried out.

The trials conducted for the FAR are 500 in total, while for the FRR, 100 trials were conducted and the results at a threshold of 0.5 and 0.3 can be seen in Table 1.

Match Type	**Threshold Value**	**FAR**	**FRR**
Simple Best Match	0.5	0.124	0.54
Robust Best Match	0.5	0.14	0.54
Average Simple Match	0.3	0.05	0.7
Average Robust Match	0.3	0.064	0.69

Table 1: Match score comparison

Conclusion

Fingerprints are a good form of authentication as you cannot lose them easily, and they are unique for different individuals so they ensure proper identification and verification and can be used as security measures to protect important information. With the algorithms that have been developed for fingerprint matching, it shows that fingerprints of different individuals can be accurately identified to be a match or not without the need for experts in the traditional fingerprint recognition field where the naked eye is used to compare fingerprints, and this greatly enhances productivity, while reducing the costs of operation of businesses with need for high level of security.

The implementation of the combined template and minutia-matching algorithm presented in this research work shows that it can verify fingerprints that come from the same fingers and reject those from different fingers, though not to a fine degree due to the issues it faces when encountered with peculiar situations such as the template location of the enrolment image being cut out of the query image, noise, illumination and other deformations such as scaling and rotation. The algorithm combines techniques and algorithms from both the areas of minutia-based matching and image-based matching to create a new approach to matching fingerprints, which can be improved upon in areas such as time and accuracy by further research. Proper guidance given to users during scanning and capturing of fingerprints, if observed, will also help to increase the accuracy of this fingerprint system in both the identification and verification of people.

Recommendations

The proposed algorithm in this project suffers some drawbacks which can be tackled in the following ways:

i. Including the use of a fingerprint reconstruction algorithm in the preprocessing stage to deal with issues that arise from deformed fingerprints due to noise and light inconsistency, which causes increase in number of fake minutiae or bad template matching, and sometimes both.

ii. To reduce the time taken for the algorithm to run to completion, which is very necessary in a real-time fingerprint matching system, either a faster implementation of the ZNCC should be employed or a faster template-matching algorithm should be employed.

iii. To deal with the accuracy of the template matching, a new approach to template matching that can extract rotation and scale invariant features from templates that are uniform in pixel intensities, as seen in fingerprints where we have one ridge followed by a valley continuously, should be developed and used in place of the ZNCC that is bounded by both scale and rotation factors.

iv. To increase the minutia-matching accuracy of this algorithm, the minutia that are not in the enrollment image that appear in the query image needs to be excluded from the match score calculation as it severely impairs the calculation when the enrollment or query fingerprints experience occlusion which is often seen in fingerprint capturing, which leads to either some minutiae in the enrollment image not being seen in the query image or vice versa and if the match score is calculated based on the number of minutiae matched divided by the total number of minutiae in the enrollment fingerprint then this will lead to errors in the matching and also low matching accuracy.

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Camouflaged Object Detection Using Deep Learning

Khalak Bin Khair, Saqib Jahir, Mohammed Ibrahim, Fahad Bin and Debajyoti Karmaker

***Abstract*- Object detection is a computer technology that deals with finding instances of semantic items of a specific class in digital photos and videos. It is connected to computer vision and image processing. On top of object detection, we detect camouflage objects within an image using Deep Learning techniques. Deep learning is a subset of machine learning that is essentially a three-layer neural network. Over 6500 images which possess camouflage properties are gathered from various internet sources and divided into 4 categories to compare the result. Those images are labelled and then trained and tested using vgg16 architecture on the jupyter notebook using the TensorFlow platform. The architecture is further customized using Transfer Learning. Methods for transferring information from one or more of these source tasks to increase learning in a related target task are created through transfer learning. The purpose of this transfer of learning methodologies is to aid in the evolution of machine learning to the point where it is as efficient as human learning. After training the model using all the techniques and customization mentioned and described above, At last the architecture gives us outstanding accuracy.**

Keywords*: *Deep Learning, Transfer Learning, TensorFlow, Camouflage, Object Detection, Architecture, Accuracy, Model, VGG16.

I. Introduction

1.1 Overview

Object detection is a computer vision approach for detecting things in photos and videos. To obtain relevant results, object detection algorithms often use machine learning or deep learning. We can recognize and locate objects of interest in photos or video in a handful of seconds when we glance at them. The purpose of object detection is to use a computer to imitate this intelligence. But what is the purpose of object detection? Object detection's main purpose is to identify and find one or more effective targets in still or video data. It covers a wide range of techniques, including image processing, pattern recognition, artificial intelligence, and machine learning. Traditionally, object detection has been accomplished by manually extracting feature models, with popular features represented by HOG (histogram of oriented gradient), SIFT (scale-invariant feature transform), Haar (Haar-like features), and other grayscale-based approaches. As you can see in this picture [Figure 1.1], with the help of object detection we are able to spot the military soldiers and differentiate them from the tanks.

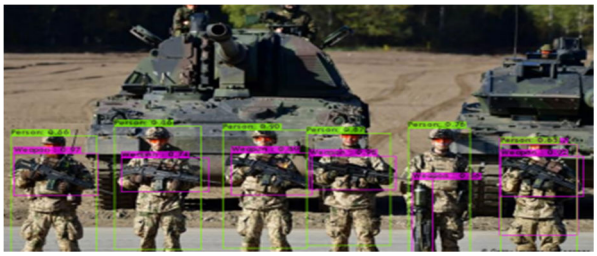

Figure 1.1: Military Object Detection

Object detection can be done in two methods, machine-learning approach or deep learning approach. We discussed in brief some of the machine-learning methods in the papers we reviewed, like Haar, HOG and so on. For the sake of this research, we'll be focusing on deep learning methods because they've become the state-of-the-art approaches to object detection. We are going to propose Camouflage Detection System using Deep Learning. Our purpose is to create a robust model that will be able to detect the camouflaged objects.

1.2 Background

Handcrafted characteristics were used to create the majority of the early object detection algorithms. People had no choice but to build complicated feature representations and a range of speed up skills to exhaust the use of limited computing resources due to the lack of effective image representation at the time.

- **Viola Jones Detectors**

P. Viola and M. Jones performed real-time face detection without any limitations for the first time 18 years ago [1], [2]. The detector, which ran on a 700MHz Pentium III CPU, was tens or even hundreds of times faster than existing methods at the time with comparable detection accuracy. The authors' names were given to the detection method, which was eventually known to as the "Viola-Jones (VJ) detector," in honor of their substantial contributions. The VJ detector uses a simple method of detection called sliding windows, which involves going through all potential locations and scales in a picture to see if any of the windows include a human face [Figure 1.2]. Although it appears to be a straightforward process, the

Khalak Bin Khair is with the American International University Bangladesh, Bangladesh (e-mail: khalakbinkhair@gmail.com).

calculations required were well beyond the capabilities of the computer at the time.

Figure 1.2: Viola Jones Detectors

• HOG Detector

N. Dalal and B. Triggs proposed the Histogram of Oriented Gradients (HOG) [3] feature descriptor in 2005. HOG is regarded as a significant advancement in the scale-invariant feature transform and shape contexts of the time. The HOG descriptor is designed to be computed on a dense grid of uniformly spaced cells and use overlapping local contrast normalization (on ”blocks”) for improving accuracy while balancing feature invariance

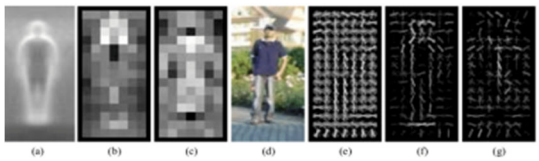

Figure 1.3: Human detector using HOG (Including translation, scale, illumination, and so on) and nonlinearity (on discriminating different object categories) [Figure:1.3].

•Deformable Part-based Model (DPM)

DPM was the pinnacle of traditional object detection systems, having won the VOC-07, -08, and -09 detection competitions. P. Felzenszwalb [4] suggested DPM in 2008 as an extension of the HOG detector, and R. Girshick improved it significantly. The DPM uses the ”divide and conquer” detection philosophy, in which the training can simply be thought of as learning a right way to decompose an object, and the inference can be thought of as an ensemble of detection on distinct object portions.

1.3 Problem Statement

Object detection of camouflage objects can be quite complex using machine learning techniques. It can be quite difficult to spot the camouflage object. For example, the pygmy seahorse is a kind of fish which is only 1cm, and its body is natural camo for under the sea objects, so detecting them can be quite difficult. The same goes with military, most military uniforms are natural camos so they can blend with the natural surroundings at war easily. To detect them can be quite complex. Therefore, building a robust model for object detection of camouflaged objects using deep learning helps us in detecting these complex objects with a lot more ease. We are providing solutions where the users can easily understand the objects and recognize them amidst their camo background.

1.4 Research Question

• How is Deep Learning technique more effective than Machine Learning technique when it comes to Object Detection?

When the data amount is high, Deep Learning outperforms conventional techniques. Traditional Machine Learning techniques, on the other hand, are preferable when dealing with tiny amounts of data. Traditional machine learning techniques, such as linear regression or a decision tree, have a relatively straightforward structure, but deep learning is based on an artificial neural network. This multi-layered ANN is complicated and interwoven, just like a human brain.

1.5 Objective

General Objective

In this study we are going to develop a camouflage object detection system. This system is will aim to detect the object that are camouflaged with the nature. This system will help us to even detect small animals such as pygmy seahorse with ease.

Specific Objective

• To design a robust camouflage object detection system using Deep Learning
• To develop a camouflage object detection system using TensorFlow platform.
• To find out the effectiveness of this architecture for object detection

Our research is based on object detection using deep learning and our aim is to make a robust object detection so that detecting the camouflage images becomes slightly easier and make a positive impact in our human life. The proposed Object Detection system will help us yield a result with high accuracy. Working with TensorFlow helps us perform a variety of tasks related to deep neural network training and inference.

II. Literature review

This research is based on research publications from a variety of fields, we go through the literature review of papers based on object detection, deep learning, CNN architectures, Anchor-based method object detection.

What exactly do we mean by the term object detection?

Detecting instances of visual objects of a specific class (such as persons, animals, or cars) in digital photographs is an important computer vision task. Object detection's goal is to create computational models and approaches that give one of the most fundamental bits of information required by computer vision applications. Object detection is one of the most fundamental problems in computer vision, and it provides the foundation for many other computer vision tasks such as instance segmentation, image captioning, object tracking, and so on. Object detection can be divided into two research topics:" general object detection" and" detection applications," with the former aiming to investigate methods for detecting various types of objects in a unified framework to simulate human vision and cognition, and the latter referring to detection in specific application scenarios such as pedestrian detection, face detection, text detection, and so on. In recent years, the rapid development of deep learning techniques [5] has brought new blood into object detection, leading to remarkable breakthroughs and pushing it forward to research hot-spot with unprecedented attention [6]. Object detection is currently widely employed in a wide range of real-world applications, including autonomous driving, robot vision, video surveillance, and so on.

Constantine Papageorgiu et al. [7] carried out a research that built a robust trainable object detection system that is used in surveillance applications, driver assistance systems and as front ends to recognition systems. Their representation is capable of capturing the structure of the object class we want to detect while ignoring the noise in the photos. Image reconstruction techniques prompted the usage of an overcomplete dictionary; our goal is classification, and the overcomplete dictionary offers us with a richer expressive language in which we may compare complicated patterns. An example-based learning strategy is used, in which a model of an object class is inferred implicitly from a set of training instances. Specializing this generic system to a specific domain in this way entails just plugging in a new batch of training data rather than changing the basic system or creating a new model by hand. The specific learning engine used is a support vector machine (SVM) classifier. This classification technique has a number of properties that make it particularly attractive and has recently received much attention in the machine learning community [7]. The system uses 1) a series of photos of the object class that have been aligned and scaled so that they are all in roughly the same position and size, and 2) a set of patterns that are not in our object class as input in the training step. In the testing phase, detecting objects in out-of-sample images is the task. The system slides a fixed size window over an image and uses the trained classifier to decide which patterns show the objects of interest [7]. Wavelets provide a natural mathematical structure for describing the patters in a more detailed manner. The Haar wavelet is perhaps the most basic finite support feature. We convert our photographs from pixel space to a three-dimensional space wavelet coefficient, yielding an overcomplete dictionary of features that can subsequently be utilized to train a machine learning algorithm. The Haar transform creates a multiresolution image by using wavelet features at different sizes to capture varying levels of information; coarse scale wavelets encode vast regions, while fine scale wavelets describe smaller, localized areas. A wavelet's strong response shows the presence of an intensity differential, or border, at that spot in the image, whereas a wavelet's weak response suggests a uniform area. The fact that wavelets capture visually realistic characteristics of the shape and interior structure of things that are invariant to specific changes is our primary motivation for employing them. As a result, diverse sample photos from the same object class map to similar feature vectors, resulting in a compact representation. A weak coefficient in a relatively dark image may still indicate the presence of an intensity difference that is significant for classification purposes, a weak coefficient in a relatively dark image may still indicate the presence of an intensity difference that is significant for classification purposes. The authors normalized a coefficient's value against the other coefficients in the same area to lessen these effects on the features utilized for categorization. Ensemble average values more than 1 show strong intensity difference features that are consistent across all examples, values less than 1 indicate consistent uniform regions, and values near 1 indicate inconsistent features or random patterns.

The term salient means most noticeable or important. Salient object identification is the process of detecting and segmenting salient objects in natural settings. In 2019, Ali Borji et al. [8] described salient object segmentation in computer vision as 1) detecting the most salient object and 2) segmenting the accurate region of that object. [8] A model should meet at least three of the following criteria for good saliency detection: 1) accurate detection: the likelihood of missing real salient regions and incorrectly marking the background as a salient region should be low; 2) high resolution: saliency maps should have high or full resolution to accurately locate salient objects while retaining original image information; and 3) computational efficiency: these models should detect salient regions quickly as front-ends to other complex processes. In recent years, with the rise in popularity of convolutional neural networks (CNNs) and in particular with the development of fully convolutional neural networks, a third wave of interest has recently emerged. Many researchers have used CNN-based approaches because they minimize the need for hand-crafted features and reduce the reliance on center bias information. Neurons with broad receptive fields provide global information that can aid in identifying the most salient region in an image, whereas neurons with narrow receptive fields provide local information that can be used to refine saliency maps generated by

the upper layers. Using CNN based models helps in refining the boundaries thus highlighting the salient regions.

In an influential study, Achanta et al. [9] adopt a frequency-tuned approach to compute full resolution saliency maps. The saliency of pixel x is computed as $s(x) = ||I\mu - I\omega hc(x)||^2$where Iμ is the mean pixel value of the image (e.g., RGB/Lab features) and Iωhc is a Gaussian blurred version of the input image (e.g., using a 5 × 5 kernel)*. Detection of salient object based on pixels or patches like the formula above suffer a couple of shortcomings: 1) high-contrast edges usually stand out instead of the salient object, and 2) the boundary of the salient object is not preserved well. To overcome this issue, the number of regions is far smaller than the number of blocks, allowing for the development of extremely efficient and quick algorithms. This above method uses heuristics to detect salient objects. While hand-crafted features enable real-time detection, they have a number of drawbacks that limit their capacity to capture important items in difficult situations. CNNs have recently been found to be quite effective when used for salient object detection. CNNs can accurately capture the most important regions without any prior information thanks to their multilevel and multi-scale properties.

Deep learning-based salient object identification algorithms can be divided into two groups. Models that use multilayer perceptron's (MLPs) for saliency detection fall into the first category. The input image is generally over segmented into single- or multiscale tiny regions in these models. Then, using a CNN, high-level features are extracted, which are then input into an MLP to compute the saliency value of each small region. Kaiwen Duan et al. [10] carried out research called Centre-Net which identifies each item as a triplet of key points rather than a pair, improving precision and recall. In this paper, the researchers create two unique modules, cascade corner pooling and center pooling, that enrich data acquired by both the top-left and bottom-right corners while also providing more recognized data from the center regions. The anchor-based flowchart, one of the most common flowcharts today, sets a series of rectangles with predetermined sizes (anchors) on a picture then regresses the anchors to the desired location using ground- truth objects. The drawbacks that arise from anchor-based approaches are tackled by an object-detection pipeline named Corner-Net. However, CornerNet's performance is constrained by its limited capacity to refer to an object's global information. In order to address this problem, CentreNet a low-cost yet successful approach that explores the central part of a proposal, that is, the region near the geometric center of a box, with one additional keypoint is introduced. We reason that if a predicted bounding box has a high IoU with the ground-truth box, the center keypoint in the central region of the bounding box is likely to be predicted as the same class, and vice versa. Instead of using a pair, a triplet of keypoints is used to represent each object. To improve the detection of centre keypoints, 2 strategies are used, center pooling and cascade pooling. To improve the performance of centre key points and corners, 2 strategies are introduced.

First strategy is center pooling, which is used in the branch for predicting center keypoints. Center pooling helps the center keypoints obtain more recognizable visual patterns within objects, which makes it easier to perceive the central part of a proposal. The second strategy is cascade corner pooling, which equips the original corner pooling module [11] with the ability to perceive internal information. They achieve this by obtaining the maximum summed response in both the boundary and internal directions of objects on a feature map for corner prediction [10].

CenterNet, which combines center pooling and cascade corner pooling, has an AP of 47.0 percent, outperforming all existing onestage detectors by a wide amount.

CornerNet is used as a baseline in this study. CornerNet creates two heatmaps for detecting corners: one for the top-left corners and one for the bottom-right corners. The heatmaps show the locations of keypoints in many categories and give each one a confidence level. CornerNet also predicts the embedding of each corner as well as a collection of offsets. The embeddings are used to determine if two corners belong to the same item. The offsets learn to remap the heatmap corners to the supplied image. To detect the regions inside the bounding box, unlike CornetNet, the researchers use CentreNet. CentreNet method uses a triplet of keypoints rather than a pair for object detection. This method retains a one-stage detector while partially inheriting the capabilities of RoI pooling. Their method just takes into account the most important data, and it comes at a low cost. On the basis of CornerNet, they integrate a heatmap for the center keypoints and forecast the offsets of the center keypoints. The detection results are influenced by the size of the central region in the bounding box. For small bounding boxes, for example, small center regions result in a low recall rate, whereas large central regions result in low precision. As a result, a scale-aware center region that can adapt to different bounding box sizes was proposed. For a small bounding box, the scaleaware central region tends to generate a relatively large central region, and for a large bounding box, it tends to generate a relatively tiny central region.

Miang Liang et al. [12] conducted research on multi-task muti-sensor fusion for 3D Object Detection. Most self-driving cars rely on three-dimensional perception because it allows for interpretable motion planning in a bird's eye view. In this study the authors claim that by solving numerous perception tasks at the same time, we can develop richer feature representations and hence improve detection performance. A multi-sensor

detector to achieve this goal is built, which considers 2D and 3D object identification, ground estimation, and depth completion. Importantly, our model can be taught from start to finish and accomplishes all of these functions at the same time. On the KITTI object detection benchmark [13] as well as the more difficult TOR4D object detection benchmark [14], the usefulness of the approach is demonstrated. The authors exhibit considerable performance improvements over earlier state-of-the-art approaches in 2D, 3D, and BEV detection tasks on the KITTI benchmark. Meanwhile, the proposed detector operates at a rate of over 10 frames per second, making it a viable real-time option. To combine several sensors, F-PointNet [15] employs a cascade technique. Specifically, 2D object detection is performed on images initially, followed by the generation of 3D frustums by projecting 2D detections to 3D, and the use of PointNet [16] [17] to regress the 3D location and shape of the bounding box. Each stage, which is still using a single sensor, is constrained by the overall performance in this framework. Perceiving the scene in real time is one of the most important jobs in autonomous driving.

A multi-task multi-sensor fusion model for 3D object detection is proposed in this paper. The following are some of the key aspects of our strategy. First, they create a multisensor architecture that incorporates feature fusion on a point-by-point and ROI-by-ROI basis. Second, the geometry of the road is considered by our integrated ground estimating module. Third, we use the depth completion task to improve multi-sensor feature learning and achieve dense point-wise feature fusion. A LiDAR point cloud and an RGB picture are fed into our multi-sensor detector. The backbone network is divided into two streams, one extracting image feature maps and the other extracting LiDAR BEV feature maps. To fuse multiscale picture features to the BEV stream, point-wise feature fusion is used. The final BEV feature map uses 2D convolution to anticipate dense 3D detections per BEV voxel. Network architecture includes Point-wise fusion, ROI-wise feature fusion. Point-wise feature fusion: The authors combine the convolutional feature maps of LiDAR and picture streams using point-wise feature fusion. To supplement BEV features with the information richness of image features, the fusion is routed from image steam to LiDAR steam. With a feature pyramid network, they collect multi-scale features from all four blocks in the picture backbone network. The multi-scale image feature map that results is then fused to each LiDAR BEV backbone network block.

ROI-wise feature fusion: The goal of ROI-wise feature fusion is to improve the precision of high-quality detections' localisation in 2D and 3D spaces, respectively. To do this, the ROI feature extraction must be precise in order to accurately anticipate relative box refinement. The authors get an axis-aligned image ROI and an orientated BEV ROI by projecting a 3D detection onto the image and BEV feature maps. To extract features from an axis-aligned image ROI, they use ROIAlign [18] Tao Kong et al. [19] proposed a method FoveaBox, an object detection framework that is accurate, adaptable, and fully anchor-free. While practically all modern object detectors use predetermined anchors to list possible positions, sizes, and aspect ratios for object search, their performance and generalization capabilities are also constrained by anchor design. Instead of using an anchor reference, FoveaBox learns the object's existing potential and bounding box coordinates immediately. This is accomplished by (a) predicting category-sensitive semantic maps for the item's existing possibility, and (b) generating a category-agnostic bounding box for each position that might contain an object. To improve the model's accuracy, an instance is assigned to adjacent feature levels in FoveaBox. On standard benchmarks, we demonstrate its efficacy and present thorough experimental analyses. FoveaBox achieves state-of-the-art single model performance on the standard COCO and Pascal VOC object detection benchmarks without any bells and whistles. More crucially, FoveaBox eliminates all anchor box computation and hyper-parameters, which are often sensitive to final detection performance.

In object identification frameworks, anchors must be constructed and handled with care. (a) The density with which anchors cover the instance location space is one of the most critical factors in anchor design. Anchors are meticulously designed depending on statistics computed from the training/validation set in order to attain a high recall rate. (b) A design decision based on a specific dataset may or may not be applicable to other applications, reducing the generality. (c) Anchor-methods use intersection-overunion (IoU) to determine positive/negative samples during the training phase, which adds extra computation and hyper-parameters to an object detection system.

FoveaBox is a straightforward concept: it consists of a backbone network and a fovea head network. The backbone, which is an off-the-shelf convolutional network, is responsible for calculating a convolutional feature map over a full input image. The fovea head is divided into two sections: the first performs per-pixel classification on the backbone's output, and the second performs box prediction for each place that may be covered by an object.

For each position potential contained by an instance, FoveaBox forecasts the object existence possibility and the accompanying boundary.

$$x_1^{'} = \frac{x_1}{s_1}, \quad y_1^{'} = \frac{y_1}{s_1}, \quad x_2^{'} = \frac{x_2}{s_1}, \quad y_2^{'} = \frac{y_2}{s_1},$$

$$c_x^{'} = 0.5(x_2^{'} + x_1^{'}), \quad c_y^{'} = 0.5(y_2^{'} + y_1^{'}),$$

$$\omega^{'} = x_2^{'} - x_1^{'}, \quad h^{'} = y_2^{'} - y_1^{'}$$

We'll go over the major components one by one in this section. 1) Object Occurrence Possibility: Given a valid ground-truth box denoted as (x1, y1, x2, y2). We first map the box into the target feature pyramid P1 where sl is the down-sample factor. The positive area Rpos on the score map is designed to be roughly a shrunk version of the original one. At training phase, each cell inside the positive area is annotated with the corresponding target class label. The negative area is the whole feature map excluding area in Rpos [19].

2) Scale Assignment: based on the number of feature pyramidal levels, divide the scales of objects into several bins. On pyramid levels P3 through P7, each pyramid has a basic scale rl that ranges from 32 to 512.

3) Box Prediction: Each ground-truth bounding box is stated as G = (x1, y1, x2, y2).

$$t_{x_1} = log\frac{s_1(x+0.5)-x_1}{r_1},$$

$$t_{y_1} = log\frac{s_1(y+0.5)-y_1}{r_1},$$

$$t_{x_2} = log\frac{x_2-s_1(x+0.5)}{r_1},$$

$$t_{y_2} = log\frac{y_2-s_1(x+0.5)}{r_1},$$

FoveaBox computes the normalized offset between (x, y) and four boundaries straight from a positive point (x, y) in Rpos.

Yanghao Li et al. [20] Proposed a research paper to challenge the scale variation in object detection, called TridenNet. Trident Network (TridentNet) is a project aimed at creating scale-specific feature maps with consistent representational power. The authors create a parallel multi-branch architecture in which each branch is independent of the others, has the same transformation parameters as the other, but has a different receptive field. The handling of size variation is a central challenge for both systems. Detectors, especially those that are extremely small or very huge, are hampered by the scales of object instances, which can range from small to very enormous. An intuitive option to address big scale variance is to use multi-scale image pyramids, which are common in both hand-crafted feature-based methods and contemporary deep CNN-based methods. To solve the problem of scale variation in object detection. TridentNet was able to build scale-specific feature maps with a uniform representational power thanks to its multibranch structure and scale-aware training. Through their weight-sharing trident-block design, they offer TridentNet Fast, a fast approximation with only one major branch, introducing no new parameters or computational cost during inference.

With comprehensive ablation studies, they were able to validate the effectiveness of our technique on the standard COCO benchmark. Using a single model with a ResNet-101 backbone, the suggested method obtains a mAP of 48.4 when compared to state-of-theart methods.

Although it has been widely assumed for years that modeling relationships between objects will aid object recognition, there has been little evidence that this is the case in the deep learning era. To tackle this challenge, Han Hu et al. [21] Put forward a proposal that detect systems individually without exploiting ther relations during learning. This paper proposes a module for object relationships. It processes a group of objects at the same time by interacting with their appearance features and geometry, allowing for the modeling of their relationships. It's light and stays in place. It doesn't need any extra supervision and is simple to integrate into existing networks. In the contemporary object detection pipeline, it has been demonstrated to improve object recognition and duplicate removal processes. It proves that modeling object relations in CNN-based detection is effective. It is the first object detector that is truly end-to-end. There has been no substantial development in utilizing object relations for detection learning during the deep learning period. The majority of approaches still focus on recognizing items separately. In the contemporary object detection pipeline, it has been demonstrated to improve object recognition and duplicate removal processes. It proves that modeling object relations in CNN-based detection is effective. It is the first object detector that is truly end-to-end. There has been no substantial development in utilizing object relations for detection learning during the deep learning period. The majority of approaches still focus on recognizing items separately

Relation for Duplicate Removal:

The process of removing duplicates inherently necessitates the use of object relationships. A basic example of the heuristic NMS approach is that the object with the greatest score will eliminate its neighboring neighbors with lower scores. **End-to-End Object Detection:**

The area proposal loss, instance recognition loss, and duplication classification loss are all combined with equal weights in the end-to-end training.

Mingxing Tan et al. [22] extensively examine neural network architecture design choices for object detection and offer some major enhancements to increase efficiency. First, they propose a weighted bi-directional feature pyramid network (BiFPN), which enables simple and quick multi-scale feature fusion; second, propose a compound scaling method that scales the resolution, depth, and width of all backbone, feature network, and box/class prediction networks at the same time. They built a new family of object detectors called EfficientDet based on these optimizations and

EfficientNet backbones, which consistently achieve considerably superior efficiency than prior art across a wide range of resource limitations. EfficientDet's overall architecture, which is mostly based on the one-stage detector paradigm. As the backbone network, the authors use ImageNettrained EfficientNets. The feature network in our proposal is the BiFPN, which takes

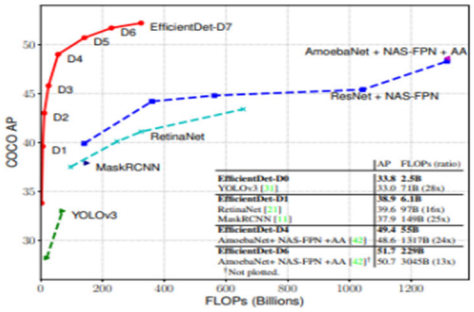

Figure 2.1: The EfficientDet achieves new state-of-the-art 52.2% COCO AP with much fewer parameters and FLOPs than previous detectors. More studies on different backbones and FPN/NAS-FPN/BiFPN.

level 3-7 features from the backbone network and applies top-down and bottom-up bidirectional feature fusion periodically. To provide object class and bounding box predictions, these fused characteristics are fed into a class and box network.

Compound Scaling:

The authors of this paper created a family of models that can fulfill a wide range of resource limitations, with the goal of optimizing both accuracy and efficiency. The ability to scale up a baseline EfficientDet model is a crucial hurdle here. They offered a new compound object recognition approach that leverages a simple compound coefficient to scale up all dimensions of the backbone network, BiFPN network, class/box network, and resolution at the same time.

Input Image Resolution:

Because BiFPN uses feature levels 3–7, the input resolution must be 2 time 7. As a result, the equation to linearly increase resolutions. Rinput = 512 + φ · 128 The EfficientDet is evaluated on COCO2017 detection datasets with 118k training images, the model is further optimized using an SGD optimizer.

Xuebin Qin et al. [23] proposed a boundary-aware salient object detection, BASNet, The architecture is made up of a highly supervised Encoder-Decoder network and a residual refinement module, which are in charge of saliency map refining and prediction, respectively. By combining Binary Cross Entropy (BCE), Structural SIMilarity (SSIM), and Intersectionover-Union (IoU) losses, the hybrid loss guides the network to learn the transformation between the input image and the ground truth in a three-level hierarchy – pixel, patch, and map level. The suggested predict-refine architecture is able to efficiently segment the salient object regions and reliably forecast the fine structures with unambiguous bounds thanks to the hybrid loss. It delivers high-quality bounds and accurate salient object segmentation (i) A new predict-refine network is presented to capture both global (coarse) and local (fine) circumstances. It combines an unique residual refinement module with a UNet-like deeply supervised Encoder-Decoder network. The Encoder-Decoder network converts the input image to a probability map, and the refinement module fine-tunes the predicted map by learning the residuals between the coarse saliency map and the ground truth. (ii) To obtain a high-confidence saliency map with a clear boundary, we suggest a hybrid loss that incorporates Binary Cross Entropy, Structural SIMilarity (SSIM), and IoU losses, all of which are expected to learn from ground truth information at the pixel, patch, and map levels, respectively.

Refine Model:

Refinement Module (RM) [24] [25] is commonly constructed as a residual block that refines the coarse saliency maps that have been forecasted. Sref ined = Scoarse + Sresidual. To define the term "coarse" before the authors talk about their refinement module. The term "coarse" has two meanings in this context. The first is the hazy and noisy limits. The other is the regional probabilities that are unevenly forecasted. SOD, ECSSD, DUT-OMRON, PASCAL-S, HKU-IS, and DUTS are six commonly used benchmark datasets on which the authors tested their technique. SOD includes 300 photos that were created with image segmentation in mind. These photographs are difficult to work with because most of them have many important items that are either low contrast or overlap with the image boundaries.he DUTS-TR dataset, which contains 10553 pictures, was used to train the network. The dataset is augmented by horizontal flipping to 21106 photos before training. Each image is scaled to 256256 pixels and then randomly cropped to 224224 pixels during training. The ResNet-34 model [18] is used to initialize some of the encoder parameters. Xavier [26] initializes the other convolutional layers. To train their network, they used the Adam optimizer, with the hyper parameters set to default.Alex Bochkoskiy et al. [27] proposed a research YOLOv4 for optimal speed and accuracy of object detection. Rather than the theoretical indicator of low computing volume, the major purpose of this work is to create a high operating speed of an object detector in production systems and optimization for parallel computations (BFLOP). The authors created a product that will be simple to train and operate. Anyone who trains and tests with a traditional GPU, for example, may get real-time, high-quality, and convincing object detection results, as the YOLOv4 does.

1. A model for detecting objects that is both efficient and powerful. It allows anyone to train a highly fast

and accurate object detector using a 1080 Ti or 2080 Ti GPU.

2. During the detector training, the influence of state-of-the-art Bag-of-Freebies and Bag-of-Specials item detection approaches.

3. They modify state-of-the-art methods and make them more efficient and suitable for single GPU training, including CBN [28], PAN [29] etc.

Bag of freebies A traditional object detector is usually trained offline. As a result, researchers are continually looking for ways to improve training methods so that the object detector can receive improved accuracy without increasing the inference cost. We refer to these strategies as ”bag of freebies” because they just vary the training plan or enhance the training expense. Data augmentation is a technique used by object detection techniques that fits the concept of a ”bag of freebies.” The goal of data augmentation is to increase the heterogeneity of the input photos so that the built object detection model can handle photographs from a variety of contexts. Photometric distortions and geometric distortions, for example, are two prominent data augmentation methods that clearly improve the object detection process. We alter the brightness, contrast, color, saturation, and noise of an image when dealing with photometric distortion. We use random scaling, cropping, flipping, and rotating to create geometric distortion. Bag of specials

“Bag of specialties” refers to plugin modules and post-processing procedures that only increase the inference cost by a little amount while greatly improving object detection accuracy. Of general, these plugin modules are used to improve particular qualities in a model, such as increasing the receptive field, adding an attention mechanism, or improving feature integration capability, while post-processing is a way for screening model prediction outcomes.

Rather than the theoretical signal of low computing volume, the primary goal of this architecture is rapid neural network operating speed in production systems and optimization for parallel computations (BFLOP). They provide two real-time neural network options:

• In convolutional layers, they use a modest number of groups (1-8) for GPU: CSPDarknet53 / CSPResNeXt50

• They employ grouped-convolution for VPU, but we don’t use Squeeze-and-excitement (SE) blocks - precisely, this applies to the following models:

MixNet [22] / GhostNet [30] / MobileNetV3 / EfficientNet-lite.

For improving the object detection training, a CNN usually uses the following:

• Activations: ReLU, leaky-ReLU, parametric-ReLU, ReLU6, SELU, Swish, or Mish

• Bounding box regression loss: MSE, IoU, GIoU, CIoU, DIoU

• Data augmentation: CutOut, MixUp, CutMix

• Regularization method: DropOut, DropPath , Spatial DropOut , or DropBlock

• Normalization of the network activations by their mean and variance: Batch Normalization (BN), Cross-GPU Batch Normalization (CGBN or SyncBN) , Filter Response Normalization (FRN), or Cross-Iteration Batch Normalization (CBN)

• Skip-connections: Residual connections, Weighted residual connections, Multi-input weighted residual connections, or Cross stage partial connections (CSP) [31]

Jia-Xing Zhao et al. [32] proposed an edge guidance network for salient object detection EGNet, The goal of salient object detection (SOD) is to find the things in a scene that are the most easily recognized. It’s been widely employed in vision and image processing applications such as content-aware picture editing, object recognition, photosynth, non-photo-realist rendering, poorly supervised semantic segmentation, and image retrieval. There have also been a number of studies published on video salient object detection and RGB-D salient object detection. The bulk of SOD techniques based on CNN architecture that take picture patches as input use multi-scale or multi-context information to generate the final saliency map. To preserve the salient object boundaries, the authors propose an EGNet that explicitly models complimentary prominent object information and salient edge information within the network. The conspicuous edge traits, on the other hand, are also useful for localisation. Their model optimizes these two complementing tasks in tandem by allowing them to mutually assist one another, resulting in much improved predicted saliency maps. On six frequently used datasets, we compare the suggested methods to 15 state-of-the-art methodologies. Our strategy outperforms the competition in three evaluation metrics even without the bells and whistles. When compared to region-based algorithms, pixel-wise salient object recognition methods have demonstrated to be superior. However, they overlooked the images’ spatial coherence, resulting in unsatisfactory salient object borders. In both segmentation and localization, a good salient edge detection result can aid the salient object detection task, and vice versa. The researchers developed an EGNet to describe and fuse the complementary salient edge and salient object information within a single network in an end-to-end way based on this concept.

In their strategy, they will still have five side paths: S (2), S(3), S(4), S(5), and S(6). These five characteristics could be denoted by a backbone features set C: C = C (2), C(3), C(4), C(5), C(6).

where C (2) denotes the Conv2-2 features and so on. Conv2- 2 preserves better edge information [33]. Thus we leverage the S (2) to extract the edge features and other side paths to extract the salient object features [32].

In short this paper, extracts U-Net-based multi-resolution salient object characteristics The researchers next present a non-local salient edge features extraction module that combines local edge information with global location information to extract salient edge features.

The use of salient edge features improves the localisation and limits of salient objects. On six frequently used datasets, their model outperforms state-of-the-art approaches without any pre-processing or post-processing. We also provide evaluations on the EGNet's effectiveness.

Xingyi Zhou et al. [34] proposes ExtremeNet, ExtremeNet is a bottom-up object de- tection framework that recognizes an object's four extreme points (top-most, left-most, bottom-most, and right-most). To locate extreme points, the researchers employ a cuttingedge keypoint estimation framework that predicts four multi-peak heatmaps for each item category. In addition, they forecast the object center using one heatmap per category, which is the average of two bounding box edges in both the x and y dimensions. This architecture was introduced to tackle the limitations of Top-down aprroaches, which have dominated object detection for years. ExtremeNet uses keypoint prediction which is similar to CornerNet, which we have discussed earlier.

Two essential components of their technique are different: keypoint definition and grouping. A corner is a type of bounding box that has many of the same problems as top-down detection. A corner is generally seen outside of an object, with few distinguishing features. Extreme points, on the other hand, are found on objects, can be seen, and have a consistent local look. The topmost point of a human, for example, is usually the head, while the bottommost point of a car or airplane is usually a wheel. This simplifies the detection of extreme points. The geometric grouping is the second difference from CornerNet. Our detection system is entirely solely on appearance, with no implicit feature learning. The appearance-based grouping performs substantially better in our tests.

HoureglassNet is used by ExtremeNet to detect five keypoints which includes four extreme points and one center. The offset prediction is category-agnostic, but it is specialized to extreme points. For the center map, no offset is predicted. As a result, their network generates 5 C heatmaps and 4 2 offset maps, where C is the number of classes. Extreme points are located on opposite sides of an object. This makes grouping more difficult. An associative embedding, for example, might not have a broad enough view to group these keypoints. They use a different technique here, utilizing the dispersed nature of extreme points. Five heatmaps per class are used as input to our grouping algorithm: one center heatmap and four extreme heatmaps. They extract the corresponding keypoints from a heatmap by detecting all peaks. t, b, r, and l are four extreme points taken from heatmaps. Their geometric center is calculated as c = (lx+tx /2 , ty+by/ 2) For three equally spaced colinear objects of the same size, center grouping may result in a high-confidence falsepositive detection. These false-positive detections are referred to as "ghost" boxes. The researchers show how to remove ghost boxes with a simple postprocessing step. A ghost box, by definition, contains a large number of tiny detections. They apply a type of soft non-maxima suppression to prevent ghost boxes. If the sum of the scores of all boxes contained in a bounding box exceeds three times its own score, we divide it by two.

Extremes do not necessarily have a distinct definition. If an object's vertical or horizontal edges form extreme points, any point along those edges could be called an extreme point. As a result, instead of a single powerful peak response, their network provides a modest reaction along any aligned edges of the object. To solve this problem, the researchers employ edge aggregation. They aggregate the score of each extreme point, retrieved as a local maximum, in either the vertical (left and right extreme points) or horizontal (top and bottom keypoints) direction.

With at least twice as many annotated values as a basic bounding box, extreme points carry a lot more information about an object (8 vs 4). By building an octagon whose edges are centered on the extreme points, they present a simple way to approximate the object mask using extreme points. They extend an extreme point in both directions on its corresponding edge to a segment that is 1/4 of the edge length. When the section reaches a corner, it is shortened. The four segments' end points are then connected to make the octagon.

Their model gets an AP of 43.7 after multi-scale testing, exceeding all published onestage object detectors and matching popular two-stage detectors. It outperforms CornerNet by 1.6 percent, demonstrating the benefit of detecting extreme and center points over detecting corners with associative characteristics.

Wanli Ouyang et al. [35] proposed a deformable deep convolutional neural network for object detection called DeepID-Net. A new deformation constrained pooling (defpooling) layer in the proposed new deep architecture mimics the deformation of object pieces with geometric constraint and penalty. To learn feature representations that are more suitable for the object identification task and have strong generalization capabilities, a new pre-training technique is proposed. A set of models with great variety is created by modifying the net architectures, training procedures,

and adding and removing some critical components in the detection pipeline, which significantly increases the effectiveness of model averaging.

Object detection with a new deep learning framework. Feature representation learning, part deformation learning, context modeling, model averaging, and bounding box location refining are all effectively integrated into the detection system. Extensive experimental examination provides a detailed component-by-component analysis. This is also the first study to look into the impact of CNN structures on large-scale item detection in the same context. Multiple detectors with substantial variability are formed by modifying the setup of this framework, resulting in more effective model averaging.A new pretraining technique for the deep CNN model.

Instead of using picture-level annotations, which are typically utilized in present deep learning object detection, we propose pretraining the deep model on the ImageNet image classification and localization dataset with 1000-class object-level annotations. The deep model is then fine-tuned on ImageNet/PASCAL-VOC object detection, which are the two datasets' targeting object classes.A novel deformation constrained pooling (defpooling) layer extends the deep model by learning the deformation of object pieces at different levels of information abstraction. The def-pooling layer can be used to learn the deformation properties of parts and replace the max-pooling layer.Candidate bound- ing boxes are proposed using a selective search method. In their experiment, an existing detector is employed to reject bounding boxes that are most likely to be background. To acquire 200 detection scores, an image region within a bounding box is clipped and fed into the DeepID-Net. Each detection score represents the degree of certainty in a cropped image comprising a single object class. The 1000-class whole-image classification scores of a deep model are used as contextual information to refine the detection scores of each candidate bounding box. To improve detection accuracy, the average of numerous deep model outputs is used. To mitigate localization mistakes, the RCNN proposes bounding box regression.

III. Methodology

3.1 Overview

This chapter comprises of the dataset used, its preparation, preprocessing and the architecture implemented to find the result. It also describes the process of how we trained our model by dividing the dataset into training data and testing data with validation.

3.2 Research Methodology

The main goal is to develop a robust camouflage object detection system using Transfer Learning on VGG16 architecture. We show the optimal accuracy we achieved using our customized training model on VGG16 architecture and the benefits we can obtain like detecting soldiers behind enemy lines in war also we can discover the life cycle of so many species which are endangered on deep sea.

3.3 Data Description

The dataset we gathered are from various internet sources. We collected a grand total of approximate 6500 pictures and divided them into 4 categories, Army, Pygmy seahorse, chameleon and octopus. Army consists of approximate 1300 pictures, pygmy and chameleon of 2000 each and octopus of over a 1000. However, we try to seek among most effective camouflage picture from the internet.

3.4 Data Preparation and Data preprocessing

After gathering the datasets from various sources and dividing them into 4 categories, we label the dataset using software. The link for this graphical image annotation tool is:https://github.com/tzutalin/labelImg

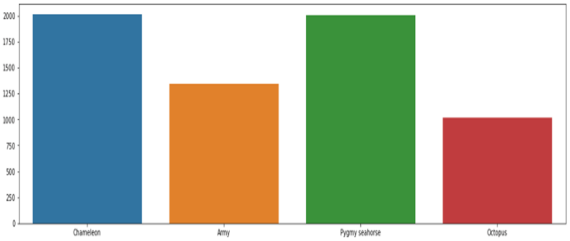

Figure 3-1: Chameleon (blue) , Army (Orange),Pygmy seahorse(Green),Octopus(Red)

From this bar chart we can see the images being divided into 4 categories. Then we label this image using labeling tools. The process of preprocessing labelling is we select that particular image, then we write the name of the image so that the tool that detect the exact image more accurately that we are referring to.

3.5 Model Training

At first, we import OS because OS module in Python provides functions for creating and removing a directory (folder), fetching its contents, changing and identifying the current directory. Then, we import cv2, it is the module name for opencv-python. After that we import glob, pyplot , sns and imageDataGenerator respectively. For the training we used seed 1000, image size 100 and batch size 128. In training generator, we used ImageDatagenerator

where, rotation range 30 width_shift_range=0.2, height_shift_range=0.2, zoom range = 0.3, horizontal_flip=True,validation_split=0.2.subset='training', class mode = 'sparse' has been used for train batch also in valid batch it remains same class mode but subset

used as 'validation'. In train batch we found 5011 images belonging to 4 classes where as in validation batch it was 1252 images belonging to 4 classes. For the base model we used 'imagenet' as weights for our training model.

In briefly, The ImageNet project is a large visual database designed for use in visual object recognition software research. More than 14 million images have been hand-annotated by the project to indicate what objects are pictured and in at least one million of the images, bounding boxes are also provided. ImageNet contains more than 20,000 categories with a typical category, such as "balloon" or "strawberry", consisting of several hundred images.

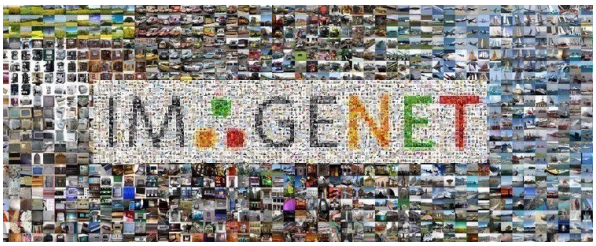

Figure 3-2:ImageNet

3.6 Architecture Selection

The preprocess data was used to train Transfer Learning on VGG16.During the architecture selection, We used ResNet50, Alexnet, SSD Mobile net and VGG16 architecture to test for accuracy. Among them VGG16 gives us highest amount of accuracy consider to all other architecture.

Figure 3.3 : VGG16 Architecture Model

About VGG16, On the ImageNet dataset, it was shown to be the highest performing model out of all the setups. A size 224 by 224 image with three channels – R, G, and B – is regarded the input to any of the network configurations. The only pre-processing done is to normalize each pixel's RGB values. Every pixel is subtracted from the mean value to achieve this. Following ReLU activations, the image is sent through a first stack of two convolution layers with a very small receptive area of 3 × 3. There are 64 filters in each of these two layers. The padding is 1 pixel, while the convolution stride is fixed at 1 pixel. The spatial resolution is preserved in this arrangement, and the output activation map is the same size as the input image dimensions. The activation maps are then run via spatial max pooling with a stride of 2 pixels over a 2 x 2-pixel window. The size of the activations is reduced by half. As a result, the activations at the bottom of the first stack are 112 × 112 x 64 in size.

The activations are then passed through a second stack, this time with 128 filters instead of 64 in the first. As a result, after the second layer, the size is 56 x 56 x 128. The third stack consists of three convolutional layers and a max pool layer. The number of filters used here is 256, resulting in a stack output size of 28 x 28 x 256. After that, there are two stacks of three convolutional layers, each with 512 filters. At the end of both stacks, the result will be 7 × 7 x 512.

Three fully connected layers follow the stacks of convolutional layers, with a flattening layer in between. The first two layers each feature 4,096 neurons, while the final fully connected layer serves as the output layer, with 1,000 neurons corresponding to the ImageNet dataset's 1,000 potential classifications. Following the output layer comes the Softmax activation layer, which is utilized for categorical categorization. [36].

In short about Transfer Learning, user can take the learning from previously trained network then customize that model according to their need. The benefit of transfer learning is if user has really small dataset, then if they try to build a network or train a network from the very scratch it will perform outstanding way. There is a misnomer that traditional machine learning is performing better compare to deep learning if the dataset size is very small. Now that is no longer true because using transfer learning technique in pre train network even if user has very small datasets, they can build a wonderful network which will outperform any machine learning or traditional machine learning approaches.

3.7 Summary

Overall, in this chapter we discussed about efficiency of VGG16 and its architecture. what is transfer learning and how it works. We also talked about ImageNet and out training model, and how we customized the architecture of our own model.

IV. Result Analysis

4.1 Overview

In this chapter we describe the result that we have gathered from our architecture. It mainly focuses on our architecture and how we trained our model in transfer learning on VGG16. Here, all the working procedures of our architecture has been discussed. We also explain about our train, validation accuracy and also train, validation loss. Finally, we discussed about the efficiency of our developed model. Our main goal is to find the highest accuracy which will work more effectively and robustly for detecting camouflage object.

4.2 Result Description

As previously mentioned, we used Transfer Learning on VGG16 architecture. We customize our own pre-train model. In our base model input shape is 100 and weights given 'Imagenet'. As we know that VGG16 was shown to be the highest performing model out of all setups on Imagenet. In this model we used train batch and 50 epochs.

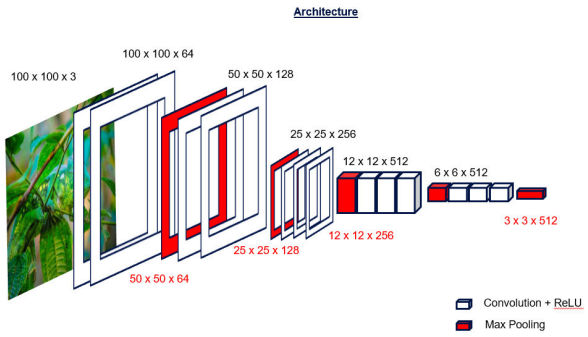

Figure 4.1: VGG16 Pre-train layer

During Implementations we made our datasets image shape is 100 x 100 with 3 filters. After that, it's gradually narrow down and remain 3 x 3 with 512 filters. Where activation function performs ReLu and 5 max polling or flattening layer remained. About flattening, it is used to convert all the resultant 2-Dimensional arrays from pooled feature maps into a single long continuous linear vector.

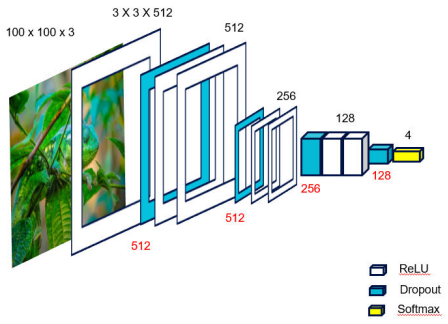

Figure 4.2: Extended layer of Architecture.

This is our customize layer (figure 4.2) where the number of filters getting reduced from 512 to 4 neurons. At the end it remains 4 neurons and they are Army, Octopus, Pygmy seahorses and Chameleon. There are two activation function has been used one is ReLu and another one is softmax.

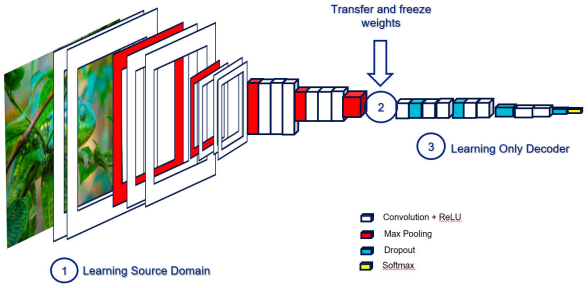

Figure 4.3: Cam_VGG16 full architecture

In figure 4.3 we draw a visual architecture of our network where all the layer has been discussed.

Train Accuracy	Validation Accuracy	Train Loss	Validation Loss
95%	91%	0.1%	0.29%

Table 4-A: It represents predicted result from the graph.

Considering Train accuracy, there are so many ups and downs trend until 50 epochs. Where it gives us almost 95% accuracy. On the other way, there was huge fluctuations on validation accuracy and it's shows nearly 91% accuracy until 50 epochs run.

Moving to the Loss part both train loss and validation loss has downwards trend, compared to validation loss train loss gives more better result.

For presenting, accuracy graph (15,5) figure size has been made for plotting figure where subplot size was (1,2,1). There are two different labels on graph one is train accuracy another one is validation accuracy. On the other hand, for showing Loss we used subplot (1,2,2) and two different labels where train loss and validation loss exist.

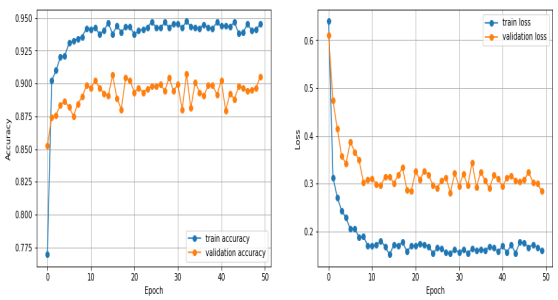

Figure 4.4: Result of this Model

As it shown from the picture Epoch are depicted horizontal line where Accuracy and Loss in Vertical line.

4.3 Summary

To conclude this chapter, we mainly focus on the making of the architecture, how we added our own customized layer and overall layer description. After that, we added the accuracy and loss from the result section and discussed about it.

V. Conclusion

5.1 Overview

This chapter demonstrates the summary of the research. The widespread objective of this research is to detect camouflage objects using Deep Learning techniques. We designed a vgg16 architecture, customized it by implementing Transfer Learning on it. The accuracy obtained from training and testing our model proves it be to robust and efficient.

5.2 Framework of this Model

The proposed framework of this research was based on Transfer Learning. In Transfer Learning, the user can take the learning from the previously trained network and customize the model according to the user needs. The most significant advantage of transfer learning are resource savings and increased efficiency while training new models.

5.3 Implementation of Methodology and Objective

We implement object detection system using Deep Learning techniques and improve the vgg16 model with Transfer Learning. Here, we develop our model in jupyter notebook using TensorFlow platform comparing several types of architecture seeking for an optimal accuracy which can detect the camo objects in a more robust and effective manner.

5.4 Limitation of the Study

We faced several drawbacks while conducting this research.

1) In our data collection step, that is collecting thousands of images from various internet sources, we had to make sure all the images are .jpeg or .png, any other formats will result in Unknown image file format.

Figure5.1: Mismatch Of File Format

2) We need a powerful gpu, the gpu we trained our model in is GeForce 2060. An outdated graphics card will not work.

3) We need to label images using labelme, while labelling we have to make sure to include weight as image net.

4) While collecting the dataset, we needed to find the right kind of images, that is, images that is properly camouflaged.

5.5 Recommendation for Future Work

Object detection technology's future is still being proven, it has the potential to release people from tiresome work that computers can accomplish more efficiently and effectively. It will also open up new research and operational possibilities, which will yield more benefits in the future. As a result, these problems avoid the requirement for extensive training that requires a large number of datasets in order to perform more sophisticated jobs. With continuing evolution, as well as the devices and methodologies that enable it, it could soon become the next big thing in the future.

Most present algorithms only address a tiny subset of the various tasks required for image comprehension and are expensive. To replicate a fraction of the normal person's capacity to recognize objects, one would need to merge multiple distinct algorithms into a single system that runs in real time, which would be a huge problem with today's hardware. Detecting objects is a crucial task for most computer vision systems.

5.6 Summary of The Research

We have developed a robust object detection system using deep learning technique. The architecture we worked on is vgg16 and customized it using Transfer Learning. We worked on the jupyter notebook using the TensorFlow platform. We obtained an accuracy of approximate 95% when we trained our model. The validation accuracy we achieved is approx. 91%. Train Loss is 0.1% and validation loss is 0.29%. In training accuracy there are many ups and downs with trend until 50 epochs. When the dataset size is small, there is a misconception that classical machine learning outperforms deep learning. That is no longer the case since, by employing the transfer learning technique in the pre-train network, users may design a fantastic network that outperforms any machine learning or traditional machine learning approaches, even if they have extremely small dataset.

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Abbreviations:

VGG	Visual Geometry Group
CNN	Convolutional Neural Network
HOG	Histogram of Oriented Gradients
SVM	Support Vector Machine
NLP	Natural Language Processing
MLP	Multi-Layer Perceptron
IOU	Intersection over Union
BIFPN	Bi-directional Feature Pyramid Network
RM	Refinement Module
etc.	etc.

Table A1:

Symbols	Name:
Φ	Phi
etc.	etc.

Khalak Bin Khair was born in Feni. His B.Sc. Degree on going in Computer Science and Engineering from American International University-Bangladesh (AIUB) in 2022. He is looking forward to doing his M.Sc. in Deep Learning. His research interests are based on Computer Vision, Object detection, image classification, Machine Learning, Artificial Intelligence. .

Saqib Jahir Chowdhury was born and raised in Kuwait, he was born on August 3rd 1999. He is currently enrolled in American International University-Bangladesh (AIUB) pursuing a degree in Computer Science and Engineering (CSE). He is set to complete his graduation by end of 2022. His area of interests comprises of Web Development, Computer Vision and Database Management.

Mohammed Ibrahim a Bangladeshi, is currently pursuing his B.Sc. Engg. degree in Computer Science and Engineering at American International University-Bangladesh (AIUB). His area of specialisation include Data Science, Database, Software Engineering and Web Development. Besides this, he has also been an active member and a promising team leader of AIESEC in Bangladesh.

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Fahad Bin Ismail By birth a Bangladeshi, he is currently pursuing his Bachelor in computer science and Engineering at American International university Bangladesh (AIUB).His area of specialization is Data Science, computer vision and pattern recognition, Software Engineering, Database .

He is an active member of different professional organizations, including IEEE (member), ICT Olympiad Bangladesh-AIUB (member).

Dr. Debajyoti Karmaker He is working as an Assistant professor in the department of computer science at American International University-Bangladesh. he worked as Postdoctoral Research Fellow at Australian National University (ANU), and Stanford University. Before joining ANU, He completed his Ph.D. from The University of Queensland (UQ). his research interests are in Deep Learning, Computer Vision, & Machine Learning. his particularly interested in the areas of image classification, object detection, segmentation, bio-inspired collision avoidance strategies, and Robust Decision-making and Learning. Before starting his Ph.D., he was working as a Lecturer at the American International University-Bangladesh (AIUB) - in the Department of Computer Science. He also worked as a software engineer at Infra Blue Technology (IBT Games)..

Pattern Synthesis of Nonuniform Linear Arrays Including Mutual Coupling Effects Based on GPR and GA

Ziqiang Mu, Ming Su, Yuanan Liu
National Natural Science Foundation of China under Grant 62031006,
Beijing University of Posts and Telecommunications (BUPT),
Beijing, China

***Abstract*—This paper proposes a synthesis method for nonuniform linear antenna arrays that combines Gaussian process regression (GPR) and genetic algorithm (GA).In this mthod, the GPR model can be used to calculate the array radiation pattern in presence of mutual coupling effects, and then the GA is used to optimize the exciations and locations of the elements, so as to generate the desired radiation pattern. In this paper, taking a 9-element nonuniform linear array as an example and the desired radiation pattern corresponding to a Chebyshev distribution as the optimization objective, Optimize the exciations and locations of the elements. Finally, the optimization results are verified by electromagnetic simulation software CST, which shows that the method is effective.**

Keywords—nonuniform linear antenna arrays; GPR; GA;mutual coupling effects; Active element pattern(AEP)

I. INTRODUCTION

In order to meet different application scenarios, a large number of array synthesis algorithms have been proposed in recent years. In [1-6], various novel intelligent optimization algorithms are used to optimize the ideal isotropic point source array, and the optimization parameters are the spacing between the elements of the antenna array and the excitation of the array elements.In these methods, the antenna array pattern is directly obtained by the pattern product theorem, the calculation speed is fast, but the AEPs of array elements and mutual coupling effects are ignored at the same time.When these methods are applied to the synthesis of actual antenna array , there will be large errors. In [7] the authors optimize the excitation of the actual antenna array. Although the coupling effect is considered, it is carried out under the condition of uniform array distribution, and the radiation performance cannot be improved by optimizing the array distribution. In [8-11] the authors propose a novel method incorporating the least-square active element pattern expansion into the iterative Fourier transform procedure.In this method, AEP of each element is deemed to be generated by a virtual subarray surrounding the radiating element,then use FFT to synthesize the AEPs of subrray, in order to achieve the purpose of fast array synthesis.However, the pattern expansion of this method is still carried out under the condition of a fixed-spacing array, and it is still impossible to optimize the distribution of the antenna array, and due to the complicated calculation process, the calculation energy error will increase significantly.

This paper proposes a synthesis method for nonuniform linear arrays including mutual coupling effects based on GPR and GA, the main steps of the method are as follows. (1) Establish a python-cst co-simulation program, so that operations such as adjustment, simulation, and data saving of the antenna array can be performed in the python program. (2) Control the CST in Python to adjust the spacing of the antenna array elements and run the simulation, and then save the AEPs of array elements obtained by the simulation to the MySQL database to obtain the original training data set. (3) Train GPR model using the training data set. After training, the GPR model can achieve the AEPs of array elements rapidly once the spacing of antenna array elements is input. Then the array radiation pattern including mutual coupling and platform effects can be obtained by superposition of AEPs. (4) According to the parametric model of antenna array based on gaussian process regression mentioned above, we use GA to search the optimal solution of the array excitations and the spacing of antenna array elements, and then use CST to verify the optimization results.

II. METHOD DESCRIPTION

Let's consider a nonuniform linear array of N elements, aligned along the X-axis. Its far-field pattern can be written as:

$$f(u)=\sum_{n=0}^{N-1}\dot{I}_n g_n(u)e^{j\beta x_n\sin(\theta)} \tag{1}$$

Where $j=\sqrt{-1}$, θ is the angle between the direction of observation and the Z-axis. $\beta = 2\pi/\lambda$ is the wavenumber in free space, λ is the wavelength. $g_n(u)$ represents the AEP of the element n at an operating frequency. $\dot{I}=[\dot{I}_0,\dot{I}_1,\cdots,\dot{I}_{N-1}]$ is a complex vector and x_n is the position of the nth element.

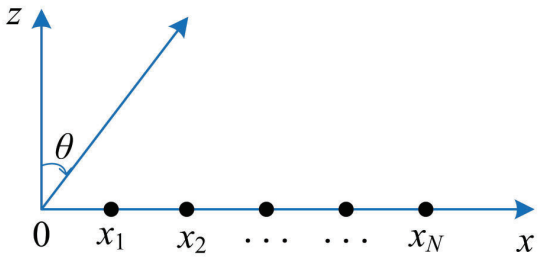

Fig .1 Geometry of an N-element nonuniform linear array

The flow chart of predicting the AEPs of array elements using GPR model is shown in Figure 2.For the AEPs of array elements, use the Python-CST co-simulation program to build a dataset on array spacing and AEPs of array elements.For an antenna array with *N* element, the radiation

pattern in the upper half plane at an operating frequency and we set the sampling interval to 1deg. The collected element numbers of training data set can be expressed as $M = N \times 181 \times M_{sam}$, where 181 is the number of angle point and M_{sam} is the number of sampled array location distributions.We establish 181×N GPR models, corresponding to each scan angle of each element of the antenna array. These models are trained with training data of size M to predict the electric field strength for each scan angle of each element of the antenna array.The 181 scanning angles of each element of the antenna array correspond to 181 GPR models, and the predicted electric field strength of these models constitutes the AEP of this array element. The, the array radiation pattern including mutual coupling effect can be obtained by superposition of AEPs of array elements.

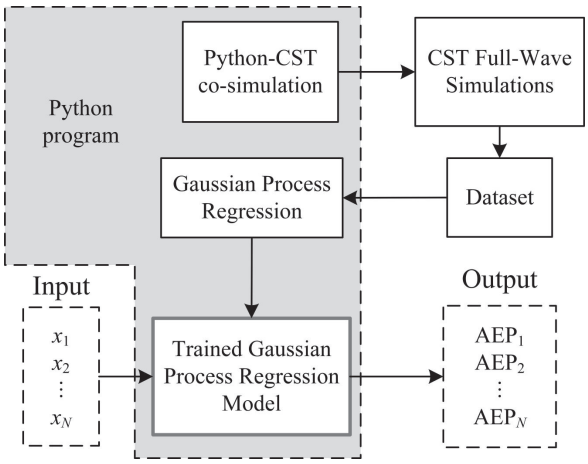

Fig. 2 Training process of Gaussian process regression

Since we have established a parametric model that can calculate the array radiation pattern through the spacing of the antenna array elements and array elements's excitations, the GA can then be used to optimize the excitations and locations of the array elements in order to achieve the target radiation characteristics..The flowchart of the whole process is shown in Figure 3.

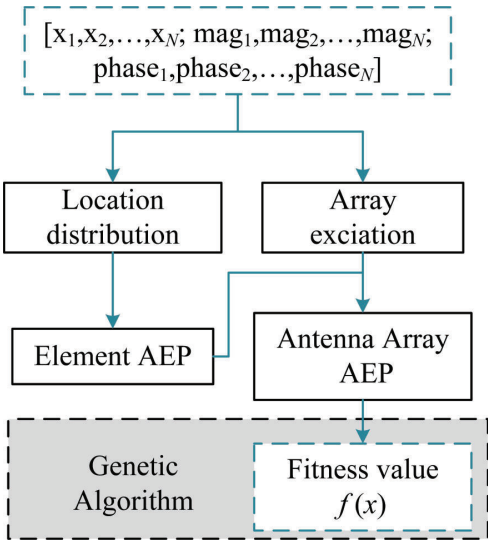

Fig. 3 Flow diagram of proposed GPR-GA

The array synthesis algorithm proposed in this paper has three advantages: First, using the GPR model instead of the electromagnetic simulation software to calculate the array radiation pattern. The actual test results show that it takes at least ten minutes to perform a simulation using the simulation software CST, and it only takes 3 seconds to perform a calculation using the model proposed in this paper. Second, other array optimization algorithms can only optimize the array elements's excitations. The algorithm in this paper can also flexibly adjust the array distribution, which can bring tremendous benefits to pattern optimization.Third, the algorithm in this paper takes into account mutual coupling effect and platform effect, which will make the synthesis result of antenna arrays more accurate.

III. Numerical Example

In this section, we use a 9-element linear array to validate the proposed synthesis algorithm. Each element of this array is a coaxial feed patch antenna , working at frequency of 1GHz. Fig. 4 show the geometry of this array.

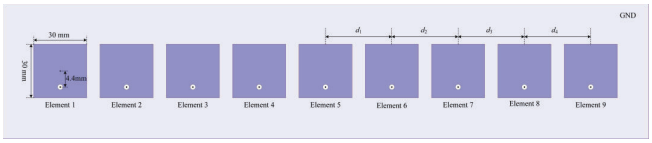

Fig. 4 Geometry of 9-element unequally spaced linear array.

1) Training Mode

Use a Python program to generate random array spacing between 0.4λ and 0.8λ, control CST to adjust the array spacing and run the simulation. In order to ensure the validity of the prediction, the above process is repeated 200 times, and finally a training data set of 9×181×200 size is finally obtained. A Gaussian process regression model is established for each radiation angle of each array element, and the training data of size 200 is used for training to establish a regression model of the array spacing and radiation field strength. In this paper, the number of array elements N=9 and the number of angles point Msam 181, so a total of 9×181 models are obtained.

In order to clarify the accuracy of the model, we verified the accuracy of the GPR model in the angle of 30 deg at element 5. We compared the predicted value of the GPR model with the CST simulation value for 30 times, as shown in Figure 5.

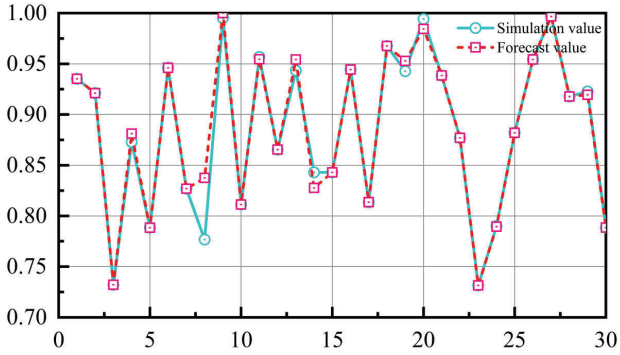

Fig. 5 Simulated AEP and predicted one for element 5 and theta=30°.

To quantify the accuracy of the model, the coefficient of determination is used to measure the accuracy of the Gaussian process regression model, and the formula for the coefficient of determination can be written as:

$$R^2 = 1 - \frac{\sum_{i=1}^{n}(y_i - f_i)^2}{\sum_{i=1}^{n}(y_i - \bar{y})^2} \quad (2)$$

Among y_i is the simulated value from full wave simulation using CST, f_i is the predicted values obtained by using the trained GPR model, and the value range of R^2 is 0~ 1. When the coefficient of determination is closer to 1, the prediction accuracy is higher. Taking array element 5 as an example, since the angle sampling interval is 1deg, there are 181 angle points. Take n=30 and calculate the correlation coefficient of each radiation angle, we obtain the correlation coefficient image of each radiation angle as shown in Fig 6.

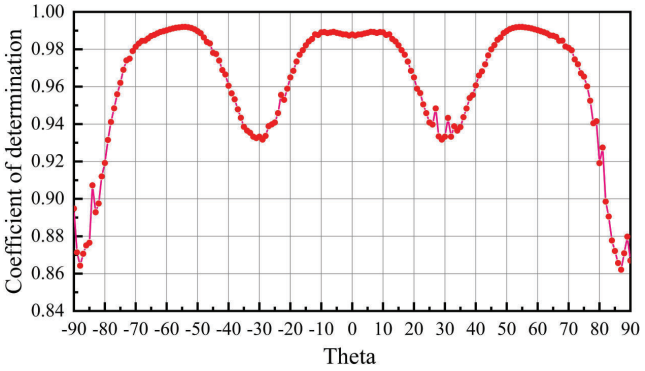

Fig. 6 Coefficient of determination for element 1.

As shown in Figure 6, the value of each coefficient of determination is bigger than 0.8, the minimum value is 0.86, the maximum is 0.99 and the average value is 0.96, which shows that the GPR model proposed in this article is very accurate. Fig 7 show the compasion between the simulated AEP and the predicted one for the 1th element.

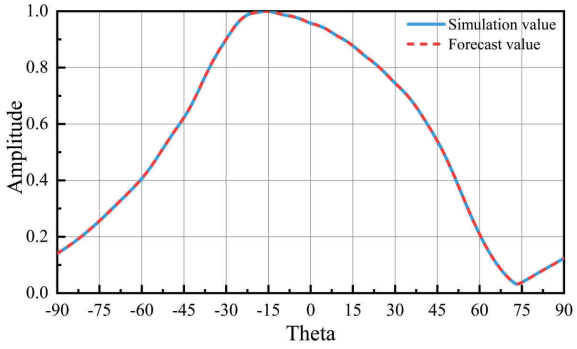

Fig. 7 Simulated AEP and predicted one for element 1

2) OPTIMIZATION

In this example, our desired radiation pattern is a Chebyshev distribution with n =9, d = 0.5λ and SLL = -20dB. To optimize with GA, we define the optimization parameter vector as:

$$x=[d_1,d_2,d_3,d_4;mag_1,mag_2,mag_3,mag_4; phase_1,phase_2,phase_3,phase_4] \quad (3)$$

Then, the loss function of the radiation pattern can be written as:

$$f(x) = \sum_{\theta=-90}^{90} |T(\theta) - P(\theta)| \quad (4)$$

T (θ) is the desired radiation pattern corresponding to a Chebyshev distribution with n = 9, d = 0.5λ and SLL = — 20dB. P (θ) is the predicted pattern. In the genetic algorithm, we set the population size to 50, the maximum number of iterations to 300, and the mutation probability to 0.01. Fig 8 shows the convergence curve of GA. Table 1 shows the optimization results for the weight and location of the elements.

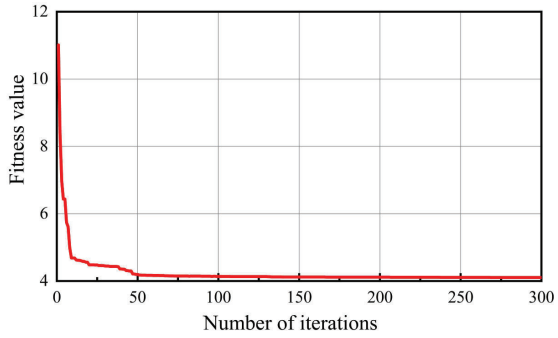

Fig. 8 Convergence curves of this example

Tab. 1 Optimized Weights and Locations for the Chebyshev Pattern

Element No.	Location (λ)	Amplitude	Phase(rad)
5	0	1	0
4, 6	-0.44, 0.44	9.15	0
3, 7	-1.15, 1.15	5.46	0
2, 8	-1.78, 1.78	4.26	0
1, 9	-2.30, 2.30	1.17	0

Fig.9 show the the compasion between the desired radiation pattern corresponding to the Chebyshev distribution, the predicted pattern and the CST simulation pattern. Based on this figure, it can be knows that the desired pattern, the predicted pattern and the simulation pattern fit very well on the main lobe. But the SLL of the simulation pattern are relatively large, greater than -20dB and less than -15dB, which is caused by the error brought by the superposition of AEPs.

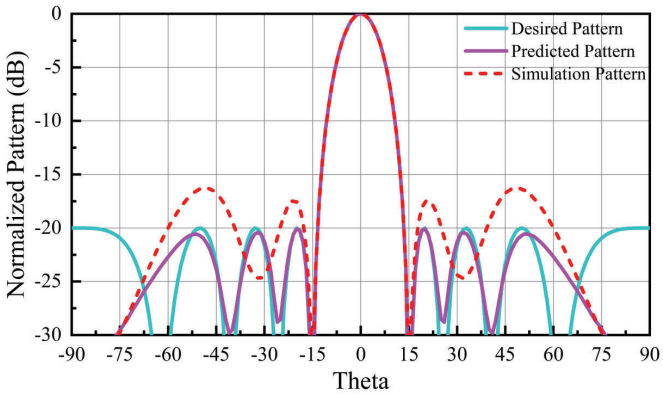

Fig. 9 Optimized results for the desired radiation pattern corresponding to the Chebyshev distribution

IV. CONCLUSION

This paper proposes a parametric modeling of nonuniform linear array based on GPR. And on this basis, use genetic algorithm to synthesize the antenna array.The

method can quickly optimize the exciations and locations of the elements under the condition of considering the mutual coupling and platform effects.In this paper, we take the radiation pattern corresponding to a Chebyshev distribution with $n = 9$, $d = 0.5\ \lambda$ and $SLL = -20$dB as the optimization target to optimize the excitations and locations of the array elements , and the optimization results proves the effectiveness of the algorithm.

ACKNOWLEDGMENT

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Contribution of Urban Wetlands to livelihood in Tanzania

Halima Kilungu*, Happiness Jackson Nko†, Munishi, P.K.T‡

*The Open University of Tanzania, Department of Tourism and Hospitality, Dar es Salaam, Tanzania
†University of Dodoma, Department of Biology, Dodoma, Tanzania
‡Munishi, Pantaleo Kirari Thomas, Sokoine University of Agriculture, Morogoro, Tanzania

*Corresponding Author: Halima Kilungu

Abstract

Wetlands contribute significantly to the national economy. Nevertheless, urban wetlands in Tanzania have been taken for granted; many have been converted into waste disposal areas and settlements despite their substantial role in climate-change flood attenuation and livelihood. This is due to the lacking informing assessments from a socio-economic perspective. This study assesses the contribution of urban wetlands to the livelihood of marginalised communities in Dar es Salaam City, Tanzania. Specifically, the study assesses the an extent and nature of change in wetlands in Dar es Salaam City for the past 30 years using the land-use land-cover change approach and the contribution of wetlands to livelihood using questionnaires. The results show that the loss of wetlands in Dar es Salaam is high to extent that will likely jeopardise their future contributions to livelihood. The results inform decision-makers on the importance of wise use of Urban Wetlands and conservation to improving livelihood for urban dwellers.

Keywords: Wetlands, Livelihood, Tanzania, Dar es Salaam, Climate-change and wetlands.

Social Economy Effects on Wetlands Change in China During Three Decades Rapid Growth Period

Ying Ge

Department of Landscape and Urban Planning, Faculty of Environmental Sciences, Czech University of Life Sciences Prague, Kamýcká 129, Praha – Suchdol, 16500, Czech Republic.
Email address: geying@rektorat.czu.cz

Abstract

Wetlands are one of the essential types of ecosystems in the world. They are of great value to human society thanks to their special ecosystem functions and services, such as protecting biodiversity, adjusting hydrology and climate, providing essential habitats and products and tourism resources. However, wetlands worldwide are degrading severely due to climate change, accelerated urbanization, and rapid economic development. Both nature and human factors drive wetland change, and the influences are variable from wetland types. Thus, the objectives of this study were to (1) to compare the changes in China's wetland area during the three decades rapid growth period (1978-2008); (2) to analyze the effects of social economy and environmental factors on wetlands change (area loss and change of wetland types) in China during the high-speed economic development. The socio-economic influencing factors include population, income, education, development of agriculture, industry, infrastructure, wastewater amount, etc. Several statistical methods (canonical correlation analysis, principal component analysis, and regression analysis) were employed to analyze the relationship between socio-economic indicators and wetland area change. This study will determine the relevant driving socio-economic factors on wetland changes, which is of great significance for wetland protection and management.

Keywords: Socioeconomic effects; wetland change; China; wetland type

Paradigms of Sustainability: Roles and Impact of Communication in the Fashion System

M. Tufarelli, E. Pucci, L. Giliberti

Abstract **-** As central for human and social development of the future, sustainability is becoming a recurring theme also in the fashion industry, where the need to explore new possible directions aimed at achieving sustainability goals and their communication is rising.
Scholars have been devoted to the overall environmental impact of the textile and fashion industry which, emerging as one of the world's most polluting, today concretely assumes the need to take the path of sustainability in both products and production processes.
Every day we witness the impact of our consumption, showing that sustainability concept is as vast as complex: with a sometimes ambiguous definition, sustainability can concern projects, products, companies, sales, packagings, supply chains in relation to the actors proximity as well as traceability, raw materials procurement, and disposal. However, in its primary meaning sustainability is the ability to maintain specific values and resources for future generations.
The contribution aims to address sustainability in the fashion system as a layered problem that requires substantial changes at different levels: in the fashion product (materials, production processes, timing, distribution and disposal), in the functioning of the system (life cycle, impact, needs, communication) and last but not least in the practice of fashion design which should conceive durable, low obsolescence and possibly demountable products.
Moreover, consumers play a central role for the growing awareness , together with an increasingly strong sensitivity towards the environment and sustainable clothing. Since it is also a market demand, undertaking significant efforts to achieve total transparency and sustainability in all production and distribution processes is becoming fundamental for the fashion system.
Sustainability is not to be understood as purely environmental, but as the pursuit of collective well-being in relation to conscious production, human rights and social dignity with the aim to achieve intelligent, resource and environmentally friendly production and consumption patterns.
Assuming sustainability as a layered problem makes the role of communication crucial to convey scientific, or production specific content so that people can obtain and interpret information to make related decisions. Hence, if it is true that "what designers make becomes the future we inhabit", design is facing great and challenging responsibility.
The fashion industry needs a system of rules able to assess the sustainability of products, which is transparent and easily interpreted by consumers, identifying and enhancing virtuous practices. There are still complex and fragmented value chains that make it extremely difficult for brands and manufacturers to know the history of their products, to identify exactly where the risks lie and to respond to the growing demand from consumers and civil society for responsible and sustainable production practices in the fashion industry.

Keywords **-** *Fashion design, Fashion system, sustainability communication, complexity*

[1]M. Tufarelli is Researcher at University of Florence, Italy. DIDA Design Campus (e-mail: margherita.tufarelli@unifi.it).
E. Pucci is Junior Researcher at University of Florence, Italy. DIDA Design Campus (e-mail: elena.pucci@unifi.it).
L. Giliberti is PhD student at University of Florence, Italy. DIDA Design Campus. (e-mail: leonardo.gilibertii@unifi.it).

Adoption of Big Data by Global Chemical Industries

Ashiff Khan, A. Seetharaman, Abhijit Dasgupta

***Abstract*—** The new era of big data (BD) is influencing chemical industries tremendously, providing several opportunities to reshape the way they operate and help them shift towards intelligent manufacturing. Given the availability of free software and the large amount of real-time data generated and stored in process plants, chemical industries are still in the early stages of big data adoption. The industry is just starting to realize the importance of the large amount of data it owns to make the right decisions and support its strategies. This article explores the importance of professional competencies and data science that influence BD in chemical industries to help it move towards intelligent manufacturing fast and reliable. This article utilizes a literature review and identifies potential applications in the chemical industry to move from conventional methods to a data-driven approach. The scope of this document is limited to the adoption of BD in chemical industries and the variables identified in this article. To achieve this objective, government, academia, and industry must work together to overcome all present and future challenges.

***Keywords*—** chemical engineering, big data analytics, industrial revolution, professional competence, data science.

Ashiff Khan is with the SP Jain School of Global Management, Saudi Arabia (e-mail: ashiff.dm20dba001@spjain.org).

Efficiency of Dhaka Division Secondary Level Schools by ICT Intervention in Bangladesh: An Estimation using Stochastic Frontier Analysis

Md. Azizul Baten[1], Md. Kamrul Hossain[2] and Abdullah-Al-Zabir[3]

[1]Department of Statistics, Shahjalal University of Science and Technology, Sylhet-3114, Bangladesh
[2]Department of General Education department, Daffodil International University, Dhaka, Bangladesh
[3]Department of Agricultural Statistics, Sylhet Agricultural University, Sylhet-3100, Bangladesh

Email: baten-sta@sust.edu; kamrul.ged@diu.edu.bd; zabir.sylau@gmail.com

Abstract

Effective teaching and learning in education depends on the performance and teaching-learning methodological development of the teachers and students. The main objective is to develop an appropriate stochastic frontier secondary schools efficiency model by ICT Intervention and to examine the impact of ICT challenges on secondary schools efficiency of Dhaka division in Bangladesh using stochastic frontier analysis. Translog stochastic frontier model was found an appropriate than Cobb-Douglas model in secondary schools efficiency by ICT Intervention. From the results of Cobb-Douglas model, the coefficient of the number of teachers, the number of students and teaching ability of the teachers were found positive and direct influence to increase the level of efficiency. The online class in school was found decreasing the level of inefficiency and it played significant role in increasing the school efficiency. In Translog model, the coefficient of class rooms variable was found positive and significant, indicated that this variable has positive effect in the secondary school efficiency while the coefficient of teaching ability of the teachers was found significant with negative effect. The coefficient of the interaction effects of the number of students and teaching ability of the teachers were observed positively significant and this has positive impact to increase the secondary school efficiency. The coefficients of teacher's preference ICT tool like multimedia projector used always, often, sometimes, rarely and never in teaching and learning were found negative and significant which indicated that multimedia projector played significantly contributor role in decreasing the secondary school inefficiency. The average secondary school efficiency of Dhaka division for Cobb-Douglas model was 0.9350 while it was found 0.9337 for Translog model. It is expected that the developed model for secondary schools efficiency and the deficiency of knowledge regarding teaching-learning method with the ICT integration would be useful in Bangladesh.

Keywords: Efficiency, Secondary Schools, ICT, Teachers' and Students' Preference and Perceptions, Bangladesh

Performance Measurement of Service Providers

Majid Azadi

Deakin Business School, Deakin University, Melbourne, Australia

m.azadi@deakin.edu.au

Abstract

The service-profit chain (SPC) provides an integrative framework to understand how a company's operational investments into service operations are related to customers' perceptions and behaviours, and how these translate into profits (Heskett et al. 1994). For a company, the SPC provides substantial guidance about the complex interrelationships among operational investments, customer perceptions, revenue growth and profitability (Ding et al. 2019).

The implementation of the SPC is a major challenge in most companies, and a very few studies have carried out modelling of different aspects of the SPC (Kamakura et al. 2002). Concentrating on separate aspects of the SPC such as customer behaviours and economic outcomes cannot provide managers and decision makers a clear picture of company's true performance (Kamakura et al. 2002). Moreover, a major drawback of current SPC frameworks (Strydom et al. 2020, Theoharakis et al. 2009, Evanschitzky et al. 2012, Pasupathy and Triantis, 2007) is that they are unable to justify the effect of one time period on another. In other words, most of the existing SPC frameworks are not suitable for volatile environments. This is especially the case with today's unstable environments in which companies' managers and beneficiaries face considerable uncertainty in their decision-making. Furthermore, the impact of uncontrollable factors such as competition, market size, government legislation, economic climate and affordability on the existing SPC frameworks has not been addressed yet. This, in turn, affects the number of customers, perceived value of the service received by the customers, the performance, and profitability of company (Pasupathy and Triantis, 2007).

To this end, the current study employs data from all dealers of a single automotive brand in Australia to extend the SPC framework. Specifically, the study aims to examine relationship between service delivery investments and customer satisfaction in unstable environments and

in the presence of uncontrollable factors such as market size, government legislation and economic climate. The proposed framework not only can improve customer and employee satisfaction, but also can increase profitability and performance of the focal company.

Background

The Service Profit Chain (SPC) was first proposed by Schlesinger & Heskett (1991) to describe relationships between employees and customers. Early SPC models incorporated human components with techniques for improving customer service and employee satisfaction. The Schlesinger & Heskett's (1991) model was extended further to emphasise the link between employees' and customers' constructs, which demonstrates that customer satisfaction can be improved when employees are engaged (Kim 2014).

Despite the advantages of the initial SPC model, Heskett et al.'s (1994) model focuses on the maximisation of customer retention and sales revenue and the reduction of costs (Strydom et al. 2020), but fails to address some important components such as profit (Kamakura et al. 2002). This apparent limitation can be found in a number of applications proposed, for example, by Rucci et al. (1998); Carr (1999); Kimes (2001); Kamakura et al. (2002); Larivière (2008); Xu and van der Heijden, (2005); Gupta et al. (2007).

To this end, Strydom et al. (2020) extended the SPC model of Kamakura et al. (2002) by integrating employee-focused measures as well as technical, non-technical and operational inputs. Nonetheless, the extended SPC framework proposed by Strydom et al. (2020) suffers from some limitations. Specifically, in spite of investigating time lag impacts within the SPC, the authors were have not shed light on the effect of one time period on another. That is, the true dynamic nature of the SPC, has still not been tackled. Furthermore, the impact of uncontrollable factors such as competition, market size, government legislation, economic climate and affordability on the proposed SPC framework by Strydom et al. (2020) has not been addressed. This, in turn, affects the number of customers, perceived value of the service received by the customers, the performance, and profitability of company (Pasupathy and Triantis, 2007). Hence, the current study bridges this gap by developing a novel the SPC framework.

Based on the research objectives and goals, the following research significance and innovations are expected to be obtained in this study:

1. **Develop an extended SPC framework for evaluating service performance:** The implementation of the SPC is a major challenge in most companies, and very few studies have been carried out to model different aspects of the SPC. Concentrating on separate aspects of the SPC is unable to provide managers and decision makers with a clear picture of company's true performance (Kamakura et al. 2002). Therefore, new studies are needed to integrate richer data such as amount of operational inputs, customer behaviours and perceptions, economic outcomes from different resources, providing managers and decision makers of company with comprehensive analysis and evaluation as well as guidelines for implementing the SPC. Furthermore, current methods are sensitive to and not able to accommodate the weaknesses and strengths of this type of data. The proposed approach in this study addresses these issues by developing a comprehensive SPC framework for services performance evaluation.

2. **Develop a dynamic data envelopment analysis (DEA) in the presence of uncontrollable factors:** Our review of the existing literature suggests that the existing SPC frameworks for measuring service performance, are not suitable for dynamic environments. In today's competitive and dynamic environment, uncertainty in decision-making variables plays a key role in the performance and profitability of companies. Moreover, the impact of uncontrollable factors such as market size, competition, government legislation, economic climate and affordability on the existing SPC frameworks has not been taken into account yet. Thus, for the first time, the proposed study will develop a novel dynamic data envelopment analysis (DEA) model to address the existence of uncontrollable factors in the SPC context, which in turn leads to improving the profitability and performance of company.

3. **Managerial implications in industry:** The framework and models developed in the SPC context can have significant implications. This study provides advice for automotive industry managers who are interested in improving service quality, customer satisfaction and customer retention through the improvement of service processes. The expected findings can also provide automotive industry managers specifically at operational level a profounder comprehension of the relationships between key service performance criteria in order to form customer interactions. Furthermore, framework and models developed in this study can assist managers and decision makers who are responsible for adopting and implementing the SPC model to

identify the existing strengths and weaknesses aimed at improving organisational performance. For instance, how can we decrease the number of staff while the same level of service is delivered? Moreover, the outcomes of this study can advise managers to either increase or reduce investment in enhancing service operations for future years. For example, if there is a negative interaction effect between profit and employee satisfaction, then managers can decrease investment in service operations for upcoming years. Most importantly, the proposed frameworks and models in this study can be applied with minor changes in many other important sectors such as healthcare and education.

Methodology

Data envelopment analysis (DEA) and network DEA models are proposed as a primary analytical framework. DEA is a non-parametric method for measuring the efficiency of a set of decision-making units (DMUs) that convert multiple inputs into multiple outputs. Because of the uniqueness of DEA, it has been widely developed and used to measure performance in different domains (Emrouznejad and Yang 2018). In this study, DEA is utilized for operational analysis and customized feedback to a single automotive brand in Australia that implements the SPC model. It will provide each department with a metric of its relative efficiency in translating inputs such as staff and annual sales turnover into relevant strategic outputs such as customer behaviours and intentions. It will also demonstrate how senior managers can utilize the operational and strategic analysis in their decision-making. While strategic model provides the essential metrics and relationships that are needed for ensuring that all department of the company follow a consistent strategy, the operational analysis enables each department for benchmarking its unique position so that the department is able to implement the strategic model in the most efficient way.

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Effect of Public Infrastructural Support on Business Growth: Evidence from Technological Enterprises in Nigeria

Prof. F M Epetimehin

Department of Actuarial Science and Insurance College of Managt. Sciences

Joseph Ayo Babalola University, Ikeji

Abstract

Technological enterprises are considered as a catalyst for economic development, nevertheless, they often run into the problem of sourcing for infrastructural facilities to enhance their business growth. The main objective of this study is to examine the effect of Public Infrastructural support on business growth: evidence from technological enterprises in Nigeria. The sample comprises of startup SME sub-manufacturer in Metal fabrication, Renewable energy (solar) and Electrical/Electronic who's business are within six years of graduation. The sample size is 240 respondents. Multistage sampling technique was employed to select the respondent for the study. The instrument used was validated and pilot tested to ascertain the internal consistency by means of Cronbach Alpha. The reliability coefficient of the questionnaire was 0.734. The data obtained were analysed by means of Partial least square (PLS)-a structural equation model (SEM) tool. The study hypothesis which states that there is no significant relationship between infrastructural support and business growth shows that the null hypothesis is rejected. Hence, the alternate hypothesis is accepted. This implies that infrastructure such as transport system, power and incubation services has a significant relationship with business growth. The study is of the view that public infrastructure support for technological enterprises should be intensified, since it has positive impact in the growth of that enterprise.

Keywords: Entrepreneur, Enterprise growth, Infrastructure, Performance, SMEs, Start-up, Technological entrepreneurship

Introduction

Technological entrepreneurship is a strategy that pushes the economy of most countries. It lay emphases on identification and utilization of technological chances that necessitate technology, as well as decision-making competences. Hence, technological entrepreneurship call for certain level of technical capabilities and running of a risky venture. Technological entrepreneurship promises job and wealth creations as well as economic revenues from varied activities. Growing the productive activities of young individuals through technology innovation is vital to a country's growth as well as development. The promotion of technological entrepreneurial and innovative skills as birthplaces of job creation, empowerment and economic vitality in a speedily growing economies has therefore progressively attracted scholar and policy considerations.

Technological entrepreneurship pertain to the operations of enterprises through scientists and engineers, recognizing applications or difficulties with technologies, using technological

opportunities to setting-up new ventures encompassing technical besides scientific knowledge as well as partnership for technical modifications. According to Ayodele, Oga, Bundot and Ogbari (2016) technological enterprises remain ventures with sales income generated via the implementation of 51 percent or more of technology centered processes and such enterprises consist of internet, electronics, automobile, fabrication, clean energy, bio-medical, communications, telephone, mechanical, fax companies.

The practice of technological entrepreneurship contains creating, take advantage of opportunities and pull together resources round a technological solution, notwithstanding of the organizational context. Quick changes in technology ought to be reacted to by enterprises in order to create alternative techniques to sustain their competitive benefit by using new techniques of assembly which brings about the capability to apply new technology invention every day to the operations of various businesses nowadays.

A developing line of research center on the support services that adds to acceleration of technological entrepreneurship since various forms of support services are essential to foster its growth and improvement in economies. Several of these support services take account of; Infrastructure, Finance, Training as well as Academic/industry linkages. However considerable study has been carried out on effect of infrastructural support on business growth, but very few on technological enterprises among young graduates in North Central States of Nigeria (Obokoh & Goldman, 2016).

Generally, the significance's of technological entrepreneurship to viable development are well recognized among policy makers, researchers and practitioners on entrepreneurship that a key basis of problems experienced in Nigeria as well as other developing countries is shortage of technological entrepreneurship, even when technological enterprises have turn out to be an essential measure of the development of the international and regional economy. These enterprises are frequently suffering from insufficient technical and marketing savvy, little management skill, inadequate infrastructural amenities, failure to discover initial funding, and enormous overheads.

Hence the study examine the effect of public infrastructural support on business growth with evidence from technological enterprises especially among young graduates in Kwara, Niger and Kogi states. These young graduates ventured into a number of technological enterprises between one and six years post-graduation.

Literature Review

Technological entrepreneurship is mainly the merger of two words from dualistic disciplines: technology from innovation discipline as well as entrepreneurship from the business discipline. Technology based entrepreneurship is consequently understood as the combination of technological plus entrepreneurial areas. Ajagbe, Olujob, Uduimoh, Okoye and Oke (2016) look at technological entrepreneurship as a form of business headship founded on the practice of identifying great potential, technology-demanding business opportunities, collecting resources such as talent and money, and handling fast growth by usage of principled, here and now decision making skills.

Onimole (2018) opined that technological entrepreneurship encompasses the control of innovative skills for design of new products, processes, markets and new systems of business. Based on this, technological entrepreneurship is well-defined as a thoughtful business that necessitates extensive knowledge contribution, machine, skills, and specialize equipment.

However, Bailetti (2012) concluded that technological entrepreneurship is an investment in a task that bring together and set out professionals and diverse resources that are well associated to advances in scientific as well as technological understanding for the purpose of generating and seizing value for a firm. Furthermore, Technological entrepreneurship is a technique of business administration that includes recognition of high-potential technology based money-making opportunities, managing resources related to capital, managerial skills that boost fast growth and significant risk using specific decision-making skills (Dorf & Byers, 2007).

Technological enterprises can be interpreted to mean that the basic activities of the business rely greatly on the use of high technology (Ajagbe, Long, Aslan & Ismail, 2012). In same manner, Maula (2001) ; Maula, Keil and Zahra (2013) defined technological enterprises as those privately owned firms that have existed for less than six years and operates in science and engineering areas that includes; medical and health science, communications, computer software and services, biotechnological, computer hardware or semiconductor industries. This suggests that technological enterprises are firms who majors in technologically inclined products and services.

Hitherto, there is no apparent and globally acknowledged meaning of support services; however, many efforts by researchers, to define the term have been made. Despite the fact that support services are well recognized in many nations of the world, its definitions differs from one nation to the other. Owuala (1999) opined that support services are programme of activities to improve the performance of individual and selected people to assume the position of entrepreneurs. The Committee of Donor Agencies for Small Enterprise Development (2001) defines support service as a service that improves the performance of the enterprise, its access to markets, and its ability to compete.

The government of Nigeria render her support services to SMEs through the following agencies; Central Bank of Nigeria (CBN), National Directorate of Employment (NDE), Technology Incubation Centre (TIC), Bank of Industry (BOI), National Poverty Eradication Programme (NAPEP), Small and medium enterprises development agency of Nigeria (SMEDAN), Small medium enterprises equity investment scheme (SMEEIS), Agricultural small and medium enterprises investment scheme (AGSMEIS), National economic empowerment development strategy (NEEDS) (CBN Annuar report, 2018).

Easterly (2003), sees infrastructure facilities as the basic structures, physical and organizational, which offers support to enhance the growth of an organisation or economy. This provide linkage connecting a firm to its markets, it has potential impact on the organization revenue and general efficiency (Price, Stoica & Boncella, 2013). This support includes; storage and warehousing, transport and delivery, business incubators, telecommunications, courier, money transfer, internet access, computer services, secretarial services and information through; print, radio, Television.

An enterprise is doing well if it is growing. Growth has diverse connotations. It can be described in terms of expansion, value addition, revenue generation and in terms of capacity of the business. It can also be measured in the form of qualitative features like market position, quality of product, and goodwill of the customers (Kruger, 2004). As viewed by Penrose (2006) growth is the result of an internal process in the development of an enterprise and an increase in quality and/or expansion. Also, growth is defined as a change in size during a prescribed time span (Dobbs & Hamilton, 2007). However, Achtenhagen, Naldi, and Melin (2010) researched entrepreneurs´ ideas on growth and listed the following: increase in sales, increase

in the number of employees, increase in profit, increase in assets, increase in the firm´s value and internal development.

The study is anchored on Keynesian theory, developed by the British economist John Maynard Keynes during the 1930s in an attempt to understand the Great Depression (Ogechukwu, 2011).

Empirical Review

Akinyele, Akinyele and Ajagunna (2016) investigated the impacts which some infrastructures have on SMEs performance, this was achieved by taking into consideration some infrastructural facilities such as electricity, transportation and technology. The study adopted quantitative research design, the sampling techniques used was Multi Stage which included stratified and the simple random sampling techniques. The results showed that there is a substantial positive relationship amid infrastructures and SME performance, this indicates that infrastructures carry out a vast role in guaranteeing the effective set-up of SMEs. Recommendation was made to government that, adequate basic infrastructures should be made available to SMEs.

Akinlemi (2018) examined the effect of infrastructures on performance of SMEs in Nigeria. The research method employed was quantitative method, using a survey research design plus a judgmental and convenience sampling technique to obtain data from the respondents selected from four major SMEs clusters in Lagos using questionnaires. The study used percentages and chisquare to analyse the data collected. The results gotten reveals that many SMEs operators in Nigeria make available for the basic infrastructural facilities themselves and that many of these operators are put out of business as a result of high cost of the infrastructures needed, such as power and water. The study concluded that SMEs infrastructures are necessity for enterprise growth.

Ayogu (2007) carried out a review of infrastructure and economic development in Africa with a conclusion that, infrastructure is important in different contexts and the level of its importance have not been fully appreciated by developing countries governments, in the sense that considerable resources have been expended on the provision of infrastructure with marginal success because of a lack of commitment and corruption.

Chowdhury, Islam and Alam (2013) investigated the factors that influence the growth and development of small and medium sized enterprises (SMEs) in Bangladesh and the implications these factors have for policy. This research study uses varimax orthogonal rotation method. The results shows that variables related to finance, infrastructure, market, technology experience and political influence are highly perceived as growth inhibitors.

Mbugua, Mbugua, Wangoi, Ogada, and Kariuki (2013) examined the factors affecting the growth of micro and small enterprises: a case of tailoring and dressmaking enterprises in Eldoret. Questionnaires with structured and unstructured questions were employed and reinforced by interviews and observations, data collected was analysed using chi-square and regression analysis. The study showed that most of the tailoring and dressmaking enterprises were in disconnection stage either not growing or having a slim growth. Insufficiency of finances, poor business management skills, poor marketing and entrepreneurial attribute of the owner managers were found to be statistically significant in determining growth of these enterprises.

Methodology

The study employed the primary method of data collection. Banister, Bunn, Burman and Daniels (2011) suggested that survey method is the most universal way by which researchers collect primary data. This method permits the exploration of the phenomena that cannot be directly observed by the researcher (Sekaran & Bougie, 2010). To make certain data validity and enhanced analytical reasons, self-administered questionnaires were used. To examine the effect of Infrastructural support on business growth: evidence from technological enterprises in Nigeria, first hand sources was employed, making adequate use of the data derived from the respondents in the survey.

The study adopted multistage which included stratified random sampling and simple random sampling techniques. The stratified sampling technique is a probability sampling method, which ensures that different groups within the population are adequately represented while Simple random sampling technique was used to administered questionnaire to the respondents and the respondents are the owners of technological enterprises in Kwara, Kogi and Niger States. The reason for using random sampling was that it offered the respondents equal chance of being selected in the exercise. Questionnaire was the instrument used for data collection in this study. The study employed partial least squares (PLS) approach to analyse the data collected. Barclay, Higgins and Thompson (1995) submits that the PLS is a structural equation modeling tool (SEM) that allows the study to simultaneously analyze numerous variables and predictor constructs and analyze unobservable theoretical variables.
SEM is a multivariate extension of the multiple linear regression model with one dependent (Y) variable:
$y = i + Xb + e$

Where y = a vector containing observed scores on the dependent variable, i is a vector of 1's representing the y- intercept, X is a matrix of continuously distributed or categorical (dummy-coded) independent variables, b is the vector of regression weights, and e represents the vector of residual or error or leftover scoring unexplained by the model.

Data Presentation and Analysis

This section details the analysis and interpretation of collected field data obtained from the survey questionnaire.

Demographic Characteristics of Respondents

The frequency distribution of the respondents' demographic characteristics revealed that out of the 240 respondents, 185 (77.1%) are male, while 55 (22.9%) are female. Although, the findings recorded higher number of male respondents of the selected enterprises to their female counterpart, but by implication, it can be deduced that few females venture into engineering and science related studies, which indicated that female are yet to be adequately involved in manufacturing business.

Goodness of Fit: Assessment of PLS-SEM Path Model Results

The present study adopted a two-step process to evaluate and report the results of PLS-SEM path, as suggested by prior studies (Henseler, Ringle & Sinkovics, 2009).
The goodness of fit criteria such as goodness of fit index (GFI), comparative fit index (CFI), normed fit index (NFI), Non-Normed fit Index (NNFI), Root mean square error of approximation (RMSEA), incremental fit index (IFI) and relative fit index (RFI), results value >0.90 means the resulted model is good fit. So does another criterion of root mean square residual (RMR) resulting value about 0.1 which means the resulted model is good fitted. Because of all criteria infer the model is good of fit, testing the hypothetic theory can be done. This represents that resulted questionnaire data are able to answer the built theory for the study.

Table 1 Goodness of fit Model

Goodness of fit	Cut-off-value	Result	Annotation
RMR	0.05 and 0.1	0.047	Good fit
RMSEA	≥0.08	0.078	Good fit
GFI	≤0.90	0.97	Good fit
NFI	≤0.90	0.93	Good fit
CFI	≤0.90	0.91	Good fit
NNFI	≤0.90	0.94	Good fit
IFI	≤0.90	0.91	Good fit
RFI	≤0.90	0.92	Good fit

Source: Field Survey, 2021

Hypothesis : Effect of Infrastructure on Enterprise Growth

H_O: there is no significant relationship between infrastructural support and business growth among technological enterprises in Nigeria.

This predicts the effect of infrastructure on enterprise growth. The result of hypothesis is as follows:

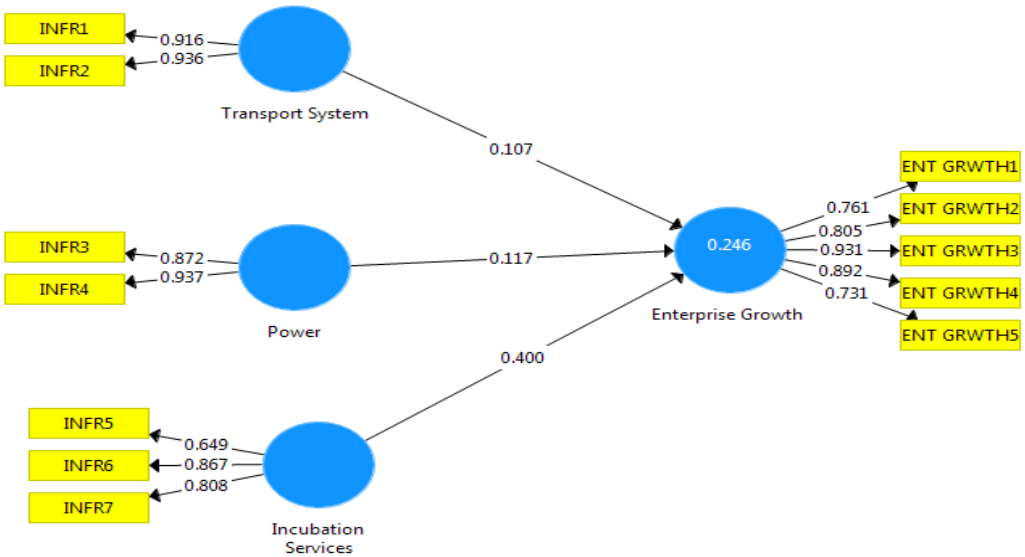

Figure 1 Enterprise growth *Measurement Model (Algorithm testing)*

Source: Field Survey, 2021

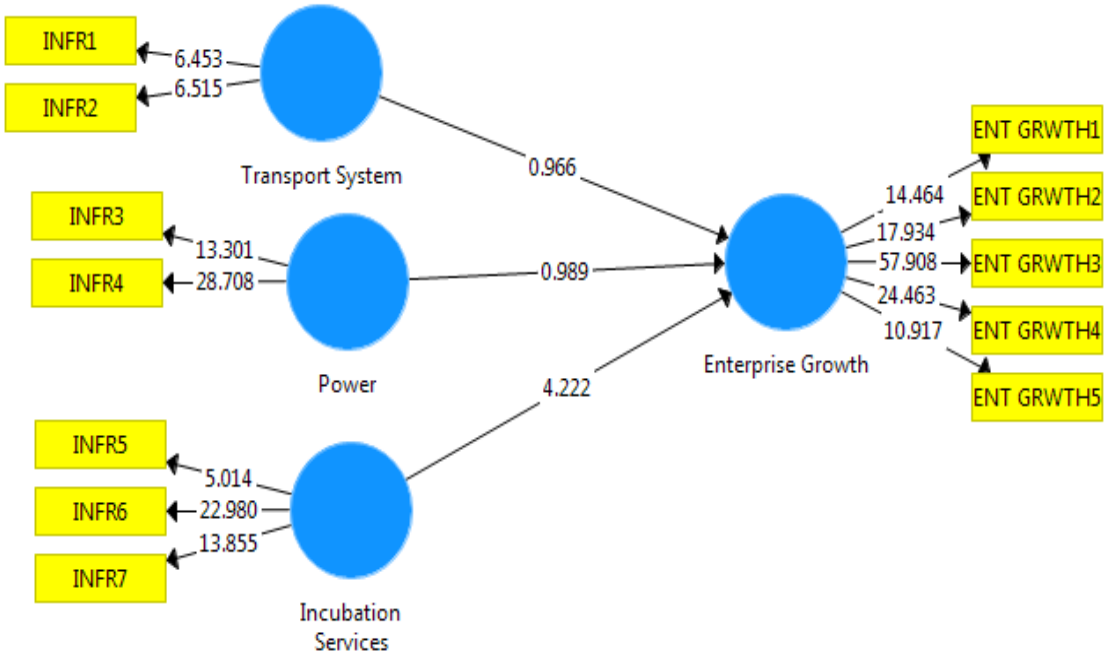

Figure 2 Enterprise growth *Measurement Model (Bootstrapping testing)*

Source: Field Survey, 2021

Table 2, Figures 1 and 2 indicated that infrastructure has a significant effect on enterprise growth with R^2 value of 0.246. This is shown by usage of transport system having significant relationship on enterprise growth. As shown in Table 2, a significant effect of transport system on enterprise growth ($\beta = 0.107$, $t = 0.926$, $p < 0.355$) was found, indicating support for the alternate hypothesis which states that there is a significant relationship between infrastructural support and business growth. Also, the result shows that power system has significant effect on enterprise growth with ($\beta = 0.117$, $t = 1.001$, $p < 0.317$) was found, indicating support for the alternate hypothesis which states that infrastructure has significant effect on enterprise growth. On the other hand, regarding the influence of infrastructure on enterprise growth, result on Table 1, indicated that incubation services had significant effect on enterprise growth ($\beta = 0.400$, $t = 4.363$, $p < 0.000$).

Table 2 Structural Model Result for the Enterprise Growth

	Path coefficient (β)	**Sample Mean**	**Standard Deviation**	**T statistics**	**P values**
Incubation Service-> Enterprise Growth	0.400	0.417	0.092	4.363	0.000
Power Utilisation -> Enterprise Growth	0.117	0.118	0.117	1.001	0.317
Transport System -> Enterprise Growth	0.107	0.111	0.115	0.926	0.355

Source: Field Survey, 2021

Discussion of Findings

The study hypothesis which states that infrastructure do not have significant influence on enterprise growth revealed that the null hypothesis is rejected. Hence, the alternate hypothesis is accepted. This implies that transport system, electrical power and incubation services are

essential in enterprise growth. This is supported by the studies of Hulten, Bennathan, and Srinivasan (2006); Calderón and Servén (2004); Ayogu (2007) also found that growth of road and electricity-generating capacity seems to have accounted for nearly half the growth of the productivity residual of India's registered manufacturing industries. Obokoh and Goldman (2016) found that deficiency in infrastructure negatively impacts the profitability and performance of SMEs, due to the high cost incurred by SMEs in the self-provision of infrastructure and distribution of finished goods. Similarly, Abioye, Adeniyi and Mustapha (2017) employed a qualitative multiple case study by purposively contacting 56 SME operators in Matori, Lagos Industrial Centre for interview. This is also supported by Akinyele, Akinyele and Ajagunna (2016).

Conclusion and Recommendation

Public infrastructural support services have a great and positive impact on the growth of technological enterprises among young graduate in North Central States, Nigeria. Thus, well packaged and adequate supply of infrastructural supports such as incubation services, power supply and transport system will assist technological entrepreneur in growing their businesses. Therefore, it is recommended that, government of Nigeria should provide adequate transport services to transport their finished goods to the market, as well as incubation service to nurture these enterprises. Also, electrical energy to power their machines and equipment should be adequately supplied. Government should prioritise the issue of infrastructural support to technological enterprises in order to inspire young graduates who venture into sub-manufacturing sector, in that way there will be an appreciable decrease to the level of increasing unemployment currently been experience in the country. In addition, infrastructural support services to technological enterprises should be given a priority by setting up intervention programmes specifically for this segment as it is found in other sectors of the economy.

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Preparation of Papers - Lying Decreases Relying

Jenna Barriault, Reeshma Haji

***Abstract*—** Online consumer behaviour and reliance on online reviews may be more pervasive than ever, and this necessitates a better scientific understanding of the widespread phenomenon of online deception. The present research focuses on the understudied topic of deceiver's distrust, where those who engage in deception later have less trust in others, in the context of online restaurant reviews. The purpose was to examine deception and valence in online restaurant reviews and the effects they had on deceiver's distrust. Undergraduate university students (N = 76) completed an online study where valence was uniquely manipulated by telling participants that either positive (or negative reviews) were influential and asking them to write a correspondingly valenced review. Deception was manipulated in the same task. Participants in the deception condition were asked to write an online restaurant review that was counter to their actual experience of the restaurant (negative review of a restaurant they liked, positive review of the restaurant they did not like). In the no deception condition, participants were asked to write a review that they actually liked or didn't like (based on the valence condition to which they were randomly assigned). Participants' trust was then assessed through various measures including future reliance on online reviews. There was a main effect of deception on reliance on online reviews. Consistent with deceiver's distrust, those who deceived reported that they would rely less on online reviews. This study demonstrates that even when participants are induced to write a deceptive review, it can result in deceiver's distrust, thereby lowering their trust in online reviews. If trust or reliance can be altered through deception in online reviews, people may start questioning the objectivity or true representation of a company based on such reviews. A primary implication is that people may reduce their reliance upon online reviews if they know they are easily subject to manipulation. The findings of this study also contribute to the limited research regarding deceiver's distrust in an online context, and further research is clarifying the specific conditions in which it is most likely to occur.

***Keywords*—** Deceiver's distrust, deception, online reviews, trust, valence.

Jenna Barriault is with the Laurentian University, Canada (e-mail: jbarriault@laurentian.ca).

On the Operators Related to C. W. T. Ongeneral Homogeneous Spaces

Olia Dokht Sajadirad, Rajabali Kamyabigol, Fatemeh Esmaeelzadeh

***Abstract*—** For homogeneous space G/H equipped with strongly quasi invariant measure ν, we introduce the two-wavelet constant for the orthogonal sub spaces of $L^2(G/H)$, which are related to continuous wavelet transform (C.W.T). For admissible wavelet η and $\Theta \in L^p(G/H)$; $1 \leq p \leq \infty$, thelocalization operator $\Upsilon\Theta,\eta$ is introduced. The bounded properties of localization operator is studied.

***Keywords*—** localization operator, homogeneous space, strongly quasi invariant measure, admissible wavelet.

Olia Dokht Sajadirad is with the Ferdowsi University, Iran (e-mail: sajadyrad@mail.um.ac.ir).

Optimize Data Evaluation Metrics for Fraud Detection using Machine Learning

Jennifer Leach, Umashanger Thayasivam

***Abstract*—The use of technology has benefited society in more ways than one ever thought possible. Unfortunately, though as society's knowledge of technology has advanced so has its knowledge on ways to use technology to manipulate people. This has led to a simultaneous advancement in the world of fraud. Machine learning techniques can offer a possible solution to help decrease this advancement. This research explores how the use of various machine learning techniques can aid in detecting fraudulent activity across two different types of fraudulent data and the accuracy, precision, recall and F1 were recorded for each method. Each machine learning model was also tested across five different training and testing splits in order to discover which testing split and technique would lead to the most optimal results.**

***Index Terms*—data science, fraud detection, machine learning, supervised learning,**

I. Introduction

Since technology has become a fundamental part of how society runs and operates, it has become even easier for people to utilize these new advancements to manipulates others. This is where the area of fraud detection starts to have a greater importance within the foundations of our society.

A. Fraud Detection within Society

As technology has advanced, the various ways people can be manipulated has also advanced with it. Today fraud can be seen within multiple areas within society. One can find it with the financial field through the manipulation of one's banking accounts to obtain monetary gains. One can see fraud within the security field through the use of identity theft. Fraud is even found within normal email inboxes through the use of spam, or phishing emails. But, through the use of fraud detection, one is able minimize the amount of people who are affected by the perpetrators of fraud.

B. Usefulness of Machine Learning

Machine learning techniques are a crucial part of the field of data science. The various techniques within the area of machine learning help aid with problems within multiple fields of study. Within the field of fraud detection, machine learning can pose a potential method of identifying fraudulent activity or perpetrators of fraud. This can drastically minimize the number of individuals who are negatively impacted by fraud. [1], [2]

C. Summary of Analysis to be Done

For this analysis, the use of various machine learning techniques were analyzed across two types of fraud. The areas of consists of credit card fraud, and cyber-attacks fraud. These diverse types of fraud were then analyzed across five different machine learning techniques. The techniques that this analysis focused on were the ones of: Logistic Regression, Random Forest, Bagging, Support Vector Machine, and K- Nearest Neighbors. [3]–[5]

D. Objectives of Research

The objective of this research is, first, to find which machine learning techniques optimize the accuracy, precision, recall, and F1 of the various fraud detection data. Secondly, to find the optimal training and testing split that will give the most efficient model of detecting fraudulent activity.

E. Evaluation Metrics

In order to evaluate the results of each of the five machine learning techniques, the methods of accuracy, precision, recall, and F1 were used. [6], [7] Each of the four methods using the following four type of predictions in order to calculate the appropriate results:

- True Positive (TP)
  - Where the model predicted the outcome was fraudulent and it was in fact fraudulent.
- False Negative (FN)
  - Where the model predicted the outcome was not fraudulent but it in fact was fraudulent.
- False Positive (FP)
  - Where the model predicted the outcome was fraudulent and it was not actually fraudulent.
- True Negative (TN)
  - Where the model predicted the outcome was not fraudulent and it was not actually fraudulent.

1) Accuracy: Accuracy is the most common evaluation method. It calculates the percentage of observations that were correctly predicted through the formula:

$$Accuracy = \frac{TP + TN}{TP + FN + FP + TN} \tag{1}$$

2) Precision: Precision calculates the amount of correct positive predicted outcomes compared to the total positive predicted outcomes. This is done through the formula:

$$Precision = \frac{TP}{TP + FP} \tag{2}$$

Jennifer Leach is with the Rowan University, United States (e-mail: Leachj15@students.rowan.edu).

3) Recall: Recall calculates the amount of correct positive predicted outcomes compared to the total accurate predicted outcomes. This is done through the formula:

$$Precision = \frac{TP}{TP + FN} \tag{3}$$

4) F1: F1 calculates the harmonic mean of the precision and recall through the formula:

$$Precision = \frac{2 * Precision * Recall}{Precision + Recall} \tag{4}$$

II. Summary of Datasets

For this research, the use of a machine learning techniques were analyzed across two different fraud detection datasets.

A. Cyber-Attack Dataset

The first dataset [8] looks to identify cyber-attacks that occurred in the province of Elaziğ in Turkey between 2015 and 2019. It consisted of 901 cases of cyber-attack which are analyzed across eleven unique features. Those features are all categorical and consists of: Crime, Gender, Age, Income, Job, Marital Status, Education, Harm, Attack, Attack Method, and Perpetrator.

The 'Crime' attribute describes the crime done by the attacker and consists of the following three categories: misuse of debit/credit card, through informatics theft, and hacking into the information system and capturing data. The next attribute is 'Gender' and is categorized by either male or female. 'Age' describes the age of the attacker and consists of the following four categories: 27 years old and under, between 28 and 37 years old, between 38 and 50 years old, and 51years old and older. Next, the attribute 'Income' is the income level of the cyber-attacker and is categorized as Low, Medium, or High. The attribute 'Job' describes the job the attacker had during the time of their attack, and consists of the following nine categories: other, student, retired, justice and security, health sector manager, housewife, education, technical, and finance sector. 'Marital Status' is the martial status of the attacker is either labelled single or married. 'Education' is the highest educational status of the attacker and is categorized as either: Primary Education, High school, undergraduate and graduate. The attribute 'Harm' is categorized into the following seven categories. 'Attack' is categorized into the five categories. The feature 'Attack Method' can be used as either an attribute or a response variable and is categorized into 5 categories. The description of the categories can be found in the journal, "Cyber-Attack Method and Perpetrator Prediction using Machine Learning Algorithms" who provided the dataset. [8] For the sake of this analysis, 'Attack Method' was used as one of the attributes. Finally, 'Perpetrator' can also be used as either an attribute or a response variable and describes whether the cyber-attacker was either Known or Unknown.

For this analysis, 'Perpetrator' was used as the response variable. Therefore, for this analysis of cyber-attacks there was a total of ten attributes across 901 different cyber-attack cases in order to try to predict whether one can identify the perpetrator of the attack or not.

B. Credit Dataset

The second dataset is a R dataset under the CASdatasets [9]–[11] package. It consisted of 1,000 credit records which are analyzes across 21 unique features. Those features are a combination of categorical and numerical variables and consist of: Credit Status, Duration, Credit History, Purpose, Credit Amount, Savings, Employment, Installment Rate, Personal Status, Other Parties, Residence Since, Property Magnitude, Age, Other Payment Plans, Housing, Existing Credits, Job, Number of Dependents, Telephone, Foreign Worker, and Class.

The "Checking Status" attribute is a categorical variable that describes the status of the existing checking account, with the following categories: Less than 0, from 0 to 200, more than 200, or no running account/unknown account. "Duration" is a numerical variable explaining the credit duration in months. "Credit History" is a categorical variable that consists of the following categories: delay in paying off in the past, critical account, no credits taken or all credit paid back duly, existing credits paid back duly till now, all credits at this paid back duly. The attribute "Purpose" is a categorical variable describing the purpose of the credit. It has the following categories: new car, used car, item of furniture/equipment, radio/television, domestic household appliances, repairs, education, vacation, retraining, business, and others. "Credit Amount" is a numerical variable stating the credit amount in Deutsch marks. "Savings" is a categorical variable with the following categories: less than 100, from 100 to 500, from 500 to 1,000, more than 1,000, and no savings/unknown account. "Employment" is a categorical variable describing how long the person has been employed. It consists of the following: unemployed, less than 1 year, from 1 to 4 years, from 4 to 7 years, and more than 7 years. "Installment Rate" describes the person's installment rate in percentage of disposable income with the following categories: greater than 35, between 25 and 35, between 20 and 25, and less than 20. "Person Status" is a categorical variable explaining the person's martial status and sex. It consists of the following: male: divorced/separated, female: divorced/separated/married, male: single, male: married/widowed, and female: single. "Other Parties" describes any other debtors or guarantors with the following options: none, co-applicant, and guarantor. "Resident Since" is a categorical variable broken up by: less than 1 year, from 1 to 4 years, from 4 to 7 years, and more than 7 years. "Property Magnitude" describes the person's most values property with the following categories: real estate, savings contract with building society/life insurance, car or other, and unknown/no property. "Age" is the age of the person in years. "Other Payment Plans" consists of: at other bank, at department store or mail order house, and no further running credits. "Housing" is the type of housing the person has from the following: rented flat, owner-occupied flat, and free apartment. "Existing credits" states the number of existing credits the person has at this

bank. It consists of the following categories: one, two or three, four or five, and six or more. “Job” consists of the following: unemployed/unskilled with no permanent residence, unskilled with permanent residence, skilled worker/ skilled employee/ minor civil servant, and executive/self-employed/higher civil servant. “Number of Dependents” is a categorical variable explaining the number of dependents the person is liable to provide maintenance for. It has the following categories: zero to two, and three and more. “Telephone” is a categorical variable consisting of either “none” or “yes, registered under the customers name”. “Foreign Worker” is whether or not the person is a foreign worker. Finally, class is a binary variable where 0 represents good and 1 represents bad.

For this analysis, “Class” was used as the response variable. So, this analysis of credit data had a total of 20 attributes across 1,000 credit records. In order to predict whether a specific credit report is good or bad.

C. Splitting of Credit Dataset

Since the credit dataset was a combination of numerical and categorical variables, it was then split into its corresponding numerical and categorical parts. This was to see how the different variable types affect the outcomes of the machine learning models.

1) Numerical Variables: For this analysis, only the numerical variables within the credit dataset were analyzed. Therefore, the dataset consisted of the following variables: ”Duration”, ”Credit Amount”, ”Installment Rate”, ”Residence Since”, ”Age”, ”Existing Credits”, ”Number of Dependents”, and the categorical response variable, ”Class”. So, the analysis had a total of 8 attributes across 1,000 credit records.

2) Categorical Variables: For this analysis, only the categorical variables within the credit dataset were explored. Therefore, the dataset consisted of the following categorical variables: ”Checking Status”, ”Credit History”, ”Purpose”, ”Savings”, ”Employment”, ”Personal Status”, ”Other Parties”, ”Property Magnitude”, ”Other Payment Plans”, ”Housing”, ”Job”, ”Telephone”, ”Foreign Worker” and the response variable, ”Class”. So, the analysis had a total of 14 attributes across 1,000 credit records.

III. Programming Software Used

The analysis of the aforementioned datasets was mainly done using R and RStudio to analyze the different variables across five different training and testing splits. JMP Pro was also used to help assist with some of the analysis as well.

IV. Results of Cyber-Attack Dataset

The Cyber-Attack dataset used five different machine learning techniques in order to help predict whether or not one could detect who the perpetrator of fraud was. The model was created using the following training splits of the original dataset: 70%, 75%, 80%, 85%, and 90%. Then, the model created from those splits was applied to the corresponding testing splits for each of the five machine learning techniques analyzed. The table and graphs below show the accuracy, precision, recall and F1 obtained when applying those models.

TABLE I
Results of Cyber-Attack Data by Machine Learning Type

Cyber-Attack Results	Machine Learning Techniques				
Training/ Testing Split	*Logistic Regression*	*Random Forest*	*Bagging*	*SVM*	*KNN*
Accuracy %					
70% / 30%	64.8%	62.6%	63.0%	68.9%	**86.7%**
75% / 25%	63.3%	65.0%	61.9%	67.7%	**85.4%**
80% / 20%	62.2%	58.9%	58.9%	62.8%	**81.1%**
85% / 15%	65.9%	63.0%	58.5%	72.6%	**88.9%**
90% / 10%	61.1%	63.3%	61.1%	67.8%	**87.8%**
Precision %					
70% / 30%	60.8%	57.3%	57.5%	70.4%	**85.8%**
75% / 25%	58.6%	61.2%	57.1%	69.2%	**86.5%**
80% / 20%	59.6%	52.7%	52.6%	59.3%	**78.2%**
85% / 15%	62.7%	59.6%	52.6%	72.6%	**90.7%**
90% / 10%	56.7%	57.9%	55.0%	69.2%	**85.0%**
Recall %					
70% / 30%	53.0%	53.8%	55.6%	48.7%	**82.9%**
75% / 25%	52.0%	53.1%	49.0%	45.9%	**78.6%**
80% / 20%	39.7%	50.0%	51.3%	44.9%	**78.2%**
85% / 15%	54.2%	47.5%	50.8%	54.2%	**83.1%**
90% / 10%	43.6%	56.4%	56.4%	46.2%	**87.2%**
F1 %					
70% / 30%	56.6%	55.5%	56.5%	57.6%	**84.3%**
75% / 25%	55.1%	56.8%	52.7%	55.2%	**82.4%**
80% / 20%	47.7%	51.3%	51.9%	51.1%	**78.2%**
85% / 15%	58.2%	52.8%	51.7%	63.4%	**86.7%**
90% / 10%	49.3%	57.1%	55.7%	55.4%	**86.1%**

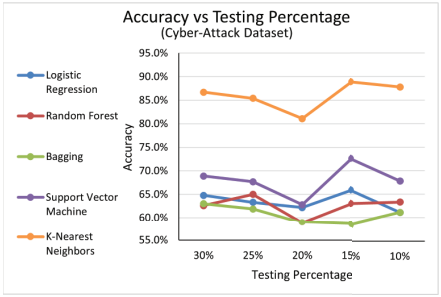

Figure 1. Accuracy of Each Machine Learning Across Five Testing Splits for Cyber-Attack Dataset

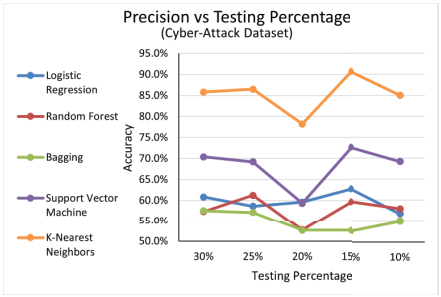

Figure 2. Precision of Each Machine Learning Across Five Testing Splits for Cyber-Attack Dataset

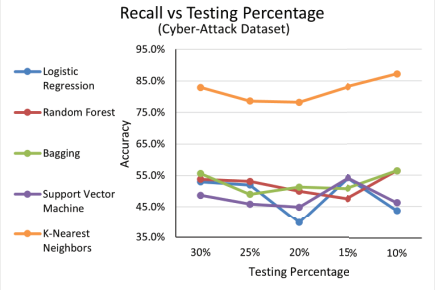

Figure 3. Recall of Each Machine Learning Across Five Testing Splits for Cyber-Attack Dataset

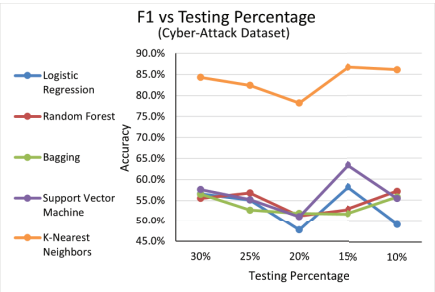

Figure 4. F1 of Each Machine Learning Across Five Testing Splits for Cyber-Attack Dataset

For the Cyber-Attack dataset, K Nearest Neighbors produced the greatest accuracy, precision, recall, F1 across all different training and testing splits. When analyzing the specific training and testing splits done with KNN, overall, the split of 85% training and 15% testing produced the optimal results.

V. Comparing Cyber-Attack Data

Since the Cyber-Attack Dataset was obtained from an academic journal [4], the results from this analysis was compared to the results within that journal. Both analyses have the following machine learning techniques in common: Logistic Regression, Random Forest, and KNN. Also, the academic journal where the Cyber-Attack dataset came from only performed the aforementioned machine learning techniques at a 80% Training 20% Testing split.The table and graph below show the accuracy, precision, recall, and F1 obtained from both analyses at the 80% Training / 20% Testing split, where "Journal" represents the original journal from which the Cyber-Attack dataset was obtained.

TABLE II
Results of Cyber-Attack Data by Machine Learning Type

Cyber-Attack Results	**Machine Learning Techniques**					
Measurement Type	***Logistic Regression***	***Logistic Regression (Journal)***	***Random Forest***	***Random Forest (Journal)***	***KNN***	***KNN (Journal)***
Accuracy %	62.2%	65.40%	58.9%	63.54%	*81.1%*	64.57%
Precision %	59.6%	60.67%	52.7%	63.91%	*78.2%*	56.85%
Recall %	39.7%	60.22%	50.0%	63.54%	*78.2%*	56.91%
F1 %	47.7%	59.14%	51.3%	62.92%	*78.2%*	56.85%

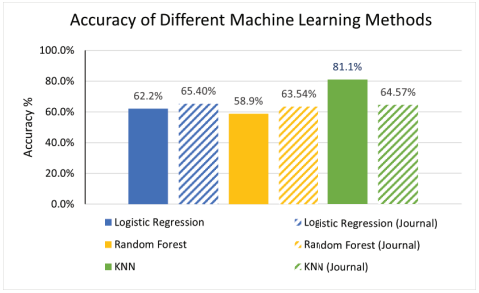

Figure 5. Comparing Accuracy of Each Machine Learning Technique Across Two Analyses

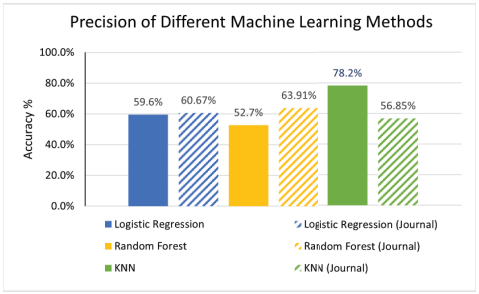

Figure 6. Comparing Precision of Each Machine Learning Technique Across Two Analyses

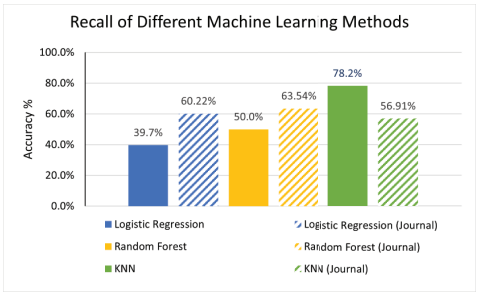

Figure 7. Comparing Recall of Each Machine Learning Technique Across Two Analyses

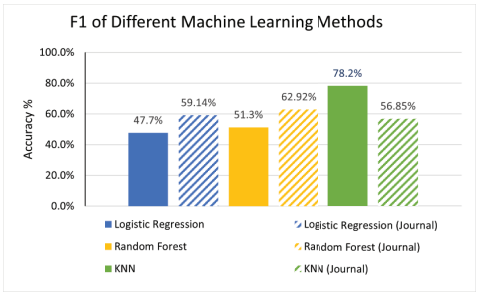

Figure 8. Comparing F1 of Each Machine Learning Technique Across Two Analyses

Logistic Regression and Random Forest produced similar results as the original journal for all four types of measurements. The only discrepancy between the original journal and this analysis was in K-Nearest Neighbors. The K-Nearest

Neighbors in this analysis was higher than the ones obtained in the original journal. The reason for this difference could be due to the different programming softwares used between the two analyses, or due to the selected k-value used for the analysis. The original journal used Python to run their analyses while this research used R. The way the different programs perform the K-Nearest Neighbor analysis may be the reason for the discrepancies. Also, this research selected the k-value for the analysis by sequentially picking values for k until they found a value that produced the highest accuracy. The process/value of k used in the original journal is unknown. This may also explain the discrepancy between the two results.

VI. Results from Credit Dataset (Full Dataset)

The Credit dataset used five different machine learning techniques in order to help predict whether or not a specific credit report was good or bad. The model was created using the following training splits of the original dataset: 70%, 75%, 80%, 85%, and 90%. Then, the model created from those splits was applied to the corresponding testing splits for each of the five machine learning techniques analyzed. The table and graphs below show the accuracy, precision, recall and F1 obtained when applying those models.

TABLE III
Results of Full Credit Data by Machine Learning Type

Credit Data Results (Full Dataset)	**Machine Learning Techniques**				
Training/ Testing Split	***Logistic Regression***	***Random Forest***	***Bagging***	***SVM***	***KNN***
Accuracy %					
70% / 30%	73.3%	**75.0%**	72.3%	72.0%	68.3%
75% / 25%	78.0%	78.0%	75.2%	**79.2%**	66.4%
80% / 20%	75.0%	**76.5%**	71.5%	75.0%	69.5%
85% / 15%	**80.7%**	78.7%	78.0%	**80.7%**	71.3%
90% / 10%	76.0%	**78.0%**	73.0%	74.0%	71.0%
Precision %					
70% / 30%	**79.3%**	78.2%	78.5%	77.6%	72.5%
75% / 25%	**81.6%**	79.4%	79.6%	80.6%	71.6%
80% / 20%	**78.5%**	78.2%	77.1%	76.8%	73.4%
85% / 15%	**82.2%**	78.3%	80.5%	81.1%	73.5%
90% / 10%	80.3%	79.3%	**81.2%**	76.8%	73.0%
Recall %					
70% / 30%	83.8%	**89.0%**	83.3%	84.3%	88.1%
75% / 25%	88.6%	**92.6%**	86.9%	**92.6%**	86.3%
80% / 20%	88.6%	**92.1%**	84.3%	**92.1%**	88.6%
85% / 15%	92.4%	**96.2%**	90.5%	94.3%	92.4%
90% / 10%	87.1%	**92.9%**	80.0%	90.0%	**92.9%**
F1 %					
70% / 30%	81.5%	**83.3%**	80.8%	80.8%	79.6%
75% / 25%	84.9%	85.5%	83.1%	**86.2%**	78.2%
80% / 20%	83.2%	**84.6%**	80.5%	83.8%	80.3%
85% / 15%	87.0%	86.3%	85.2%	**87.2%**	81.9%
90% / 10%	83.6%	**85.5%**	80.6%	82.9%	81.8%

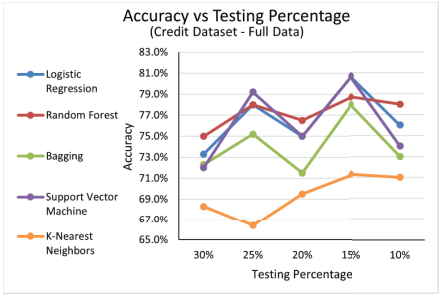

Figure 9. Accuracy of Each Machine Learning Across Five Testing Splits for Full Credit Dataset

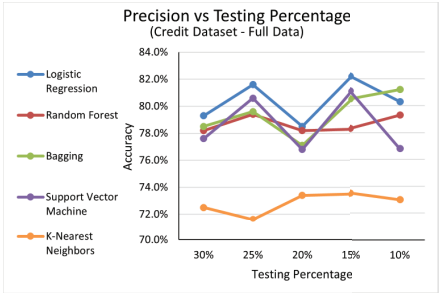

Figure 10. Precision of Each Machine Learning Across Five Testing Splits for Full Credit Dataset

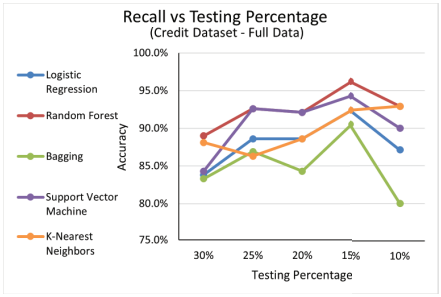

Figure 11. Recall of Each Machine Learning Across Five Testing Splits for Full Credit Dataset

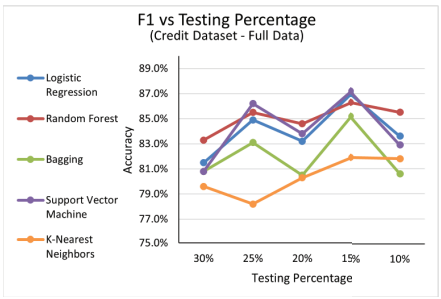

Figure 12. F1 of Each Machine Learning Across Five Testing Splits for Full Credit Dataset

For the Full Credit dataset, in general, Logistic Regression, Support Vector Machines, and Random Forest produced the highest accuracy, precision, recall, and F1 across all training and testing splits. Support Vector Machines produced the highest or about equal to the other aforementioned machine learning techniques. In conclusion, Support Vector Machines performs the best when predicting whether a credit report is good or bad when using both categorical and numerical variables. Across all four tests of measurements the optimal training and test was 85% Training and 15% Testing.

VII. Results From Credit Dataset (Only Numerical Variables)

After running the analyses on the Full Credit model, the credit model was then split into only numerical values and only categorical variables in order to predict whether a specific credit report was good or bad. Therefore, the model was created using the same training splits on the dataset for only numerical variables: 70%, 75%, 80%, 85%, and 90%. Then, the model created from those splits was applied to the corresponding testing splits for the five machine learning techniques analyzed. The table and graphs below show the accuracy, precision, recall and F1 obtained when applying those models to only the numerical variables.

TABLE IV
Results of Credit Data by Machine Learning Type (Numerical Variable Only)

Credit Data Results (Numerical Only)	**Machine Learning Techniques**				
Training/ Testing Split	***Logistic Regression***	***Random Forest***	***Bagging***	***SVM***	***KNN***
Accuracy %					
70% / 30%	69.3%	**70.7%**	65.0%	70.0%	68.3%
75% / 25%	**71.2%**	**71.2%**	65.6%	70.8%	66.4%
80% / 20%	69.5%	**72.0%**	67.0%	70.5%	69.0%
85% / 15%	69.3%	68.7%	68.0%	70.0%	**72.7%**
90% / 10%	72.0%	73.0%	**74.0%**	71.0%	72.0%
Precision %					
70% / 30%	71.9%	**74.6%**	73.8%	70.5%	72.5%
75% / 25%	72.5%	**73.5%**	71.9%	70.7%	71.6%
80% / 20%	71.1%	**74.1%**	73.7%	70.8%	73.2%
85% / 15%	71.2%	72.3%	**74.8%**	72.1%	73.9%
90% / 10%	71.9%	74.2%	**76.8%**	70.7%	73.3%
Recall %					
70% / 30%	92.4%	88.1%	77.6%	**98.1%**	88.1%
75% / 25%	94.9%	92.0%	83.4%	**99.4%**	86.3%
80% / 20%	95.0%	92.1%	82.1%	**98.6%**	87.9%
85% / 15%	**94.3%**	89.5%	81.9%	93.3%	**94.3%**
90% / 10%	98.6%	94.3%	90.0%	100.0%	94.3%
F1 %					
70% / 30%	**80.8%**	**80.8%**	75.6%	80.7%	79.6%
75% / 25%	**82.2%**	81.7%	77.2%	78.9%	78.2%
80% / 20%	81.3%	82.2%	77.7%	**86.3%**	79.9%
85% / 15%	81.1%	80.0%	78.2%	79.0%	**82.8%**
90% / 10%	**83.1%**	83.0%	82.9%	79.2%	82.5%

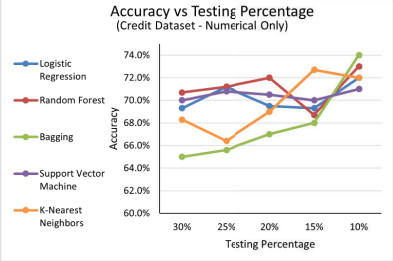

Figure 13. Accuracy of Each Machine Learning Across Five Testing Splits for Numerical Values in Credit Dataset

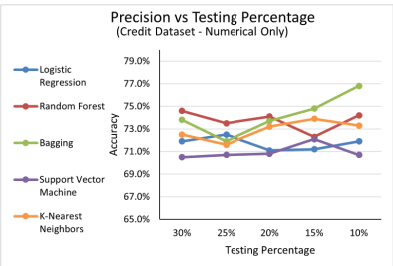

Figure 14. Precision of Each Machine Learning Across Five Testing Splits for Numerical Values in Credit Dataset

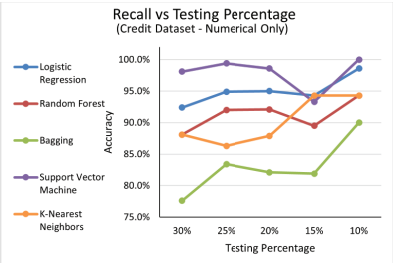

Figure 15. Recall of Each Machine Learning Across Five Testing Splits for Numerical Values in Credit Dataset

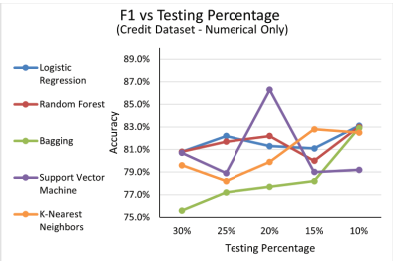

Figure 16. F1 of Each Machine Learning Across Five Testing Splits for Numerical Values in Credit Dataset

For the Credit dataset for only the numerical variables, Bagging and Random Forest provided the largest accuracy, and precision at the 90% Training 10% Testing split. Meanwhile, Logistic Regression and Support Vector Machine produced the highest Recall and F1 across four of the five training and testing splits, but moderate accuracy, precision. Therefore,

when analyzing the numerical variables within the Credit dataset, Boosting and Random Forest performed the best when predicting whether a credit report is good or bad, with an optimal training test split of 90% Training 10% Testing.

VIII. Results From Credit Dataset (Only Categorical Variables)

After running the analyses on the Full Credit model, the credit model was then split into only numerical values and only categorical variables in order to predict whether a specific credit report was good or bad. Therefore, the model was created using the same training splits on the dataset for only categorical variables: 70%, 75%, 80%, 85%, and 90%. Then, the model created from those splits was applied to the corresponding testing splits for each of the five machine learning techniques analyzed. The table and graphs below show the accuracy, precision, recall and F1 we obtained when applying those models to only the categorical variables.

TABLE V
Results of Credit Data by Machine Learning Type
(Categorical Variables Only)

Credit Data Results (Categorical Only)	**Machine Learning Techniques**				
Training/ Testing Split	***Logistic Regression***	***Random Forest***	***Bagging***	***SVM***	***KNN***
Accuracy %					
70% / 30%	72.0%	72.7%	70.7%	72.3%	**80.7%**
75% / 25%	74.4%	75.6%	71.6%	74.4%	**83.6%**
80% / 20%	74.5%	75.0%	74.0%	74.0%	**84.5%**
85% / 15%	78.0%	77.3%	78.7%	77.3%	**86.0%**
90% / 10%	72.0%	71.0%	68.0%	70.0%	**84.0%**
Precision %					
70% / 30%	77.9%	77.8%	78.2%	76.8%	**83.0%**
75% / 25%	78.5%	77.1%	77.1%	77.6%	**85.6%**
80% / 20%	76.6%	77.1%	78.9%	74.4%	**85.2%**
85% / 15%	78.1%	78.9%	81.2%	77.5%	**86.8%**
90% / 10%	76.3%	75.3%	75.0%	75.0%	**85.5%**
Recall %					
70% / 30%	83.8%	85.2%	80.5%	86.7%	**91.0%**
75% / 25%	87.4%	**92.6%**	84.6%	89.1%	92.0%
80% / 20%	91.4%	91.4%	85.7%	**95.7%**	94.3%
85% / 15%	**95.2%**	92.4%	90.5%	**95.2%**	94.3%
90% / 10%	87.1%	87.1%	81.4%	85.7%	**92.9%**
F1 %					
70% / 30%	80.7%	81.4%	79.3%	81.4%	**86.8%**
75% / 25%	82.7%	84.2%	80.7%	83.0%	**88.7%**
80% / 20%	83.4%	83.7%	82.2%	83.8%	**89.5%**
85% / 15%	85.8%	85.1%	85.6%	85.5%	**90.4%**
90% / 10%	81.3%	80.8%	78.1%	80.0%	**89.0%**

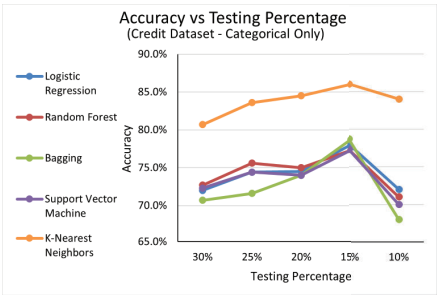

Figure 17. Accuracy of Each Machine Learning Across Five Testing Splits for Categorical Variables in Credit Dataset

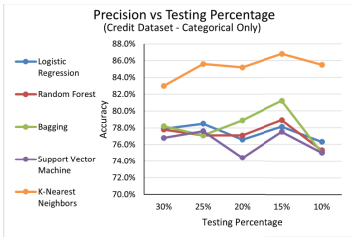

Figure 18. Precision of Each Machine Learning Across Five Testing Splits for Categorical Variables in Credit Dataset

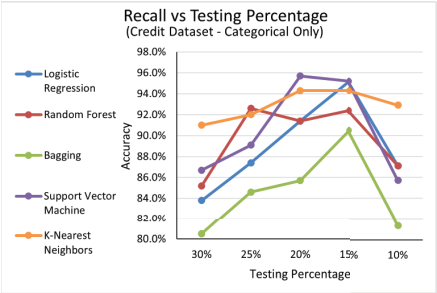

Figure 19. Recall of Each Machine Learning Across Five Testing Splits for Categorical Variables in Credit Dataset

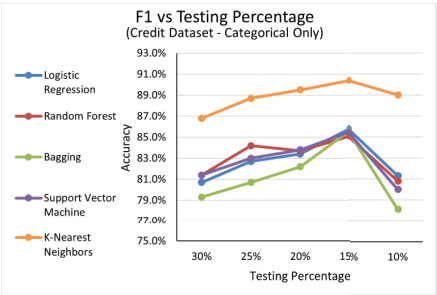

Figure 20. F1 of Each Machine Learning Across Five Testing Splits for Categorical Variables in Credit Dataset

For the Credit dataset for only the categorical variables, K-Nearest Neighbors produced the highest accuracy, precision, and F1 across all training and testing splits, compared to the other four machine learning models. As for recall, the machine learning algorithms that produced the highest results were K-Nearest Neighbors, Support Vector Machine, and Logistic Regression. Within those K-Nearest Neighbors produced higher or approximately equal results to the other two aforementioned machine learning techniques across all training and testing splits. Therefore, K-Nearest Neighbors performed the best for predicting, using only categorical variables, whether a credit report is good or bad, with an optimal training and testing split being 85% Training and 15% Testing since this split generally produced the highest accuracy, precision, recall, and F1 for this dataset.

IX. Conclusions/ Future Research

Therefore, across all data sets, K-Nearest Neighbors, Support Vector Machines, Bagging and Random Forest were the optimal model for predicting fraudulent activity. K-Nearest Neighbors performs the best when used for analyzing fully categorical data. Bagging or Random Forest performs the best when used for analyzing fully numerical data. Finally, Support Vector Machines performs the best when used for analyzing data with a combination of numerical and categorical variables. Also, in general, the optimal training and testing split was 85% Training and 15% Testing across the various data sets. The only exception to this was when analyzing only numerical values, then the optimal training and testing split was 90% Training and 10% Testing.

Future research direction of this study is to analyze the various datasets including deep learning and other ensemble learning. Also, to perform the analysis and optimize performance evaluation analysis between different software programs, such as Python.

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Pricing American Options under Irrational Behavior

Mohammad Saber Rohi, Hossein Azari and Saghar Heidari

Abstract—In this paper, we consider the pricing problem of American options under an irrational exercise strategy with a rationality parameter. Irrational behavior of option holders as reactions to market movements can lead to an exercising option strategy at a time that might not be an optimal time. Under the irrational exercising time strategy, the pricing problem of the American-style option results in the overvalued option price. A common way to study the irrational behavior of option holders and its impact on the American option pricing problem is to consider intensity-based models with stochastic intensity parameters. Under these models, the option pricing problem leads to a nonlinear parabolic partial differential equation (PDE) with an additional term to the PDE of the American option under rational strategy (classical American option with optimal exercise strategy) due to the intensity functions of models. Although the solution converges to the solution of the classical American option price when the parameter tends to infinity, for finite values of the parameter the classical boundary conditions cannot apply. For this, we propose a finite element method to solve the resulted PDE with a numerical approach. We also present numerical results to show the accuracy of the proposed method.

Keywords—irrational exercise strategy, rationality parameter, American option, finite element method.

I. Introduction

Nowadays, financial derivatives, in particular, American-style options are widely considered in the modern financial markets. In these contracts, the option holder has the right to exercise his option based on his choice at any time until its expiration date to get the option payoff. In this way, the value of an American option is formulated as an optimal stopping time problem [1] where the stopping time is optimal for the option holder to exercise and receive the maximum exercise value. However, in real markets experimental data show that there is a large number of irrational behavior that lead to irrational exercises [2]–[4].

Irrational behavior may be due to many reasons such as emotional reactions to market movements, incorrect information, or imperfect input for models. In addition, sometimes holding American options as a hedging strategy can lead to exercise at a time that might not be an optimal time and is known as an irrational exercise strategy. Due to the irrational behavior and so the irrational exercise strategy, the pricing problem of American-style options results in overvalued option prices, such that we cannot consider the classical model of American options under rational exercise strategy. Thus, the irrational exercise behavior is needed to take into account through other alternative option pricing models. Recently, a new nonlinear Black-Scholes model is proposed in [4]. The authors considered an intensity-based model (based on penalty methods) for the valuation of American options to capture irrational behavior. For this, they assumed the exercise time as the first jump time of a process with a stochastic intensity parameter which has been called as rationality parameter. On the other hand, if the option holder decides to exercise the option at the non-optimal time (early or late exercise), his profit at each exercise time can be measured as the difference between the payoff and the value of the option, so the dependence of the exercise intensity in terms of the profitability can be described by the rationality parameter. The authors also provided probabilistic proof of the existence of a solution to the pricing problem and show that under the proposed model the American option prices converge to the corresponding American options under the rational strategy when the rational parameter tends to infinity.

To value American options under irrational strategy with the PDE approach, there is only one research paper [8] where a finite difference method is applied by authors to solve the pricing problem of American put options with a numerical scheme. But to the best of our knowledge, almost no work has been done on the problem with other efficient numerical methods. This motivated us to propose a finite element method to obtain more accurate and fast solutions for the pricing problem of American options under the irrational strategy. For this purpose, first, by using a variable transformation technique, the pricing problem is transformed into a nonlinear parabolic equation with constant coefficients in an infinite domain. Then a finite element method is applied to solve the variational problem for option price on a truncated domain. Our numerical experiments demonstrated the accuracy and efficiency of the proposed method to obtain fast solutions for the pricing problem of American options under irrational behavior.

The paper is organized as follows: In section 2 we consider the intensity-based models to obtain an appropriate PDE with boundary conditions for the American option under the irrational behavior of its holder. In section 3, a transformation technique is used to take some numerical advantages of working on PDEs with constant coefficients. In section 4, we first truncate the resulted problem in a bounded domain, then we apply a finite element method to the time-discretized form of the variational problem. Some numerical examples are examined in section 5 to show the accurate and fast results of applying the proposed method for American option price under the irrational strategy. Finally, the conclusion is presented in section 6.

II. American Options with Rationality Parameter

Let's fix a filtered probability space $(\Omega, \mathcal{F}, \{\mathcal{F}_t\}_{t\geq 0}, P)$ and assume that the dynamics of an underlying asset price

H. Azari and M. S. Rohi are with the Department of Mathematical Sciences, Shahid Beheshti University, Iran, e-mails: (h_Azari@sbu.ac.ir) and (rohimohammad2@gmail.com)

S. Heidari is with the Department of Actuarial Sciences, Shahid Beheshti University, Iran, e-mail: (s_heidari@sbu.ac.ir)

$\{S_t, t \geq 0\}$ follows a geometric Brownian motion (GBM) under a risk-neutral probability measure $\mathbb{Q}$, which are captured by the following stochastic differential equation (SDE)

$$dS_t = rS_t dt + \sigma S_t dW_t,$$

where, r denotes the constant risk-free interest rate, $\sigma > 0$ is the constant instantaneous volatility of the asset and W_t represents Wiener process (standard Brownian motion).

Now, if we consider an American put option on the underlying asset S_t, with strike price $\$E$, maturity time T and the exercise value which is given by payoff function $(E - S_t)^+ = \max(E - S_t, 0)$ at time $t < T$, then the value of the option, denotes by $P(t, S_t)$, can be characterized as the solution to the following optimal stopping time problem

$$P(t, S_t) = \sup_{\tau \in \mathscr{S}} \mathbb{E}_{\mathbb{Q}}\big[e^{-r(\tau - t)}\big(E - S_\tau\big)^+ | \mathcal{F}_t\big],$$

where, $\mathscr{S}$ is the set of the stopping times taking values in $[t, T]$ and $\mathbb{E}_{\mathbb{Q}}$ denotes the conditional expectation under the risk-neutral probability measure $\mathbb{Q}$ and filtration $\mathcal{F}_t = \sigma(\{S_s, \quad 0 \leq s \leq t\})$.

It is shown that there exists an optimal stopping time τ^* and corresponding rational boundary exercise price $S^*(t)$, for which the supremum is attained (It is known as an optimal strategy) and the option should be exercised for $S \geq S^*(t)$. Under the optimal strategy, we assume that the option investor is rational and his decision occurs at rational exercise time. Thus, we derive the option price as follows:

$$P(t, S_t) = \mathbb{E}_{\mathbb{Q}}[e^{-r(\tau^* - t)}\big(E - S_{\tau^*}\big)^+ | \mathcal{F}_t].$$

However, irrational behavior as a reaction to real market movements can lead to an exercising option strategy (at a time τ up to the time of the contract) which might not be an optimal strategy. Under the irrational exercising time strategy, the pricing problem of the American style option results in the overvalued option price. Thus, to study the irrational behavior of option holders and its impact on the option pricing problem, the authors in [4] considered the irrational exercise strategy τ as the minimum of the maturity time T and the first jump time of a point process with stochastic intensity $\{\mu_t, 0 \leq t \leq T\}$. For this, they considered an intensity function $f : [-E, E] \longrightarrow [0, \infty]$ and defined μ_t as the intensity function of differences between the American option payoff and its value under exercise strategy τ:

$$\mu_t = f^\lambda\big[(E - S_t)^+ - P(t, S_t; \tau)\big], \quad 0 \leq t \leq T,$$

where $P(t, S_t; \tau)$ is American put option price under exercise strategy τ,

$$P(t, S_t; \tau) = \mathbb{E}_{\mathbb{Q}}\Big[e^{-r(\tau - t)}\big(E - S_\tau\big)^+ | \mathcal{F}_t\Big].$$

Then, they measured the rational behavior of the option holder by a parameter $\lambda > 0$ which is called the rationality parameter. Each parameter λ is associated with a family of intensity functions which is denoted by f^λ and the corresponding irrational exercise strategies τ^λ.

In Theorem 2 in [4], sufficient conditions for an index of a family of intensity functions to be a rationality parameter are illustrated. The Theorem also states that the value of the American put option under irrational exercise strategy τ^λ converges to the value of corresponding American put option $P(t, S_t)$ with rational exercise strategy τ^* when λ tends to infinity:

$$\lim_{\lambda \to \infty} P(t, S_t, \tau^\lambda) = P(t, S_t), \quad 0 \leq t \leq T.$$

For more details, see Theorem 2 in [4].

Now in order to obtain American option price under the irrational exercise strategy τ, as the first jump time of a point process with stochastic intensity $\mu_t = \alpha(t, S_t)$, which α is a positive deterministic measurable function. Then we define

$$\mathcal{F}_t = \sigma(\{X_s, \quad 0 \leq s \leq t\}),$$
$$\mathcal{G}_t = \sigma(\{1_{\{\tau \leq s\}}, \quad 0 \leq s \leq t\}),$$

and use the following Lemma from [4]:

Lemma 1. *Under the assumptions*

$$\mathbb{E}_{\mathbb{Q}}\Big[e^{-r(T-t)}\big(E - S_T\big)^+\Big] < \infty,$$

and

$$\mathbb{E}_{\mathbb{Q}}\Big[\int_t^T \Big(\alpha(\tau, S_\tau) e^{-r(\tau - t) - \int_t^\tau \alpha(u, S_u) du}\big(E - S_\tau\big)^+\Big) d\tau\Big] < \infty,$$

we have

$$\mathbb{E}_{\mathbb{Q}}\Big[1_{\{\tau \geq T\}} | \mathcal{F}_T \vee \mathcal{G}_t\Big] = 1_{\{\tau > t\}} e^{-\int_t^T \alpha(u, S_u) du},$$

thus,

$$\mathbb{E}_{\mathbb{Q}}\Big[e^{-r(\tau - t)}(E - S_\tau)^+ 1_{\{\tau \geq T\}} | \mathcal{F}_T \vee \mathcal{G}_t\Big] = e^{-r(T-t)} \mathbb{E}_{\mathbb{Q}}\Big[e^{-\int_t^T \alpha(u, S_u) du}\big(E - S_T\big)^+ | \mathcal{F}_t\Big],$$

and

$$\mathbb{E}_{\mathbb{Q}}\Big[e^{-r(\tau - t)}\big(E - S_\tau\big)^+ 1_{\{\tau < T\}} | \mathcal{F}_t \vee \mathcal{G}_t\Big] = \int_t^T e^{-r(\tau - t)} \Big(\mathbb{E}_{\mathbb{Q}}\Big[\alpha(\tau, S_\tau) e^{-\int_t^\tau \alpha(u, S_u) du}\big(E - S_\tau\big)^+ | \mathcal{F}_t\Big]\Big) d\tau.$$

Proof: See the Proposition 3.1 in ref. [4]. ■

Under irrational exercise strategy τ, the American option price at each time t is given by expression

$$\begin{aligned} P(t, S_t; \tau) &= \mathbb{E}_{\mathbb{Q}}\Big[e^{-r(\tau - t)}\big(E - S_\tau\big)^+ | \mathcal{F}_t\Big] \\ &= \mathbb{E}_{\mathbb{Q}}\Big[e^{-r(\tau - t)}\big(E - S_\tau\big)^+ 1_{\{\tau \geq T\}} | \mathcal{F}_T \vee \mathcal{G}_t\Big] \\ &\quad + \mathbb{E}_{\mathbb{Q}}\Big[e^{-r(\tau - t)}\big(E - S_\tau\big)^+ 1_{\{\tau < T\}} | \mathcal{F}_t \vee \mathcal{G}_t\Big]. \end{aligned} \tag{II.1}$$

Using the Lemma (1), expression (II.1) can be rewritten as

$$\begin{aligned} P(t, S_t; \tau) &= e^{-r(T-t)} \mathbb{E}_{\mathbb{Q}}\Big[e^{-\int_t^T \alpha(u, S_u) du}\big(E - S_T\big)^+ | \mathcal{F}_t\Big] \\ &+ \int_t^T e^{-r(\tau - t)} \mathbb{E}_{\mathbb{Q}}\Big[\alpha(\tau, S_\tau) e^{-\int_t^\tau \alpha(u, S_u) du}\big(E - S_\tau\big)^+ | \mathcal{F}_t\Big] d\tau. \end{aligned} \tag{II.2}$$

In the rest of this paper, to emphasize the importance of the intensity parameter on option price, we denote the value of the American option under irrational strategy τ and intensity

parameter λ by $P(t, S_t; \lambda)$.

Now according to the Feynman-Kac Theorem [5] and applying the Ito's Lemma, we obtain the following nonlinear Black-Scholes equation [8] for option price $P(t, S_t; \lambda)$ corresponding to price (II.2) under exercise strategy τ, intensity parameter λ, time to maturity $t \in (0, T]$ and S_t in unbounded domain $(0, \infty)$:

$$\begin{aligned}\frac{\partial P}{\partial t}(t, S_t; \lambda) &= \frac{1}{2}\sigma^2 S^2 \frac{\partial^2 P}{\partial S^2}(t, S_t; \lambda) \\ &+ (r - q)S\frac{\partial P}{\partial S}(t, S_t; \lambda) - rP(t, S_t; \lambda) \\ &+ \big((E - S_t)^+ - P(t, S_t; \lambda)\big) f^\lambda\big((E - S_t)^+ \\ &- P(t, S_t; \lambda)\big), \end{aligned} \tag{II.3}$$

with the initial condition which is provided by the put option payoff at maturity time T,

$$P(0, S; \lambda) = (E - S)^+. \tag{II.4}$$

Now we need to obtain the boundary conditions for American put options under the irrational exercise strategy. For this, when S tends to ∞, the boundary condition as in the rational case of American options is established, so

$$\lim_{S\to\infty} P(t, S; \lambda) = 0, \tag{II.5}$$

However, note that under the irrational strategy, the option holder may exercise the option at a time that may not be optimal, so at this irrational time, the option value is not the same as the corresponding option value under the rational exercise strategy (especially when $\lambda \to 0$). Thus, when $S \longrightarrow 0$, the boundary condition for American options under rational strategy can not be applied to an irrational strategy. To derive a new boundary condition, we use the equation (II.5) when $S \longrightarrow 0$. So we have the following boundary condition

$$\begin{aligned}\frac{\partial P}{\partial t}(t, 0; \lambda) &= -rP(t, 0; \lambda) \\ &+ \big(E - P(t, 0; \lambda)\big) f^\lambda\big((E - P(t, 0; \lambda)\big). \end{aligned} \tag{II.6}$$

Thus, based on the intensity parameter λ and the corresponding intensity function f^λ, the value of the American option can be governed by equation (II.3) with initial and boundary conditions (II.4)-(II.6).

The next step is to consider a family of intensity functions f^λ so that parameter λ satisfies the condition of rationality parameter according to Theorem 2 in [4]. Authors in [5] considered the two following intensity functions:

$$f_1^\lambda(x) = \begin{cases} \lambda & x \geq 0, \\ 0 & x < 0, \end{cases} \tag{II.7}$$

and

$$f_2^\lambda(x) = \lambda e^{\lambda^2 x}. \tag{II.8}$$

Note that under the first family of intensity functions, the option holder does not exercise when it is not profitable. Thus, the non-optimal behavior of option holders is due to exercising too late. However, the second family of functions shows that the option holder considers larger profits from exercising the option as well as its profitability [4].

TABLE I
CONVERGENCE AMERICAN OPTION PRICE UNDER IRRATIONAL STRATEGY TO THE VALUE OF THE CLASSICAL AMERICAN OPTION IN [3] WITH INCREASING λ FOR INTENSITY FUNCTIONS (II.7)-(II.10)

λ	f_1	f_2	f_3	f_4
0	6.9948	6.9948	6.9948	6.9948
1	7.9543	8.0815	7.7269	7.2048
10	8.6022	8.6978	8.6512	8.5291
100	8.6987	.....	8.7043	8.6914
1000	8.7090	.....	8.7096	8.7083
10000	8.7102	.....	8.7108	8.7107
$Tree$	8.7106	8.7106	8.7106	8.7106
$Penalty$	8.7100	8.7100	8.7100	8.7100

Recently, more functions are proposed to use as intensity functions, which we mention the two following:

$$f_3^\lambda(x) = \frac{2\lambda}{1 + e^{-\lambda^2 x}}, \tag{II.9}$$

$$f_4^\lambda(x) = \lambda(1 + \frac{2}{\pi}\arctan\lambda^2 x). \tag{II.10}$$

Now to obtain American option prices under the irrational strategy, we need to solve the pricing problem (II.3)-(II.6) with the intensity functions (II.7)-(II.10).

III. NUMERICAL ANALYSIS

In this section, we examine the results of applying the finite element method for pricing the American options under the irrational strategy to verify the accuracy of our computational scheme. Since the exact solutions to the pricing problem are unknown, we illustrate a comparison with other recent works. To implement the proposed method, the computations were carried out in Matlab R2017a with 4.00 GB RAM and a 1.60 GHz processor

We consider an American put option with parameters [3] as follows:

$$r = 0.05, \qquad \sigma = 0.2, \qquad T = 3, \qquad E = 100.$$

By applying the finite element scheme for the resulted equation for pricing the American options under the irrational strategy, the dependence of the solution at the point $S = E$ with respect to the rational parameter λ for different intensity functions (II.7)-(II.10) is illustrated in Table I.

The results show that the solution tends to American option price as $\lambda \longrightarrow \infty$. We compare the results with other known techniques, such as Penalty method [10] and the Tree method proposed in [11]. Additionally, in Fig. 1 for family (II.10) and different values λ the American put option price is shown. Note that the case $\lambda = 0$ corresponds to the European option, while $\lambda = 1$ corresponds to a near zero rationality parameter which can be understood as a case with large irrational exercise and the value of the American put option is below the exercise value for small values of the asset. This situation maybe caused by additional circumstances that prevent the owner to exercise, although the option price is bellow exercise prices. For $\lambda = 100$ the irrational case tend to the rational one, which corresponds to the American option pricing problem.

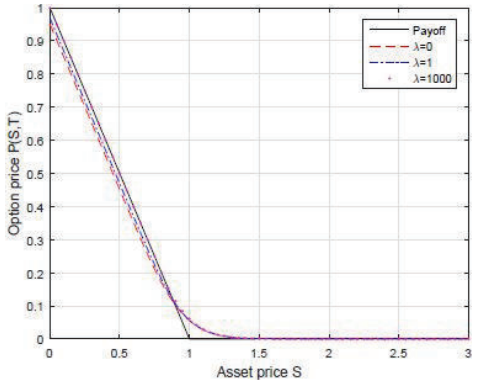

Fig. 1. Numerical solution for the intensity function belonging to family (II.7) for various values of λ.

IV. Conclusion

In this paper, we studied the irrational behavior of the American option holder to market movements that leads to an exercising option strategy at a time that might not be an optimal time and is known as an irrational exercising time strategy. Under this situation, the pricing problem of American-style options results in overvalued option prices such that different alternative models need to be considered in order to incorporate possible irrational exercises. In this study, irrational exercise strategy was considered through families of intensity functions depending on rational parameters. Under these models, the resulted nonlinear PDE with appropriate boundary conditions and intensity functions were obtained for American options. By using a variable transformation technique, the problem was transformed into a nonlinear parabolic equation with constant coefficients in an infinite domain. Then a finite element method was applied to solve the resulted variational problem for option price. Our numerical experiments also demonstrated the accuracy and efficiency of the proposed method to obtain fast solutions for the pricing problem of American options under irrational behavior.

Acknowledgment

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Hossein Azari is an Assistant Professor in the Department of Applied and Industrial Mathematics, Faculty of Mathematical Sciences at Shahid Beheshti University in Iran. He has got his BS degree in Applied Mathematics from Mashhad Ferdowsi University in Iran and Ms in numerical analysis from the Iran University of Science and Technology-Tehran and his Ph.D. in Applied Mathematics Numerical Analysis from Iran University of Science and Technology -Tehran. His research interest includes Numerical analysis of partial differential equations, Financial mathematics, Numerical Analysis, and Industrial mathematics.

Saghar Heidari is an Assistant Professor in the Department of Mathematical Sciences, Faculty of Actuarial Sciences at Shahid Beheshti University in Iran. She received her BS and Ms degrees in Applied Mathematics and Financial Mathematics from the Sharif University of Technology in Iran and her Ph.D. in Computational Finance from Shahid Beheshti University. Her research interest includes Financial Mathematics, Computational Finance, Numerical Analysis, and Partial Differential Equations. Recently her research has expanded to Insurance and Actuarial Sciences.

Mohammad Saber Rohi has gotten his bachelor's degree from the University of Kermanshah in applied mathematics then he achieves his Master's degree in Shahid Beheshti University in Iran in the same major. He is studying as a P.h.d student at Shahid Beheshti University in Iran currently. His dissertation has to do with finances in MS.c. and also his research area is Financial Mathematics in P.hD. degree.

Bayesian Borrowing Methods for Count Data: Analysis of Incontinence Episodes in Patients with Overactive Bladder

Akalu Banbeta[1,2,*], Emmanuel Lesaffre[3], Reynaldo Martina [4] and Joost van Rosmalen [5]

[1]I-Biostat, UHasselt, Hasselt, Belgium

[2]Department of Statistics, Jimma University, Jimma, Ethiopia

[3]I-Biostat, KU Leuven, Leuven, Belgium

[4]Faculty of Science, Technology, Engineering and Mathematics, Open University, Milton Keynes, UK

[5]Department of Biostatistics, Erasmus University Medical Center, Rotterdam, the Netherlands

Abstract

Including data from previous studies (historical data) in the analysis of current study may reduce the sample size requirement and/or increase the power of analysis. The most common example is incorporating historical control data in the analysis of current clinical trial. However, this only applies when the historical control data are similar enough to the current control data. Recently, several Bayesian approaches for incorporating historical data have been proposed, such as the meta-analytic-predictive (MAP) prior and the modified power prior (MPP) both for single control as well as for multiple historical control arms. Here, we examine the performance of the MAP and the MPP approaches for the analysis of (over-dispersed) count data. To this end, we propose a computational method for the MPP approach for the Poisson and the negative binomial models. We conducted an extensive simulation study to assess the performance of Bayesian approaches. Additionally, we illustrate our approaches on an overactive bladder data set. For similar data across the control arms, the MPP approach outperformed the MAP approach with respect to the statistical power. When the means across the control arms are different, the MPP yielded a slightly inflated type I error (TIE) rate, whereas the MAP did not. In contrast, when the dispersion parameters are different, the MAP gave an inflated TIE rate, whereas the MPP did not. We conclude that the MPP approach is more promising than the MAP approach for incorporating historical count data.

Keywords: Count data, meta-analytic prior, negative binomial, Poisson, over-dispersion, power prior.

* Presenting author, Email address: akalubanbetastat@gmail.com

Heat Transfer Characteristics of Dual Flame with Rich Outer Swirling Flame Impinging On a Flat Surface

Satpal Singh, Subhash Chander

Abstract- An experimental study on heat transfer characteristics of dual flame impinging on a flat surface has been conducted. The effect of dimensionless separation distance (H/D_h) has been investigated for dual flame with rich outer flame ($\phi = 1.2$). The inner flame was non-swirling with fixed Reynolds number of 1300 under stoichiometeric conditions. The outer swirling flame Reynolds number was varied from 3000 to 11000. It has been concluded that in case of open swirling impinging flames, the initial rich conditions (ϕ~1.2) of outer swirling flame gives higher heat fluxes. The presence of inner flame considerably alters the heating characteristics on the impingement surface. Even with presence of the inner flame, the heating has not become like *cake top* in the impingement area but it has improved considerably from uniformity aspect viewpoint.

Keywords **-** Heat flux, heating uniformity, dual flame, and impingement.

I. INTRODUCTION

MANY types of heating systems in general are used for domestic and industrial applications however direct flame impingement heating is one of the efficient ways that has been used for last many years. Advantages like faster and efficient heating with very less pollutant emission can be achieved with direct flame impingement heating. This heating method is still used with some vacillation by the metal processing industry due to its inherent drawback of non-uniformity of heat transfer distribution on the impingement surface. Combustion systems generally work in a range of equivalence ratios depending upon the flow rates and type of application. Leaner combustion produces lesser soot, low NO_x but with poor stability.

Satpal Singh is Assistant professor in the Department of Mechanical Engineering, Maharaja Ranjit Singh Punjab Technical University, Punjab, INDIA-151001 (Tel: +91-9872151560, Email: dr.satpalsingh@mrsptu.ac.in)

Subhash Chander is Professor in the Department of Mechanical Engineering, National Institute of Technology Jalandhar, Punjab, INDIA-144011 (Tel: +91-9417864015, Email: chanders@nitj.ac.in)

However, the rich flames have the advantage of high stability along with lots of soot production. Many times the stability becomes so critical that the system needs to be operated at rich conditions for getting better reliability in operation. It has been noticed that non-swirling richer flames produce considerably large amount of soot whereas if the same flow is swirled then the soot production can be reduced considerably due to entrainment of surrounding air. In swirling unconfined flames, the initially rich mixture conditions can produce a near stoichiometeric burning of the flame depending upon the magnitude of swirl and entrainment [1]. This will also lead to better swirling flame stability. In case of flame impingement with rich swirling flame, higher heat transfer rates are also expected.

The main characteristic of the swirling flow in combustion systems is the formation of toroidal recirculation zones above the nozzle exit resulting in five times better overall fuel-air mixing rate of swirl-stabilized flame than that of a simple jet. This results in five fold reduction of flame length [2]-[4]. Also, this formation of central recirculation zone makes the stability of the swirling flame around five times better than the non-swirling flame [1] [5]. At sufficiently high swirl intensities, lifted stable swirling flames were observed [6]-[8]. Gupta et al. [9] observed that improved flame stability can also be achieved by burner modifications as multi-annular swirl burner was providing better flame stability compared to conventional swirl burner. Pilot flames are further added to aid stability to the swirling flames [10].

In the process of flame impingement heating with non-swirling jets, a focused heat flux distribution at and around stagnation point was noticed [11]. On the other hand swirling flame jets produce considerable high heat transfer away from stagnation point with suppression in heating at and around stagnation point [12] [13]. To overcome the inherent drawback in the flame impingement heating i.e., non-uniformity in heat transfer distribution, a number of alterations and modifications in burner design have been explored [14] -[16]. Still there is a need to design a burner assembly where positives of both non-swirling and swirling flames can be combined swirling to have efficient and more uniform heating.

In the present research, a dual flame burner with inner non-swirling and outer swirling flame has been conceptualized, designed and fabricated. Dual flame impingement heat transfer covers the drawbacks of both non-swirling and swirling impinging. In the present work heat transfer characteristics of compressed natural gas (CNG)/ air dual flame with rich outer swirling flame ($\phi(o) = 1.2$) have been investigated. Effects of different operating parameters

like, Re (o) (3000-11000) and dimensionless separation distance (H/D_h = 1-5) have been investigated at fixed inner non-swirling flame (Re(i) = 1300 and ϕ(i) = 1.0). Further in a sample investigation effect of variation of outer swirling flame equivalence ratio (ϕ(o) = 0.8-1.2) has also been explored. Swirling flow was generated with helical swirling insert with helix angle of 40°.

II. EXPERIMENTAL SETUP AND PROCEDURE

Fig. 1 illustrates the schematic of the experimental setup used for investigation of heat transfer characteristics of dual rich flame impinging on a flat surface. This setup consists of arrangements to provide measured quantity of fuel and air to the dual flame burner. Commercial Compressed Natural Gas (CNG) has been used as a fuel. The composition of the CNG was: Methane-93.5 %, Ethane- 3.95 %, Propane- 1% and traces of Carbon-dioxide and other gases. Measured quantities of fuel and air are supplied using mass flow controllers (Make: Alicat Inc.) of different ranges. Mixing tube was used to mix the air and fuel before being fed to the burner to produce premixed inner non-swirling flame. Separate arrangements for air and fuel supply were provided to outer swirling flame. The burner was mounted on the burner stand which was fixed on the 3D traversing mechanism to alter the separation distance between the exit plane of the burner and the impingement surface. Heat flux measurement system consists of a flat plate calorimeter and water supply system. In case of calorimeter, it consists of a flat square copper plate (600 mm x 600 mm, thickness = 6 mm) fixed with heat flux sensor fixture at the centre and cooling water jacket on the rear side. A controller quantity and quality of water is supplied to the calorimeter from a constant temperature water bath to avoid any condensation of combustion products on the impingement surface. Constant temperature in the water bath is maintained with PID temperature controller. The heat flux sensor (HFM-7E/H, Make: Vatell Corporation, USA) is used to measure the heat flux and temperature distribution on the impingement plate. The output from the heat flux sensor is recorded by incorporating the signal conditioning amplifier (AMP - 6) and high precision digital multi-meters (Make: Agilent Inc., Model: 34411A). With these high precision multi-meter-cum-data-loggers heat fluxes and plate temperatures were simultaneously recorded at a sampling rate of 150 samples per second for duration of 7s. The surface heat flux and plate temperature values recorded in millivolt were converted to W/m^2 and ^{o}C respectively using calibration software (Hfcompv4) of sensor. Due to high turbulent nature of the flame, it is necessary to average a large number of readings in order to provide reliable and consistent results in temperature and heat flux measurements. The recorded samples of heat fluxes and temperatures were then averaged to provide the values given in the paper. A digital camera (Make: Nikon D90) was used to take direct photographs of the free and impinging flames.

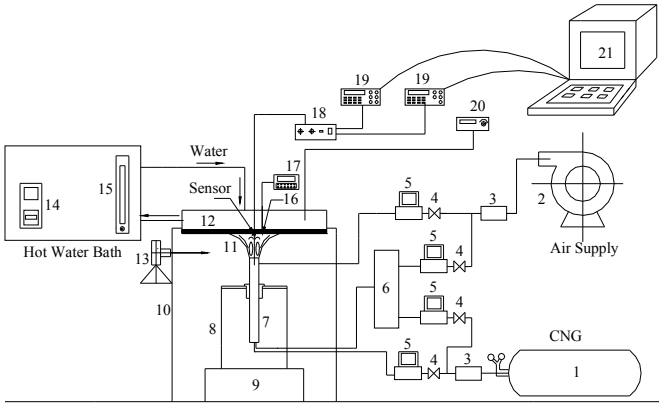

Fig. 1 Schematic of the experimental setup.
1. CNG Cylinder 2. Air Compressor 3. Filter 4. Needle Valve 5. Mass Flow Controller 6. Mixing Tube 7. Swirl Burner 8. Burner Stand 9. Traversing Mechanism 10. Calorimeter Stand 11. Swirling flame 12. Calorimeter 13. Camera 14.PID Controller 15. Water Rotameter 16. Pressure Tap 17. Digital Micro-Manometer 18.Conditioning amplifier 19. Multimeter-cum-data-logger 20. Digital temperature indicator 21. Computer

III. DESCRIPTION OF DUAL FLAME BURNER

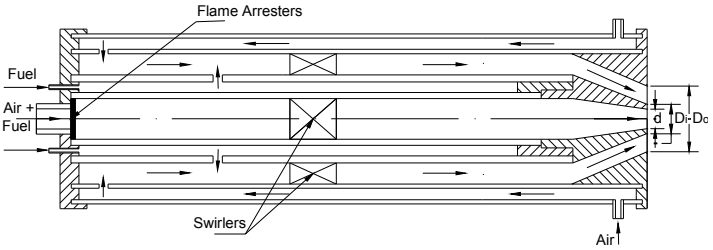

Fig. 2 Schematic of the dual flame burner.

This burner dual flame burner (Fig. 2) consists of concentric tubes with provision to supply premixed charge (fuel/air mixture), air and fuel separately. Through the inner tube fuel/air mixture is supplied which is enabling the formation of central premixed flame. A proper safety arrangement had been made by providing a packing of wire meshes at the tail of the inner tube which acts as flame arresters. Fuel is supplied through the inlet at the bottom of the burner into the annulus around the inner tube. Fuel enters into the outer annular tube through number of small holes (diameter of1.5 mm each) and mixes with the air. Further the mixture was swirled through the outer swirling insert. Air is made to enter into the outermost annulus from the inlets provided near the top of the burner and allowed to enter into the inner annulus where it mixes with the fuel before entering into the swirler. This arrangement for the flow of air is made to ensure the uniform distribution of air in the entire annulus before entering into the swirling insert. Tapered inserts are used at the top of the burner to facilitate creating different burner exit diameters. The inner exit diameter (d) of the inner tube burner was 6 mm. The outer and inner diameters (D_o and D_i) of the burner exit annulus were 25 mm and 10 mm respectively.

IV. EXPERIMENTAL PROCEDURE

Measured quantity of fuel and air was fed to swirl burner and mixture was ignited. Hot water is supplied at 45°C to the calorimeter to avoid condensation of combustion products at the impingement surface. All the readings were taken under steady state when the temperature of outlet water became constant. The exit Reynolds numbers and equivalence ratios were calculated as:

$$\mathrm{Re} = \frac{\rho_{mix} V_{mix} D}{\mu_{mix}} \qquad (1)$$

Here D = D_h for outer swirling flame and D = d for inner swirling/non swirling flame.

$$\phi = \frac{\left(A/F\right)stoic}{\left(A/F\right)actual} \qquad (2)$$

In first set of experiments, measurements were taken for impingement heat flux at different dimensionless separation distances (H/D_h) corresponding to Re (i) = 1300, Re(o) = 7000, ϕ(i) = 1.0 and ϕ(o) = 1.2. In the second set of experiments heat flux measurements were taken inner flame Re(i) of 1300 and outer swirling flame Re(o) was varied from 3000-11000 for ϕ(i) = 1.0 and ϕ(o) = 1.2 corresponding to different separation distances. In a sample experiment measurements were also taken for variation of equivalence ratio (ϕ(o) = 0.8 to 1.2) at fixed other operating conditions. Measurements for heat flux distribution on the impingement surface are also made for outer swirling flame only. Uncertainty analysis was carried out using method given by Kline and McClintock [17]. Uncertainties in equivalence ratio and Reynolds number were 2.83% and 2.2%, respectively. Maximum uncertainty in heat flux measurements was 5.88%.

V. RESULTS AND DISCUSSION

In this study the impingement heat transfer characteristics of dual flame (with outer rich flame) based on uniformity aspect has been discussed. Effects of various operating parameters on heat transfer characteristics on the impingement surface have been evaluated.

A. Impinging flame shapes

Fig. 3a) shows the direct photograph of the dual flame impinging on a flat surface at H/D_h = 3, Re(o) = 7000, Re(i) = 1300, ϕ(o) = 1.2, ϕ(i) = 1.0, θ(o) = 40° . Fig.3b) shows the qualitative schematic of the above impinging flame showing the flow and central recirculation zone. It has been noticed that presence of plate flattened the central recirculation zone. The inner flame penetrates through the recirculation zone and strikes on the impingement surface. The outer swirling flame reaction zone is slating which makes the flame boundary of the outer flame to strike on the impingement surface at far radial location from the stagnation point. It has also been observed that the presence of inner flame helped in getting better stability of the outer swirling flame. It is further noticed that at large separation distances the visible reaction zone was found to be quite away from the impingement surface.

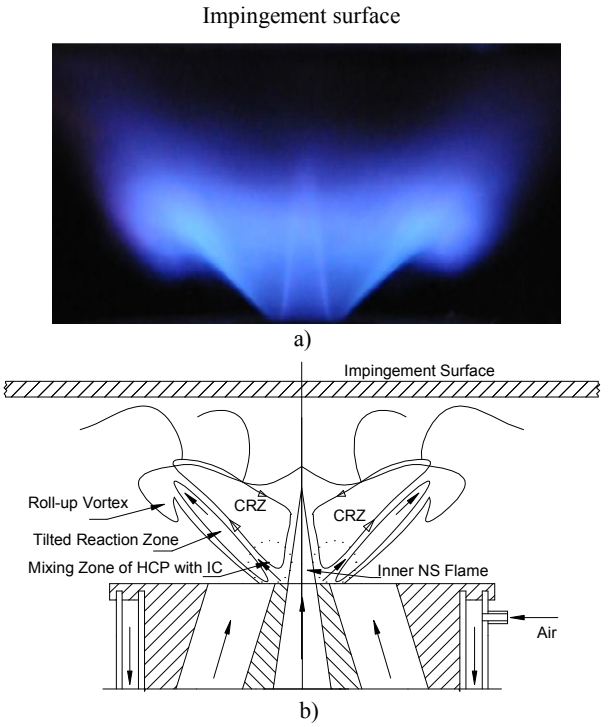

Fig. 3 a) Direct photograph of the dual flame impinging on a flat surface at H/D_h = 3, Re(o) = 7000, Re(i) = 1300, ϕ(o) = 1.2, ϕ(i) = 1.0, θ(o) = 40° b) a qualitative schematic of the above impinging flame showing the flow and central recirculation zone

B. Heat Transfer characteristics

1. Effect of H/D_h

Fig. 4 shows the heat flux distribution of dual flame (rich outer swirling flame (ϕ(o) =1.2) and stoichiometeric inner non swirling flame) impinging at various dimension less separation distances (H/D_h) at fixed other operating conditions (Re(o) = 7000, Re(i) = 1300). High heat fluxes were observed at smaller separation distances with a significant contribution of inner non swirling flame at around the stagnation point. At H/D_h=1, the tip of the inner non swirling flame gets intercepted by impinging surface resulting in direct striking of un-burnt cold mixture. This results in very low heating at the stagnation point [11] [18] at H/D_h=1. However a high flux was noticed at immediate vicinity of the stagnation point due to direct striking of reaction zone of inner flame. A second low region in heat flux distribution was observed around the influential region of the inner flame. That is because of the recirculation effect of the outer swirling flame resulting in low approach velocities on the impingement surface in that region.

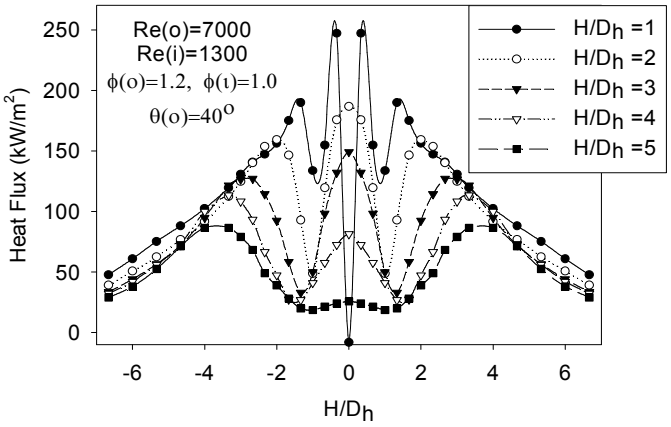

Fig. 4 Heat flux distribution of dual rich flame at various dimensionless separation distances (H/D_h = 1-5) keeping other operating conditions fixed (Re(o) = 7000, Re(i) = 1300, ,ϕ(o) = 1.2, ϕ(i) = 1.0).

Further away in the radial direction again a high heating was observed due to direct striking of the outer swirling flame boundary on the impingement surface. This results in a high annular hump in heat flux at that region. Location of peak of this hump shifts away from the stagnation point with increase in the separation distance between the exit plane of the burner and the impingement surface. This can be attributed to the striking of the slanting reaction zone of outer swirling flame at higher separation distances. Similar trends in the heat transfer characteristics were observed for the other separation distances (H/D_h = 2-4) with decrease in the heat flux magnitude at each radial location. At very large separation distance (H/D_h = 5), the effect of inner non-swirling flame on heat transfer to stagnation region was almost negligible. This can be due to location of the inner flame with respect to the impingement surface and could also be due to suppression of the flow coming out from the inner flame by the strong central recirculation effect of the outer swirling flame. Further it has been noticed that the heat flux distribution is continuously decreasing on the impingement surface beyond r/Dh of 4 and ends up to almost zero value at very large radial locations (r/Dh ~ 10). It is worth mentioning here that the measurements of the heat flux distribution have been taken upto r/Dh = 10 but to show better segregation of heat flux distribution lines in the effective impingement area the information is shown upto r/Dh of 7. Thus from the trends of heat flux lines on the impingement surface at various values of the H/Dh, it is concluded that the even with presence of the inner flame the heating has not become like cake top in the impingement area but it has improved considerably from uniformity aspect viewpoint.

2. Effect of Equivalence Ratios

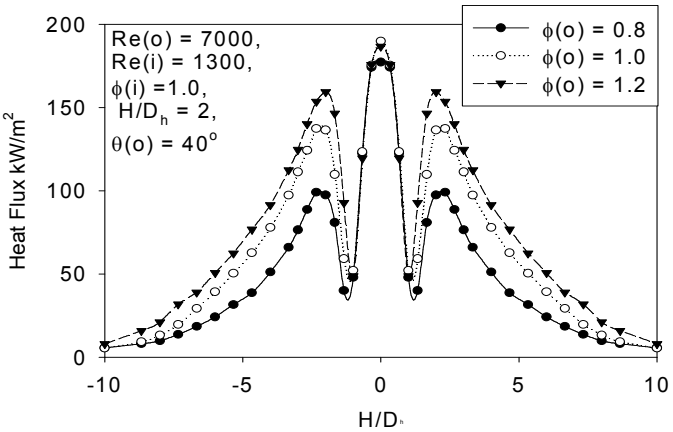

Fig. 5 Heat flux distribution of dual flame at various outer swirling flame equivalence ratios (ϕ(o)) at fixed other operating conditions (Re(o) = 7000, Re(i) = 1300, ϕ(i) = 1.0) for a fixed outer swirling insert with helix angle of 40° a) at H/D_h = 2.

Fig. 5 shows the heat flux distribution of dual impinging flame at various outer swirling flame equivalence ratios (ϕ(o)) at fixed other operating conditions (Re(o) = 7000, Re(i) = 1300, ϕ(i) = 1.0 ,θ = 40° and at H/D_h = 2. It has been seen that heat transfer due to inner flame remains almost unaffected by the variation of equivalence ratio of outer swirling flame. However the heating characteristics of outer flame varied considerably with change in equivalence ratio. With increase in ϕ(o), the heat fluxes of outer flame increases due to increase in firing rate corresponding to all radial locations. Annular hump created due to the impingement of the flame boundary of the outer swirling flame has significant variation in the heat flux values. Peaking of the heat flux values remains almost at same radial location for different values of outer swirling flame equivalence ratios. It has been further noticed that the rate of increase in heat flux at various radial locations was higher for 0.8 to 1.0 compared to from 1 to 1.2. At ϕ(o) = 1.2, the flame temperatures would have been maximum resulting in more heat transfer to the impingement surface. This is because of entrainment effect which will make the initial rich flame to near stoichiometeric flame. Thus in case of swirling open flames the initial rich conditions (ϕ~1.2) should be preferred as it will give higher heat fluxes corresponding to all radial locations. By adjusting the flow rates of the inner flame corresponding to that the heat flux distribution can be made more uniform on the impingement surface.

3. Comparison of dual rich flame and outer only swirling rich flame

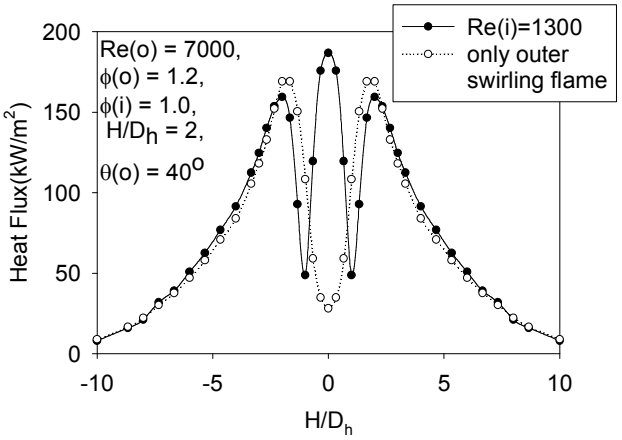

Fig. 6 Comparison of heat flux distribution of only outer swirling impinging flame (Re (o) = 7000,ϕ(o) = 1.2) and dual flame with inner non swirling flame (Re(i)= 1300, ϕ(i) = 1.0) at $H/D_h = 2$

Fig. 6 shows the comparison of heat flux distribution on the impingement surface for only outer swirling impinging flame (Re(o) = 7000,ϕ(o) = 1.2) and dual flame with inner non-swirling flame (Re(i)= 1300, ϕ(i) = 1.0) at H/D_h of 2 . The heating patterns of both types of flames are similar except there are considerably low heat fluxes [12] [13] at and around the stagnation point in case of only outer swirling flame. However in case of dual flames this low heat flux zone is replaced by a peak heat flux due to presence of central flame. Secondary peak in the heat flux due to outer swirling flame was observed at certain radial location and after the peak heat flux point the heat flux was gradually decreasing to minimum value in the wall-jet region. Moreover there is little shifting of peak heat fluxes radially outward corresponding to outer flame due to pushing of outer flame by inner one. This comparison of both flames also reveals the possibilities of better uniformity in heat flux distribution with the help of dual flame compared to single swirling flame. Thus it is concluded that irrespective of the equivalence ratio of the outer swirling flame the dual flame impingement is expected to give better uniformity in the heat flux distribution on the impingement surface by filling the low heat flux region at and around the stagnation point with the presence of inner flame.

4. Average heat transfer and heating uniformity

It was noticed from the literature that direct flame impingement heat transfer has great potential in the heating processes widely used in industry and domestic applications. However flame impingement heat transfers have some limitations like non-uniformity at high average heat transfer corresponding to smaller separation distances. At small separation distances, due to closeness of the visible reaction zones with the target surface, high heat fluxes are expected but uniformity in the heat flux distribution is sacrificed. Whereas at larger separation distances the average heat fluxes go down but better uniformity is expected. Non-swirling flames are very good in producing spot heating, however for large surface heating these generates heat flux gradient in the impingement area. On the other hand swirling flame produce better flame spread and allowing large surface heating but again it deteriorates heating at and around the stagnation point. The dual flame under consideration has advantages of both types of these flames and we can expect better uniformity even at smaller separation distances. Calculations for average heat flux to the impingements surface and uniformity in heat flux distribution are done as per the procedure given at Chander and Ray [19].

$$\dot{q}''_{avg} = \frac{1}{A}\int \dot{q}''dA \tag{3}$$

$$\dot{q}''_{dev} = \dot{q}''_{avg} - \dot{q}'' \tag{4}$$

$$\dot{q}''_{dev,rms} = \sqrt{\frac{\sum\left(\dot{q}''_{dev}\right)^2}{n}} \tag{5}$$

$$\text{Percentage relative deviation} = \frac{\dot{q}''_{dev,rms}}{\dot{q}''_{avg}} \times 100 \tag{6}$$

For calculation of area weighted average heat flux as mentioned in (3), the impingement area corresponding to $r/D_h = 10$ has been considered for all cases.

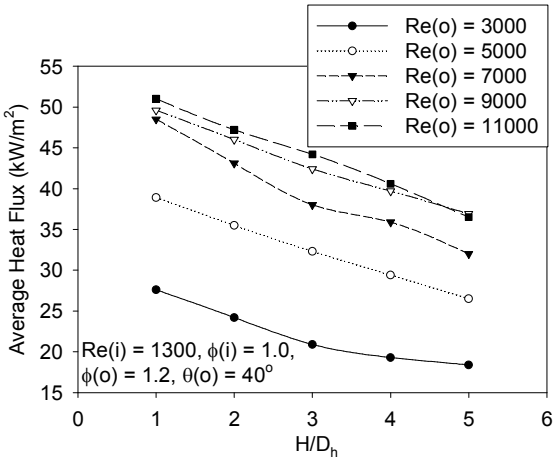

Fig. 7 Average heat flux variation at different separation distances corresponding to different outer swirling flame Re(o) and at fixed other operating parameters Re(i) = 1300, ϕ(o) = ϕ(i) = 1.2, θ(o) = 40°.

Fig. 7 shows the average heat flux variation at different separation distances (H/Dh) corresponding to different outer swirling flame Re(o) and at fixed other operating parameters Re(i) = 1300, ϕ(o) = 1.2, ϕ(i) = 1.0, θ(o) = 40°. It has been observed that the average heat flux gradually increases with decrease in separation distance at all Re(o). This can be attributed firstly to movement of the flame visible reaction zone away from impingement resulting in low heat fluxes and secondly at higher separation distances impinging flow velocities become considerably less which makes low convective heat transfer. It has been further observed that the rate of increase of heat flux with Re(o) is higher at lower

outer swirling flame Re(o) but it goes on decreasing with increase in the value of Re(o). This might be due to fact that at higher Re(o) the recirculation zone get large and produces strong entrainment effect resulting in inclusion of more fresh cold air which leads to lowering the average temperatures of the flame. This entrainment effect balances the increase in the heat transfer due to higher velocities at higher Re(o) resulting in very less enhancement in overall heat transfer to the impingement surface.

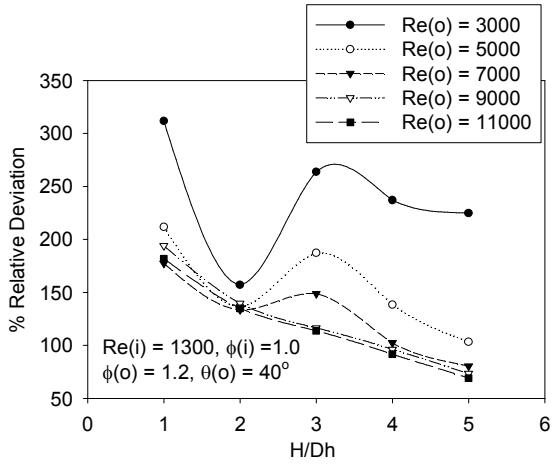

Fig. 8. Percentage relative deviation at different separation distances corresponding to different outer swirling flame Re(o) and at fixed other operating parameters Re(i) = 1300, $\phi(o) = 1.2$, $\phi(i) = 1.0$, $\theta(o) = 40^o$.

Fig. 8 show the percentage relative deviation at different separation distances corresponding to different outer swirling flame Re(o) and at fixed other operating parameters Re(i) = 1300, $\phi(o) = \phi(i) = 1.2$, $\theta(o) = 40^o$. It has been observed that percentage relative deviation was lesser at H/D_h of 2 compared to H/Dh of 1, 3 and 4 for Re(o) 3000 to 7000 but for Re(o)= 9000 to 11000 it is continuously decreasing with increase in separation distances. At higher separation distances H/Dh = 5, lowest percentage relative deviation for all case has been noticed except for Re (o) = 3000. These high separation distances although are providing minimum of percentage relative deviations in the heat flux distribution on the impingement surface but the average heat fluxes imparted to the impingement surface were also become very low (Fig. 5). Thus it is evident from the deviation graphs that a separation distance of H/D_h of 2 gives a minimum deviation in the heat flux distribution while having reasonably high heat fluxes at Re (o) ranging from 5000 to 11000. Thus it can be concluded that the optimum separation distance corresponding to minimum deviation for most of the Re(o) is $H/D_h = 2$ and moreover this is the separation distance at which the average heat transfer to the impingement surface is significantly high.

Nomenclature

A	impingement area (m^2)
A/F	air fuel ratio
D_h	hydraulic diameter in m ($D_h = D_o - D_i$)
d	diameter of inner burner (m)
H/D_h	dimensionless separation distance
$\dot{q}''$	heat flux (kW/m^2)
r	radial distance in (m)
r/D_h	dimensionless radial dimension
Re(o)	outer swirling flame Reynolds number
Re(i)	inner non-swirling/swirling flame Reynolds number
V	velocity (m/s)
	Greek Symbols
μ	dynamic viscosity (kg/m-s)
ρ	density (kg/m^3)
ϕ(o)	outer swirling flame equivalence ratio
ϕ(i)	Inner swirling/non-swirling flame equivalence ratio
θ	outer swirling insert helix angle in degree
	Subscripts
dev	deviation
mix	mixture
rms	root mean square
stoic	stoichiometeric

VI. CONCLUSIONS

An experimental study on heat transfer characteristics of dual flame (with outer swirling rich flame) impinging on a flat surface has been conducted. Following conclusions are arrived at:

1. The presence of inner flame considerably alter the heating characteristics at smaller separation distances ($H/D_h \leq 3$) however at larger separation distances the effect of recirculation zone dominates over the axial flow resulting in low heat flux region around the stagnation point.

2. It is further noticed that irrespective of the equivalence ratio of the outer swirling flame the dual flame impingement is expected to give better uniformity in the heat flux distribution on the impingement surface by filling the low heat flux region at and around the stagnation point with the presence of inner flame.

3. In case of open swirling impinging flames, the initial rich conditions ($\phi \sim 1.2$) of outer swirling flame should be proffered as it will give higher heat fluxes corresponding to all radial locations.

4. Even with presence of the inner flame, the heating has not become like *cake top* in the impingement area but it has improved considerably from uniformity aspect viewpoint. But by adjusting the flow rates (of both the flames) and dimensionless separation distances (H/D_h) the heat flux distribution can be made more uniform on the impingement surface.

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First Author Satpal Singh did his Masters of Engineering from Victoria University Melbourne Australia in 2009 and Phd from NIT Jalandhar Punjab India. Currently he is working assistant professor in the Department of Mechanical Engineering Maharaja Ranjit Singh Punjab Technical University Bathinda Punjab.

Second Author: Subhash Chander did his PhD from Indian Institute of Technology Delhi, INDIA in 2007. He is currently working as Professor in the department of Mechanical Engineering, National Institute of Technology, Jalandhar, Punjab, INDIA. His main research interests are combustion and heat transfer. He is life member of Combustion Institute India chapter along with life member of Indian Society of Technical Education.

Differential Local Cooling Rates in Quenching of Steel Plate by Impinging Jet Technique

Mohammad Jahedi, Getiye Wodaje Gebeyaw, Bahram Moshfegh

***Abstract*—** The demand for steel components with tailored properties in as-quenched conditions has increased the need to implement more controllable quenching techniques in the hardening stage of the heat treatment process. To obtain a specific variation of mechanical properties along the metal component, various local cooling rates must be introduced on the surface of the component. This can be done by using the water impinging jet quenching technique. The specific variation of mechanical properties and microstructure along the component is important in specific applications where various local mechanical properties are required for steel products. In this study, a series of quenching experiments were carried out on a 15 mm steel plate with different impingement configurations of water impinging in a developed test rig for the water Impinging Jet Quenching Technique. Results present differential local cooling rates achieved by different impingement setups, resulting in variation of mechanical properties of steel (such as hardness) along the width of the component. A developed heat conduction inverse solution based on the GMRES method is implemented to apply the recorded temperature data inside the steel plate and predict the surface temperature and heat flux along the steel surface during the quenching experiment.

***Keywords*—** impinging jets, transient boiling, unsteady inverse heat conduction, quenching, experimental study, differential cooling rate.

Mohammad Jahedi, Getiye Wodaje Gebeyaw, Bahram Moshfegh are with the Department of Building engineering, Energy systems and Sustainability science, Faculty of Technology and Environment, University of Gävle, 801 76, Gävle, Sweden (e-mail: MOHAMMAD.JAHEDI@HIG.SE).

Bahram Moshfegh is with the Division of Energy Systems, Department of Management and Engineering, Linköping University, 581 83 Linköping, Sweden.

Efficient Monolithic FEM for Compressible Flow and Conjugate Heat Transfer

Santhosh A. K.

***Abstract*—** This work presents an efficient monolithic finite element strategy for solving thermo-fluid-structure interaction problems involving compressible fluids and linear-elastic structure. This formulation uses displacement variables for structure and velocity variables for the fluid, with no additional variables required to ensure traction, velocity, temperature, and heat flux continuity at the fluid-structure interface. Rate of convergence in each time step is quadratic, which is achieved in this formulation by deriving an exact tangent stiffness matrix. The robustness and good performance of the method is ascertained by applying the proposed strategy on a wide spectrum of problems taken from the literature pertaining to steady, transient, two dimensional, axisymmetric, and three dimensional fluid flow and conjugate heat transfer. It is shown that the current formulation gives excellent results on all the case studies conducted, which includes problems involving compressibility effects as well as problems where fluid can be treated as incompressible.

***Keywords*—** linear thermoelasticity, compressible flow, conjugate heat transfer, monolithic FEM.

Santhosh A K, Department of Mechanical Engineering, Indian Institute of Science, Bangalore, Karnataka – 560012, India. (e-mail: santhoshak@iisc.ac.in).

Chandrashekhar S Jog, Professor, Department of Mechanical Engineering, Indian Institute of Science, Bangalore, Karnataka – 560012, India. (e-mail: jogc@iisc.ac.in).

Tailoring Quantum Oscillations of Excitonic Schrodinger's Cats as Qubits

Amit Bhunia[1], Mohit Kumar Singh[1], Maryam Al Huwayz[2,3], Mohamed Henini[2] And Shouvik Datta[1] *

[1]Department of Physics, Indian Institute of Science Education and Research, Pune 411008, Maharashtra, India
[2]School of Physics and Astronomy, University of Nottingham, Nottingham NG7 2RD, UK,
[3]Physics Department, Faculty of science, Princess Nourah Bint Abdulrahman University, Riyadh, Saudi Arabia.
*email: *shouvik@iiserpune.ac.in*

Abstract— We report [https://arxiv.org/abs/2107.13518] experimental detection and control of Schrodinger's Cat like macroscopically large, quantum coherent state of a two-component Bose-Einstein condensate of spatially indirect electron-hole pairs or excitons using a resonant tunneling diode of III-V Semiconductors. This provide access to millions of excitons as qubits to allow efficient, fault-tolerant quantum computation. In this work, we measure phase coherent periodic oscillations in photo generated capacitance as a function of applied voltage bias and light intensity over a macroscopically large area. Periodic presence and absence of splitting of excitonic peaks in the optical spectra measured by photocapacitance point towards tunneling induced variations in capacitive coupling between the quantum well and quantum dots. Observation of negative 'quantum capacitance' due to screening of charge carriers by the quantum well indicate Coulomb correlations of interacting excitons in the plane of the sample. We also establish that coherent resonant tunneling in this well-dot heterostructure restricts the available momentum space of the charge carriers within this quantum well. Consequently, the electric polarization vector of the associated indirect excitons collective orients along the direction of applied bias and these excitons undergo Bose-Einstein condensation below ~100 K. Generation of interference beats in photocapacitance oscillation even with incoherent white light further confirm the presence of stable, long range spatial correlation among these indirect excitons. We finally demonstrate collective Rabi oscillations of these macroscopically large, 'multipartite', two-level, coupled and uncoupled quantum states of excitonic condensate as qubits. Therefore, our study not only brings the physics and technology of Bose-Einstein condensation within the reaches of semiconductor chips, but also opens up experimental investigations of the fundamentals of quantum physics using similar techniques.

Operational temperatures of such two-component excitonic BEC can be raised further with more densely packed, ordered array of QDs and/or using materials having larger excitonic binding energies. However, fabrications of single crystals of 0D-2D heterostructures using 2D materials (e.g. transition metal di-chalcogenides, oxides, perovskites etc.) having higher excitonic binding energies are still an open challenge for semiconductor optoelectronics. As of now, these 0D-2D heterostructures can already be scaled up for mass production of miniaturized, portable quantum optoelectronics devices using the existing III-V and/or Nitride based semiconductor fabrication technologies.

Keywords— exciton, Bose-Einstein condensation, quantum computation, heterostructures, semiconductor Physics, quantum fluids, Schrodinger's Cat.

The Life and Death of In-Person Retail

Samsun Knight

***Abstract*—** The dependence of retail stores on their local business environment is of first-order importance to both their success and to predicting the impacts of environmental changes on their business, as well as micro-founding urban agglomeration. For example, researchers need a strong understanding of this interdependence in order to predict how much a permanent switch to remote work might affect downtown retail, or to anticipate how much online grocery delivery competition might affect shopping centers that are anchored by in-person grocery retail. I use precise cell phone data from SafeGraph and a novel data identification strategy—relying on sudden exogenous changes in the local business environment to identify true causal effects—and incorporate these quasi-experiments into a complementary-choice logit model framework from Gentzkow (2007) to answer these questions. First, I inspect the natural experiments of mass retail chain bankruptcies, principally the mass closures of Sears and K-mart stores, and find that nearby stores suffer a sharp 6% decline in foot traffic after a nearby Sears closure; additionally, I inspect the construction of Amazon warehouses to show that nearby stores see a roughly 0.2 ratio increase in foot traffic for having nearby workers, suggesting (in line with Barrero et al. 2021) that a 20% decline in in-person work would lead to a 4% decline in retail traffic. Second, I use this quasi-experimental variation to improve the basic logit store-choice and show that leveraging this quasi-experimental identification in model estimation can significantly improve out-of-sample prediction of store interdependence, as measured by out-of-sample prediction of the effects of store closures. Finally, I use my estimated model to project the effects of differential levels of declines for in-person grocery store demand on stores that are collocated in shopping centers with grocery stores, and describe the heterogeneous effects by area characteristics and store type.

***Keywords*—** urban economics, the death of retail, causal inference, cell phone data.

Samsun Knight is with the Brown University, United States (e-mail: samsun_knight@brown.edu).

Planning and Implementation of the Urban Plan Simultaneously: Case Study in the City of Mashhad, Iran

Sohrab Mashhoodi

***Abstract*—** Urban planning is based mainly on natural expansion rather than the start of each period of planned development. Thus only 15% of planned proposals are completed despite many bureaucratic regulations. Traditionally presentations and preparations for urban construction (development) coincided with the emergence of new towns or cities. Industrialization and accelerated growth of the cities brought imbalance and mayhem, which in turn gave birth to strict governing regulations. Moreover, with the destruction of cities during the Second World War, the idea of an oversight committee by the government became more concrete. The new Urban planning model that the writer suggested in this article called "Simultaneal Planning and Realization" can solve the traditional type of urban planning challenges by regular monthly, weekly, and daily updating.

***Keywords*—** rigid planning, fluid planning, specific dimension, simultaneous, balance specific dimension, city of Mashhad, Iran.

Sohrab Mashhoodi is with the Parsoumash Consulting Engineers, Iran (e-mail: mashhoodi24@gmail.com).

Punjab looks at Crop Diversification, Mechanization to Promote Punjab's Agriculture

Dr. Gorakh Singh
Head
PG Department of Geogarphy
GSSDGS Khalsa College, Patiala
teja.gorakhsingh27@gmail.com
Contact No. 98556-02727

ABSTRACT

Agriculture is the most important economic practice of the world in which various crops have been grown like grains, cereals, fodder and other products along with the domestication of the animals. It is undoubtedly the single practice of the world where human beings enjoy the free gifts from the lap of nature in the form of sunlight, rainfall, humidity, air and land. Throughout the world, various agricultural practices have been adopted to produce variety of crops as per their physical setup which is indigenous to their respective area. This research will focus on the eco-friendly crop planning regions that will consequently increase the livelihood of the rural population, develop agricultural innovations, maintain scientific interventions in the agricultural arena and contribute in the welfare of the rural population. Crop Diversification may be defined as "the production of a variety of crops, often as a safeguard against the effects of fall in demand for a particular product". Crop diversification stands for competition among various crops grown for space in an area. Diversification from existing wheat rice monoculture to alternative crops or linking agriculture production with agri-business activities has been suggested by several economists in the wake of aggravating agrarian crisis (Sohal, 2003, Singh L and Singh S 2002; Singh 2004). Its magnitude shows the degree of crop diversification which further reveals whether the cropping pattern is diversified or of specialized nature. It also mirrors the affects of natural and human environment on the cropping pattern. In other words, crop diversification is the off-spring of the action, reaction and inter-action among the physical and socio-economic environment. Crop diversification highlights spatio-temporal variations in the farming system prevalent among farmers with a possibility of crop relevance. In an area, where agricultural infrastructure is less developed and physical environment is uncertain, farmers grow a large number of crops, with the feeling that they will get assure returns at least from some crops. This sort of character is quite common among the small farmers. Through this research various alternatives will be explored in terms of new eco-friendly cropping pattern and eco-friendly regions. Whereas at a same time, this research will be equally beneficial at state and national level as well. At present wheat, rice involve around 85% of the state region, which results that rice and wheat have become solo yields of kharif and rabi seasons separately. Henceforth, the significant destinations of the current paper are to uncover the spatial examples of harvest enhancement in 1999 and 2020. It is additionally the point of paper to discover

changes in the size of harvest expansion and components mindful. In conclusion, ideas are made how to debilitating expansion in crop specialization, with the goal that endless loop of wheat - rice crop turn can be checked and different harvests like maize , feed, sugarcane, vegetables , natural products, cotton, oil seeds, beats, and so forth ought to be empowered . Present paper depends on auxiliary wellsprings of Data; Tehsil is taken as a unit of study. Three years midpoints are taken for each time-frame. Gibbs and Martin strategy is utilized for determining the outcomes and choropleth technique is applied for planning the outcomes.

Keywords:- Crop Diversification, Eco-friendly crop planning regions, New Agriculture Innovations, Sustainable development

INTRODUCTION

Crop diversification may be defined as "the production of a variety of crops, different articles, services, etc. often as a safeguard against the effects of fall in demand for a particular product" (Oxford English Dictionary, 1972). The concept may be explained further by considering minimum crop diversity as being the practice of single and maximum crop diversity as an equal distribution of all enterprises (Zandstra, 1993). With regard to agriculture, crop diversification may be viewed as a process with four stages. Initially, crop diversification at the cropping level where there has been a shift away from monoculture. This is a stage at which many developing countries are currently lying (Petit and Bargouti, 1993). At the second stage, the farm has more than one enterprise and may produce and sell crops at different times of the year (Metcalf, 1969). At the subsequent stage, crop diversification is understood as being mixed farming (Shucksmith et. at., 1989). Finally, activities beyond agriculture are incorporated into the meaning of crop diversification (Newby, 1988). The concept of crop diversification is often taken for shifting away from the production of surplus commodities to those which may be expanded (Newby, 1988).

STUDY AREA:

Geographically, Punjab is situated in the North-West of India, which extends between $29^0 30'$ N to $32^0 32'$ N latitudes and between $73^0 55'$ E to $76^0 50'$ E longitudes. Its total area is 50362 sq. km. and comprises 1.52 per cent of India's total reporting area of Punjab.

RESEARCH QUESTIONS

The present study aims at achieving the following broad objectives;

1. To know region under singular harvests during 1999-2000 and 2019-2020.
2. To catch the trimming examples and changes in that.
3. To recognize the prevailing harvests in the trimming example and changes in that.

METHODOLOGY

The present study is empirical in nature and is based on secondary sources of data. Tehsil is taken as unit of study. Two time periods i.e. 1999-2000 and 2019-2020 are taken. Statistical technique given by Gibbs and Martin is used for calculating the index of crop diversification. The derived results are mapped with the help of cartographic techniques.

Gibbs and Martin's technique:

$$\text{Index of crop Diversification} = 1 - \frac{\sum x^2}{(\sum x)^2}$$

where 'X' is the percentage of total cropped area occupies by an individual crop. According to this metod the index of crop diversification varies between 0.0 to 0.9.

SOURCE OF DATA

The present study depends upon secondary sources of data which are collected from various sources. These are as follows, like: Directorate of Land Records, Jalandhar; Director, Agriculture Punjab, Chandigarh; Punjab Agricultural University, Ludhiana; Economic and Statistical Organisation of Punjab, Chandigarh.

RESEARCH BODY

Several scholars from geography, economics and allied disciplines have made many attempts to study crop diversification in different parts of the world. Among them, prominent are Bhatia, Jasbir Singh, Gibbs & Martin and Ayyer, etc. In this paper, Gibbs & Martin technique is used for deriving the results and choropleth method is applied for mapping the results.

The Gibbs & Martin (1962) gave the Formula for calculation the index of crop diversification. Their Formula is as follow:

$$\text{Index of Crop Diversification} = 1 - \frac{\Sigma X^2}{(\Sigma X)^2}$$

Where X is the percentage of total cropped area occupies by an individual crop. According to this Method, the index of crop diversification varies from 0.0 to 0.9. Here, the indices are directly related to the magnitude of crop diversification. Higher the index, higher the crop diversification and lower the index, lower the crop diversification (Gibbs & Martin, 1962. For making an in-depth analysis of patterns of crop diversification and changes therein, the present chapter is divided into three major heads. These are:

A. Pattern of Crop Diversification: 1999-2000

B. Pattern of Crop Diversification: 2019-2020
C. Changes in Crop Diversification: 1999-2000 to 2019-2020
A. Pattern of Crop Diversification: 1999-2000

For deriving the results of the degree of crop diversification in Punjab, Gibbs & Martin is taken into account. The result obtained from this method is mapped and discussed as follows:

I. Spatial Distribution of Crop Diversification (after Gibbs & Martin): 1999-2000

The index value of overall crop diversification in Punjab was noted 0.689 in 1999-2000. It ranged from 0.617 in Jalalabad tehsil of Firozpur district to 0.793 in Kharar tehsil of S.A.S. Nagar district which shows that there were great spatial variations in the index value of crop diversification in Punjab. These variations were largely the result of physical environment and partly the result of human environment. To know the factors responsible for these variations, the following three categories are made as follows:

(1) Areas with High Magnitude of Crop Diversification (> 0.700 index value)

In this category, the index of crop diversification was ranging between lowest of 0.701 in Tapa tehsil of Barnala district and highest of 0.793 in Kharar tehsil of S.A.S. Nagar district. This category was found in two separate belts: One belt was lying along the Shiwalik foot hills and include the major parts of Jalandhar district. This belt had embraced the tehsils of Dhar Kalan, Pathankot, Mukerian, Dasuya, Hoshiarpur, Jalandhar-I & II, Garhshankar, Nangal, Anandpur Sahib, Balachaur, Nawanshehar, Rupnagar, Chamkaur Sahib, Kharar, S.A.S. Nagar, Rajpura, Shahkot and Nakodar. The main reasons were the presence of Shiwalik hills, undulating and dissected topography, steep gradient, infertile soils, small size of land holdings, inadequate irrigational facilities, comparatively high rainfall except Jalandhar district. recorded under fodder and sugarcane.

The second belt of this category was found in south-western parts of the state including the tehsils of Muktsar, Gidderbaha, Malout, Abohar, Bathinda, Talwandi Sabo, Mansa, Sardulgarh, Budhlada, Barnala, Dhuri and Tapa. Here, the index of crop diversification was recorded high due to frequent occurrence of sand dunes, infertile sandy to sandy-loamy soils, low rainfall, traditionally cotton-growing areas, etc.

Table 1.

Spatial Distribution of Crop Diversification, 1999-2000

Sr. No.	Name of Tehsils	Index Value
1	Amritsar-I	0.674
2	Amritsar-II	0.674
3	Baba Bakala	0.690
4	Ajnala	0.637
5	Bathinda	0.715

6	Rampura Phul	0.678
7	Talwandi Sabo	0.755
8	Barnala	0.710
9	Tapa	0.700
10	Fatehgarh Sahib	0.632
11	Khamanon	0.632
12	Amloh	0.632
13	Bassi Pathana	0.632
14	Faridkot	0.690
15	Jaiton	0.690
16	Firozpur	0.620
17	Zira	0.653
18	Jalalabad	0.617
19	Fazilka	0.694
20	Abohar	0.720
21	Gurdaspur	0.664
22	Pathankot	0.753
23	Dera Baba Nanak	0.644
24	Batala	0.644
25	Dharkalan	0.718
26	Hoshiarpur	0.725
27	Dasuya	0.700
28	Garhshankar	0.746
29	Mukerian	0.759
30	Jalandha-I	0.727
31	Jalandhar-II	0.727
32	Nakodar	0.728
33	Phillaur	0.696
34	Shahkot	0.723
35	Kapurthala	0.643
36	Sultanpur Lodhi	0.622
37	Bholath	0.645
38	Phagwara	0.687
39	Ludhiana East	0.687
40	Ludhiana West	0.675
41	Khanna	0.640
42	Samrala	0.682
43	Jagraon	0.655
44	Payal	0.680
45	Raikot	0.680
46	Muktsar	0.709
47	Malout	0.709
48	Gidderbaha	0.717

49	Moga	0.681
50	Nihal Singh Wala	0.680
51	Bagha Purana	0.680
52	Mansa	0.711
53	Budhlada	0.711
54	Sardulgarh	0.711
55	Nawan Shehar	0.731
56	Balachaur	0.737
57	Patiala	0.609
58	Rajpura	0.722
59	Samana	0.633
60	Nabha	0.645
61	Patran	0.633
62	Rupnagar	0.762
63	Chamkaur Sahib	0.762
64	Anandpur Sahib	0.710
65	Nangal	0.710
66	Sangrur	0.659
67	Malerkotla	0.697
68	Dhuri	0.700
69	Sunam	0.682
70	Lehra	0.682
71	Moonak	0.682
72	Tarn Taran	0.632
73	Patti	0.687
74	Khadur Sahib	0.658
75	S.A.S. Nagar	0.793
76	Kharar	0.793
77	Dera Bassi	0.731
	Total Punjab	**0.689**

Source: Director, Land Records, Punjab, Jalandhar.

(2) Areas of Moderate Magnitude of Crop Diversification (0.650 to 0.700 index value)

Tehsils of moderate magnitude of crop diversification were well spread throughout Punjab with more concentration in central parts. Here, index of crop diversification ranged between 0.653 in Zira tehsil of Firozpur district to 0.697 in Malerkotla tehsil of Sangrur district. It included the tehsils of Gurdaspur, Amritsar I & II, Khadur Sahib, Patti, Zira, Moga, Bagha Purana, Rampura Phul, Jaito, Faridkot, Fazilka, Jagraon, Ludhiana East & West, Phillaur, Samrala, Payal, Malerkotla, Raikot, Sangrur, Sunam, Lehra, Moonak, Derabassi and Phagwara. In all these areas, crop diversification was recorded moderate owing to developed irrigation, farm mechanization, high density of tubewells, developed infrastructure, flat lands, etc. While in Ludhiana and Moga districts, farmers had sown maize crop also during summer season. Even area under fodder crop was also noted high in these districts. But in

tehsils falling in southern Punjab including the districts of Sangrur, Faridkot, parts of Bathinda, Firozpur, etc., rice had captured considerable area from cotton crop during summer, whereas wheat had taken away area from grams during winters.

(3) Areas of Low Magnitude of Crop Diversification (<0.650 index value)

Low crop diversification was recorded in tehsils of Dera Baba Nanak, Ajnala, Batala, Bholath, Kapurthala, Sultanpur Lodhi, Tarn Taran, Firozpur, Jalalabad, Khamanon, Khanna, Amloh, Bassi Pathana, Fatehgarh Sahib, Patiala, Nabha, Samana, and Patran. Here, index value of crop diversification varied between 0.609 in Patiala tehsil of Patiala district to 0.645 in Bholath tehsil of Kapurthala district. These areas had flat and fertile soils, developed nerwork of irrigation, developed marketing network, developed agricultural infrastructure, etc. As a result, in this category the magnitude of crop diversification was recorded low.

From the above discussion, it was found that areas with physical constraints and less developed agricultural infrastructure had recorded high magnitude of crop diversification, whereas the lands with fertile soil, flat lands, and developed agricultural infrastructure had experienced either moderate or low magnitude of crop diversification.

B. Pattern of crop diversification: 2019-2020

The magnitude of crop diversification during 2019-2020 shows that several crops are grown in Punjab namely wheat, rice, fodder, sugarcane, maize, fruits, pulses vegetables, oilseeds, etc. During 2019-2020 according to Gibbs & Martin's method, the average value for the index of crop diversification 0.669 is recorded. But due to the regional variations in physiography, soils, rainfall, irrigation, development of infrastructure, etc, this average index value is not homogeneous in all the tehsils of the study region. It is recorded lowest of 0.567 in Zira tehsil of Firozpur district and highest of 0.777 in Kharar tehsil of S.A.S. Nagar district. For making a detailed study of the spatial patterns of crop diversification, table 2 shows the following three categories:

Table 2

Spatial Distribution of Crop Diversification, 2019-2020

Sr. No.	Name of Tehsils	Index Value
1	Amritsar-I	0.649
2	Amritsar-II	0.638
3	Baba Bakala	0.648
4	Ajnala	0.585
5	Bathinda	0.670
6	Rampura Phul	0.668
7	Talwandi Sabo	0.657

8	Barnala	0.594
9	Tapa	0.650
10	Fatehgarh Sahib	0.576
11	Khamanon	0.631
12	Amloh	0.640
13	Bassi Pathana	0.621
14	Faridkot	0.655
15	Jaiton	0.653
16	Firozpur	0.573
17	Zira	0.567
18	Jalalabad	0.601
19	Fazilka	0.678
20	Abohar	0.692
21	Gurdaspur	0.626
22	Pathankot	0.709
23	Dera Baba Nanak	0.580
24	Batala	0.633
25	Dharkalan	0.666
26	Hoshiarpur	0.750
27	Dasuya	0.730
28	Garhshankar	0.725
29	Mukerian	0.734
30	Jalandhar-I	0.743
31	Jalandhar-II	0.712
32	Nakodar	0.690
33	Phillaur	0.650
34	Shahkot	0.667
35	Kapurthala	0.685
36	Sultanpur Lodhi	0.651
37	Bholath	0.592
38	Phagwara	0.713
39	Ludhiana East	0.617
40	Ludhiana West	0.626
41	Khanna	0.640
42	Samrala	0.641
43	Jagraon	0.632
44	Payal	0.599
45	Raikot	0.624
46	Muktsar	0.696
47	Malout	0.660
48	Gidderbaha	0.672
49	Moga	0.608
50	Nihal Singh Wala	0.582

51	Bagha Purana	0.582
52	Mansa	0.698
53	Budhlada	0.674
54	Sardulgarh	0.660
55	Nawan Shehar	0.708
56	Balachaur	0.730
57	Patiala	0.578
58	Rajpura	0.648
59	Samana	0.582
60	Nabha	0.639
61	Patran	0.602
62	Rupnagar	0.748
63	Chamkaur Sahib	0.649
64	Anandpur Sahib	0.705
65	Nangal	0.634
66	Sangrur	0.599
67	Malerkotla	0.599
68	Dhuri	0.613
69	Sunam	0.592
70	Lehra	0.643
71	Moonak	0.585
72	Tarn Taran	0.581
73	Patti	0.609
74	Khadur Sahib	0.607
75	S.A.S. Nagar	0.750
76	Kharar	0.777
77	Dera Bassi	0.709
	Total Punjab	**0.669**

Source: Director, Land Records, Punjab, Jalandhar.

1. Areas of High Magnitude of Crop Diversification (>0.700 index value)

It contains 17 tehsils and comprises 22.50 percent of the total occurrences. The lowest and highest index value of crop diversification are 0.709 in Pathankot tehsil of Gurdaspur district and 0.777 in kharar tehsil of S. A. S. Nagar district respectively. This category includes the tehsils of Pathankot, Mukerian, Dasuya, Hoshiarpur, Jalandhar I & II and Phagwara, which is lying in north-west to south-east direction. The presence of shiwalik hills, steep gradient of land, piedmont plains, high rainfall, numerous seasonal torrents, less developed irrigation, small size of hand holdings, low magnitude of farm mechanization, poor agricultural infrastructure, occurrences of large number of sugar mills etc. are factors which have compelled the farmers to grow large number of crops like wheat, maize, rice, fodder, sugarcane, vegetables, etc. and consequently lead to high magnitude of crop diversification. In case of Jalandhar I & II and Phagwara tehsils, reasons for high crop diversification are presence of two sugar mills at Bhogpur and Phagwara, three large urban centres namely

Jalandhar, Jalandhar cantonment and Phagwara, which require large quantity of fodder for dairies, developed agricultural infrastructure, high degree of mechanization etc. which led to high magnitude of crop diversification in these tehsils.

2. Areas of Moderate Magnitude of Crop Diversification (0.650 to 0.700 index value)

This category includes 20 tehsils and cover 25.97 per cent of the total occurrences. Here, the lowest index value of 0.650 is found in Tapa tehsil of Barnala district and highest index value of 0.698 in Mansa tehsil of Mansa district. This category has two belts and one small patch. Main belt of this category is confined to south-westerns parts of the state, which cover the tehsils namely Faridkot, Jaito, Fazilka, Abohar, Muktsar, Gidderbaha, Malout, Bathinda, Rampura Phul, Talwandi Sabo, Tapa, Mansa, Budhlada and Sardulgarh. These tehsils were traditionally cotton growing areas and are having sandy soils, low rainfall, less developed agricultural infrastructure, sand dunes which are presently levelled by farmers but still their remnant are visible, saline and alkaline aquifers of sub-soil water which is unfit for irrigation purposes, well developed canal irrigation and meagre tubewell irrigation, water-logging, diffusion of green revolution technology, research and extension work of regional centre at Bathinda of Punjab Agricultural University, Ludhiana etc. are the factors which make feasible to cultivate wheat, rice, cotton, fodder, etc. in this belt.

The second belt of this category is lying in central parts of the study region comprising five tehsils namely Kapurthala, Sultanpur Lodhi, Shahkot, Nakodar and Phillaur. All these areas have developed agricultural infrastructure, small size of land holdings, high extent of irrigation mainly by tube-wells, presence of sand dunes which are presently levelled by the farmers etc. resulted into moderate magnitude of crop diversification.

3. Areas of Low Magnitude of Crop Diversification (<0.650 index value)

Central parts of the study region are blessed with low magnitude of crop diversification. There are total 40 tehsils in this category which comprise 51.94 percent of the total occurrences. Here, low magnitude of crop diversification varies from 0.567 in Zira tehsil of Firozpur district to 0.649 in Amritsar-I tehsil of Amritsar district. It includes the tehsils of Gurdaspur, Dera Baba Nanak, Batala, Amritsar-I & II, Baba Bakala, Ajnala, Tarn Taran, Khadur Sahib, Bholath, Patti, Firozpur, Zira, Jalalabad, Moga, Bagha Purana, Nihal Singh Wala, Ludhiana East & West, Jagraon, Raikot, Payal, Samrala, Khanna, Malerkotla, Sangrur, Dhuri, Barnala, Sunam, Lehr, Moonak, Patran, Samana, Patiala, Nabha, Rajpura, Fatehgarh Sahib, Amloh, Bassi Pathana, Khamanon, Chamkaur Sahib and Nangal. A lot of improvements are made in this category like levelling of sand dunes, reclamation of saline and alkaline soils, extension of irrigation facilities, significant role played by Punjab Agricultural University. There is also a small patch of this category which is lying in Nangal tehsil. Here low crop diversification is due to steep gradient, presence of Shiwalik hills, hostile physical and human environment for crop farming.

C. Changes in Crop Diversification: 1999-2000 to 2019-2020

A significant increase with the help of green revolution in an agriculture productivity resulting from the introduction of high-yield varieties of grains, the use of pesticides and

improved management techniques, the crop diversification regions have experienced significant change during the period under present investigation. The factors affecting the crop diversification regions are high yielding varieties of seed of wheat, and rice, supply of agricultural credits, chemical fertilizers, extent of irrigation, number of tube wells, number of harvesting combines, density of tractors, intensity of cropping, large size of regulated markets, government policies, size of sand holdings and land reforms, nature of the terrain, use of sprinklers or drip irrigation, farmers choice for growing of crops, etc. All these variables have noted significant changes which ultimately have affected the patterns of crop diversification in the state. The overall magnitude of crop diversification agriculture has become highly specialized.

Table 3
Changes in Crop Diversification in Punjab: 1999-2000 to 2019-2020

Sr. No.	Name of Tehsils	Index Value 1999-2000	Index Value 2019-2020	Change
1	Amritsar-I	0.674	0.649	-0.025
2	Amritsar-II	0.674	0.638	-0.036
3	Baba Bakala	0.690	0.648	-0.042
4	Ajnala	0.637	0.585	-0.052
5	Bathinda	0.715	0.670	-0.045
6	Rampura Phul	0.678	0.668	-0.010
7	Talwandi Sabo	0.755	0.657	-0.098
8	Barnala	0.710	0.594	-0.116
9	Tapa	0.700	0.650	-0.050
10	Fatehgarh Sahib	0.632	0.576	-0.056
11	Khamanon	0.632	0.631	-0.001
12	Amloh	0.640	0.632	-0.008
13	Bassi Pathana	0.632	0.621	-0.011
14	Faridkot	0.690	0.655	-0.035
15	Jaiton	0.690	0.653	-0.037
16	Firozpur	0.620	0.573	-0.047
17	Zira	0.653	0.567	-0.086
18	Jalalabad	0.617	0.601	-0.016
19	Fazilka	0.694	0.678	-0.016
20	Abohar	0.720	0.692	-0.028
21	Gurdaspur	0.664	0.626	-0.038
22	Pathankot	0.753	0.709	-0.044
23	Dera Baba Nanak	0.644	0.580	-0.064
24	Batala	0.644	0.633	-0.011
25	Dharkalan	0.718	0.666	-0.052
26	Hoshiarpur	0.725	0.750	0.025
27	Dasuya	0.700	0.730	0.030
28	Garhshankar	0.746	0.725	-0.021

29	Mukerian	0.759	0.734	-0.025
30	Jalandhar-I	0.727	0.743	0.016
31	Jalandhar-II	0.727	0.712	-0.015
32	Nakodar	0.728	0.690	-0.038
33	Phillaur	0.696	0.650	-0.046
34	Shahkot	0.723	0.667	-0.056
35	Kapurthala	0.643	0.685	0.042
36	Sultanpur Lodhi	0.622	0.651	0.029
37	Bholath	0.645	0.592	-0.053
38	Phagwara	0.687	0.713	0.026
39	Ludhiana East	0.687	0.617	-0.070
40	Ludhiana West	0.675	0.626	-0.049
41	Khanna	0.645	0.640	-0.005
42	Samrala	0.682	0.641	-0.041
43	Jagraon	0.655	0.632	-0.023
44	Payal	0.680	0.599	-0.081
45	Raikot	0.680	0.624	-0.056
46	Muktsar	0.709	0.696	-0.013
47	Malout	0.709	0.660	-0.049
48	Gidderbaha	0.717	0.672	-0.045
49	Moga	0.681	0.608	-0.073
50	Nihal Singh Wala	0.680	0.582	-0.098
51	Bagha Purana	0.680	0.582	-0.098
52	Mansa	0.711	0.698	-0.013
53	Budhlada	0.711	0.674	-0.037
54	Sardulgarh	0.711	0.660	-0.051
55	Nawan Shehar	0.731	0.708	-0.023
56	Balachaur	0.737	0.730	-0.007
57	Patiala	0.609	0.578	-0.031
58	Rajpura	0.722	0.648	-0.074
59	Samana	0.633	0.582	-0.051
60	Nabha	0.645	0.639	-0.006
61	Patran	0.633	0.602	-0.031
62	Rupnagar	0.762	0.748	-0.014
63	Chamkaur Sahib	0.762	0.649	-0.113
64	Anandpur Sahib	0.710	0.705	-0.005
65	Nangal	0.710	0.634	-0.076
66	Sangrur	0.659	0.599	-0.060
67	Malerkotla	0.697	0.599	-0.098
68	Dhuri	0.700	0.613	-0.087
69	Sunam	0.682	0.592	-0.090
70	Lehra	0.682	0.643	-0.039
71	Moonak	0.682	0.585	-0.097

72	Tarn Taran	0.632	0.581	-0.051
73	Patti	0.687	0.609	-0.078
74	Khadur Sahib	0.658	0.607	-0.051
75	S.A.S. Nagar	0.793	0.750	-0.043
76	Kharar	0.793	0.777	-0.016
77	Dera Bassi	0.731	0.709	-0.022
	Total Punjab	**0.689**	**0.669**	-0.020

Source: Director, Land Records, Punjab, Jalandhar.

FINDINGS:

According to Gibbs and Martin's method, the overall index value of crop diversification in 1999-2000 was 0.689 which had decreased to 0.669 in 2019-2020. This fall in index value of crop diversification shows that crop diversification in Punjab has declined in its magnitude during 1999-2000 to 2019-2020 which is largely the result of improvements in agricultural infrastructure, adoption of high yielding varieties of seed, specially of wheat and rice, extension of irrigational facilities, etc. But this decreasing magnitude of crop diversification was not homogeneous in all parts of the state, because of variations in relief, irrigation, farm mechanization, farmers' attitude, degree of mechanization, etc. Study of the data reveals the following points:

1. The areas of high magnitude of crop diversification were found in two belts in 1999-2000 and had comprised of 31 tehsils namely Dhar kalan, Pathankot, Mukerian, Dasuya, Hoshiarpur, Jalandhar I & II, Nakodar, Shahkot, Garhshankar, Nawanshehar, Balachaur, Nangal, Anandpur Sahib, Rupnagar, Chamkaur Sahib, Kharar, S.A.S. Nagar, Rajpura, Dhuri, Barnala, Tapa, Mansa, Budhlada, Sardulgarh, Talwandi Sabo, Bathinda, Gidderbaha, Muktsar, Malout and Abohar which had declined to 15 tehsils in 2019-2020 and these are lying along the Shiwalik foothills in continuous belt with the exception of Dhar kalan and Nangal tehsils. In this way there was decline of 16 tehsils is recorded which have shifted to either the moderate or low categories. The number of tehsils in high magnitude of crop diversification was high in 1999-2000, owing to less developed infrastructure and geo-climatic conditions and secondly, in the northern belt of this categor which was lying along the Shiwaliks, number of crops were grown and almost all crops were having comfortable area under their cultivation which were namely wheat, rice, maize, fodder, and sugarcane of this category. But in the south-western belt, the major crops were wheat, cotton, rice, fodder, pulses and oilseeds. But in 2019-2020, due to excessive canal irrigation, most tehsils of south-western belt had experienced rise in water table which has led to water-logging conditions and consequently rice has emerged as either second ranking or third ranking crop at present.

2. The category of moderate magnitude of crop diversification was found in 28 tehsils namely Gurdaspur, Amritsar-I & II, Baba Bakala, Khadur Sahib, Patti, Zira, Moga, Bagha Purana, Faridkot, Jaito, Jagraon, Nihal Singh Wala, Rampura Phul, Phagwara, Phillaur, Ludhiana East & West, Raikot, Samrala, Payal, Malerkotla, Sangrur, Sunam, Lehra, Moonak, Derabassi and Fazilka in 1999-2000 and was spread over all parts of the state with main concentration in the central parts of the state. This category has gained considerable area from the category of high magnitude of crop diversification, which was located in the souht-western parts comprising the districts of Bathinda (except Rampura Phul tehsil), Muktsar,

Mansa, Barnala, and tehsil of Abohar. The second concentration of this belt in 2019-2020 is found in 19 tehsils namely Kapurthala, Sultanpur Lodhi, Shahkot, Nakodar and Phillaur. Here, moderate magnitude is the result of cultivation of vegetables during rabi season. One more tehsil of this category is found in Dhar kalan tehsil during 2019-2020, which was falling in the category of high crop diversification in 1999-2000.

3. The category of low crop diversification with less than 0.650 index value had covered only 18 tehsils namely, Dera Baba Nanak, Ajnala, Batala, Tarn Taran, Bholath, Kapurthala, Sultanpur Lodhi, Firozpur, Jalalabad, Khamanon, Khanna, Bassi Pathana, Amloh, Fatehgarh Sahib, Samana and Patran in 1999-2000 which has increased to 43 tehsils in 2019-2020. The main reason for low magnitude of crop diversification were flat and fertile land, high extent of irrigation, high degree of agricultural technology, highly developed agricultural infrastructure, emerging of wheat-rice crop rotation , etc. One more tehsil namely Nangal has also experienced low crop diversification which is largely the result of physical constraints which hamper the development of infrastructure, which had compelled the farmers to grow few crops like maize, wheat and fodder for their survival.

From the above discussion, it is found that in 1999-2000 except category of high magnitude of crop diversification, had neither low nor moderate categories were having compact belts. But in 2019-2020, there is clear distinction between areas of high, moderate and low magnitude crop diversification regions. On the whole, there is decline in overall magnitude of crop diversification in Punjab from 0.689 to 0.669 during 1999-2000 to 2019-2020, which shows that the trend is from diversified to specialized cropping pattern in Punjab during the study period.

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A Campaign to Create an Innovative Opportunity for Sustainable Surface Transportation Through Advanced Recycling Technology

Rebecca Cowle

***Abstract*—** Our planet is drowning in plastic pollution. Though plastic has played a significant role in creating the modernized world we live in, more often than not when it reaches its end of useful life it ends up in landfills, in our environment, or in our oceans. Separately from the plastic waste crisis, U.S. road infrastructure is also in need of investment and modernization. The good news, however, is that there is a new, innovative solution that has the potential to ameliorate both simultaneously – plastic roads. Congressional introduction of legislation mandating a minimum recycled plastic content percentage of 10% for federal highway and roadway construction and maintenance projects would strengthen the resiliency of US roadway infrastructure for improved, sustainable mobility and economic growth, while helping achieve zero waste in the environment through commoditization of waste into a useful raw material for road construction and other industry applications.

***Keywords*—** plastic,plastic road, sustainable transportation, roads, advanced recycling.

Rebecca Cowle is with the The George Washington University, United States (e-mail: rebeccacowle7@gmail.com).

Analysing of Flow in Open Channels Using HEC-RAS Software in Langat River

Anber Yakoob Sameer Yakoob

***Abstract*—** Malaysia has situated fashionable a warm and humid region from extreme numbers or amounts of rainfall. Therefore this case study will be by using HEC- REC software to identify the charistice upstream and downstream along the direction of Langat River within the Kajang district, in addition analyse the change in the size and shape of the cross-section. The model calibration and validation efficiency will be verified by using the available data provided by the Department of Irrigation and Drainage (Analysis of flow channels by using hydrological modelling, (HEC-REC) software will aim further information about the channels flow after changing the cross-section size and flooding risk in Langat River Basin. The model calibration and validation efficiency will be verified by using the available data provided by the Department of Irrigation and Drainage; the Length of the river covered by the study is 2 kilometers. A Cross-section point with five stations will be taken; the cross-section will consist of 2000 lengths; in addition, the location upstream with a station No: 2816442 and the downstream at Station No: 2917401; both locations are in Kajang. The HEC-RAS model succeeded in identifying the river cross-section upstream and downstream by identifying the cross-section area, water level, and channel bed in every selected cross-section within the study area. The result outputs obtained from the HEC RAS model for the upstream and downstream showed that the decrease in the cross-section size is about 12.22% which led to the increase of the water level by 60%. The results showed the impact on the flood after changing the cross-section size to maximize the possibility of a flood.

***Keywords*—** Langat River, flood, HEC-RAS, analysis of flow.

Yakoob Anber is with the Infrastructure University Kuala Lumpur, Malaysia (e-mail: Eng.yakoob@gmail.com).

Environmental Performance in the West African Economy: MM-Quantile and 2SLS Approach

Hammed Musibau, Maria Belen Yanotti, Joaquin Vespignani, Rabindra Nepal

***Abstract*—** The 2019 World Bank report on West Africa's coast indicates that over $3.8 billion is lost annually due to environmental issues, like erosion, flooding, and pollution. In this paper, the newly introduced environmental performance index (EPI) is incorporate into the neoclassical growth model to empirically address the impact of environmental performance on economic growth for the Economic Community of West African States (ECOWAS). Using the novel Method of Moments-Quantile Regression methodology and 2SLS models, the empirical investigation finds a positive relationship between environmental performance and economic growth across quantiles for ECOWAS. Empirical results provide evidence supporting bidirectional relationship running from environmental performance to economic growth; from government size to economic growth; and from trade openness to economic growth across all quantiles. Results show that environmental performance, government size, labour, and capital stock have a positive impact on West African Economic Growth, while trade openness decreases economic growth. We find a 48% optimal threshold of environmental performance index (EPI) on economic Growth for ECOWAS countries. Based on the findings, policies to encourage improved environmental performance above the threshold estimated will go a long way to enhance West African economies.

***Keywords*—** economic growth,environmental performance,ECOWAS,Moment of Method-QR estimator.

Hammed Musibau is with the University of Tasmania, Australia (e-mail:hammed.musibau@utas.edu.au).

Maria Belen Yanotti is with the University of Tasmania, Australia.

Joaquin Vespignani is with the University of Tasmania, Australia.

Rabindra Nepal is with the University of Wollongong, Wollongong, Australia.

Load Balancing Algorithms for SIP Server Clusters in Cloud Computing

Sonali Chawla
Department of Software Engineering
Delhi Technological University
Delhi,India
sonalichawla_phd2k19@dtu.ac.in

Vedika Gupta
Department of Software Engineering
Delhi Technological University
Delhi,India
vedikagupta_2k18se130@dtu.ac.in

Tanmay Raj
Department of Software Engineering
Delhi Technological University
Delhi,India
tanmayraj_2k18se127@dtu.ac.in

***Abstract*— For its groundbreaking and substantial power, cloud computing is today's most popular breakthrough. It is a sort of Internet-based computing that allows users to request and receive numerous services in a cost-effective manner. Virtualization, grid computing, and utility computing are the most widely employed emerging technologies in cloud computing, making it the most powerful. However, cloud computing still has a number of key challenges, such as security, load balancing, and non-critical failure adaption, to name a few. The massive growth of cloud computing will put an undue strain on servers. As a result, network performance will deteriorate. A good load balancing adjustment can make cloud computing more productive and in- crease client fulfilment execution. Load balancing is an important part of cloud computing because it prevents certain nodes from being overwhelmed while others are idle or have little work to perform. Response time, cost, throughput, performance, and resource usage are all parameters that may be improved using load balancing.**

***Index Terms*—Load balancing, response time, cost, throughput, performance, virtual machine**

I. Introduction

Security, effective load balancing, resource scheduling, scaling, management, data centre energy consumption, data lock-in and service availability, and performance monitoring are among issues that cloud computing has encountered. One of the main challenges and concerns in cloud environments is load balancing, which is the process of assigning & re-assigning load among available resources in order to maximise throughput while minimising cost and response time, improving performance and resource utilisation, and reducing energy consumption. Excellent load balancing solutions might give a Service Level Agreement (SLA) and user satisfaction. As a result, offering effective load-balancing techniques and processes is critical for cloud computing systems to succeed. Several studies on load balancing and work scheduling in cloud systems have been conducted.

In a cloud computing context, load balancing is based on the distribution of workloads. It distributes all workload requests from diverse resources over several PCs, frameworks, or servers. The primary aims of load balancing are to: • Maintain framework stability. • To enhance the framework's execution.

II. Load Balancer

A. Load Balancing model in literature

The load balancing approach is seen in Figure 1, where the load balancer accepts user requests and uses load-balancing algorithms to distribute them across the Virtual Machines (VMs). The load balancer selects the VM that will handle the next request. Task management is the responsibility of the data centre controller. The load balancer receives the tasks and uses a load-balancing algorithm to allocate them to the appropriate VM. The VM manager is in control of virtual machines. Virtualization is a cloud computing domain technology. Virtualization's fundamental goal is to allow VMs to share costly hardware. A virtual machine (VM) is a software implementation of a computer that can run operating systems and applications. Users' queries are processed by virtual machines.

Users come from all around the world, and their requests are sent out at random. For processing, requests must be allocated to VMs. As a result, work assignment is a major concern in cloud computing.

B. Load Balancing Metrics

We'll go through the metrics for load balancing in cloud computing in this section. As previously stated, numerous load-balancing techniques have been developed by researchers.

The number of processes performed per unit time is calculated using this statistic.

- Response time: This is the amount of time it takes the system to complete a task.
- Makespan: This measure is used to compute the maximum completion time or the time it takes to provide resources to a user.
- Scalability: An algorithm's ability to execute uniform load balancing in the system according to requirements as the number of nodes increases. The algorithm of choice is extremely scalable.
- Fault tolerance: It evaluates the algorithm's ability to execute load balancing in the case of certain node or connection failures.
- Migration time: The time it takes to move a task from an overburdened node to an under burdened one.

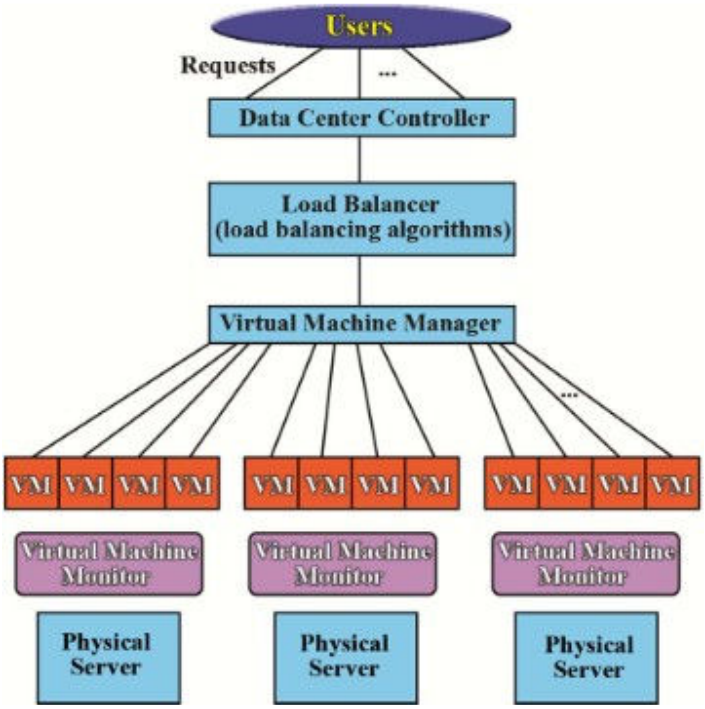

Fig. 1. The model of load balancing

- Degree of imbalance: This parameter determines how evenly VMs are distributed.
- Performance: After a load-balancing algorithm, it assesses the system efficiency.
- Energy consumption: It calculates how much energy each node consumes. By distributing the load across all nodes, load balancing helps to minimise overheating and thereby reduces energy use.
- Carbon emission: It determines how much carbon is produced by all resources. By transferring loads from under loaded nodes and shutting them down, load balancing plays a vital role in lowering this measure.

C. Taxonomy of Load Balancing Algorithms

The existing taxonomy of load-balancing algorithms is presented in this subsection. Load-balancing algorithms have been categorised in certain research based on two factors: the condition of the system and the person who started the process. Static and dynamic algorithms are separated by the state of the system. Round Robin, Min-Min and Max-Min Algorithms, and Opportunistic Load Balancing(OLB) are examples of static algorithms. Ant Colony Optimization (ACO), Honey Bee Foraging, and Throttled are just a few of the dynamic algorithms. Almost every dynamic algorithm has four steps:- Load monitoring: The load and condition of the resources are monitored in this stage.

- Synchronization: The load and state information are exchanged in this stage.
- Rebalancing Criteria: A new work distribution must be calculated, and load-balancing judgments must be made based on this new computation.
- Task Migration: This stage involves the actual data migration. This phase will execute when the system decides to move a task or process.

Static algorithms have the following characteristics:

1) They make decisions based on a set of rules, such as input load.
2) They aren't adaptable.
3) They must be familiar with the system.

Dynamic algorithms have the following characteristics:

1) They make decisions depending on the present state of the system.
2) They are adaptable.
3) They boost the system's performance.

There are two types of dynamic algorithms: distributed and non-distributed. The distributed technique involves all nodes in the system executing the dynamic load-balancing algorithm and sharing the load-balancing burden. Cooperative and non-cooperative interactions exist between the system nodes. In the cooperative form, the nodes work together to achieve a common objective, for example, to decrease the response time of all tasks. In the non-cooperative variant, each node works independently to achieve a local goal, such as reducing a local task's response time.

1) Call-Join-Shortest-Queue: Based on the number of calls (sessions) assigned to the server, the Call-Join-Shortest Queue (CJSQ) method determines the amount of work a server has left to complete. The load balancer keeps track of the number of calls assigned to each server in counters. When a new INVITE request (corresponding to a new call) is received, the request is allocated to the server with the lowest counter, and the server's number is incremented by one. The load balancer knows the server has done processing the request when it receives a 200 OK response to the BYE corresponding to the call and decrements the counter for the server. The amount of calls assigned to a server is not necessarily an appropriate indicator of the demand on a server, which is a shortcoming of this technique. Between transactions in a call, there may be significant periods of inactivity. Furthermore, various calls may include varying numbers of transactions and use varying amounts of server resources. CJSQ has the benefit of being able to be utilised in situations where the load balancer knows about the calls assigned to servers but does not have an accurate estimate of the transactions assigned to servers.

2) Transaction-Join-Shortest-Queue: Another option is to predict server load using the number of transactions assigned to each server. Based on the number of transactions assigned to the server, the Transaction-Join-Shortest-Queue (TJSQ) method determines the amount of work a server has left to accomplish. The load balancer keeps track of the number of transactions allotted to each server in counters. The servers with the lowest counter are given new calls. The fact that

all transactions are weighted equally is a drawback of this strategy. INVITE requests cost more than BYE requests in the SIP protocol because the INVITE transaction state machine is more sophisticated than the one for non-INVITE transactions (such as BYE). This difference in processing cost should ideally be taken into account in making load balancing decisions.

3) Transaction-Least-Work-Left: This problem is addressed by the Transaction-LeastWork-Left (TLWL) algorithm, which assigns various weights to distinct transactions based on their respective costs. In the exceptional scenario where all transactions have the same estimated overhead, TLWL and TJSQ are the same. The load balancer keeps track of counters that show the weighted quantity of transactions assigned to each server. The server with the lowest counter is assigned new calls. A ratio is defined as the cost difference between INVITE and BYE transactions. Different weights depending on the overheads of the transaction types can be used to adjust TLWL to workloads with various transaction kinds.

We discovered that the load balancer's efficiency is influenced by the hash function used. The hash function that is employed by the distribution of call IDs by OpenSER was not very good. spanning bowls of hash Given a sample of 300,000 phone calls, The hash algorithm in OpenSER distributes the calls to around 88,000 people. different buckets As a result, there were a lot of buckets. contains a number of call ID data; looking through these buckets increases overhead We tried a few different hash algorithms. FNV hash was proven to be the best function. As a result, FNV Hash mapped these calls to the same 300,000 calls in the same test. There are around 228,000 unique buckets. The typical length of a search was consequently lowered by approximately a factor of three.

4) Transaction-Least-work-left-Modified : The novelty of this modified algorithm is FNV-Hash has been replaced with SipHash to resist hash flooding Denial-Of-Service Attacks.SipHash uses a variable-length message and a 128-bit secret key to generate a 64-bit message authentication code. It was built to be efficient even for short inputs, with performance equivalent to non-cryptographic hash functions like CityHash. It may be used to protect hash tables against denial-of-service attacks ("hash flooding") or to authenticate network packets. Later on, a version was developed that yields a 128-bit result.

Only the complete output of an unkeyed hash algorithm like SHA is collision-resistant. No technique can prevent collisions when used to create a tiny output, such as an index into a hash table of realistic size; an attacker simply has to make as many attempts as there are viable outputs.

D. Concept of Load Balancing

In a cloud computing context, load balancing is based on the distribution of workloads. It distributes all workload requests from diverse resources over several PCs, frameworks, or servers. The primary aims of load balancing are to maintain framework stability and improve framework execution.

E. Load Balancing Architecture

The four principles of load balancing described in the diagram are the client, data centre controller, load balancer, and the computation to be used. The following stages are used by the customer to complete a solicitation.

1) The data centre controller receives every request from the client.
2) The data centre controller queues up all incoming solicitations and asks the central load balancer for solicitation assignment.
3) The central load balancer has a database with tables that are parsed after the calculation to be utilised determines the most appropriate virtual machine and returns the ID to the data centre controller.
4) Finally, the data centre controller distributes the request to the VM whose ID is provided by the central load balancer.

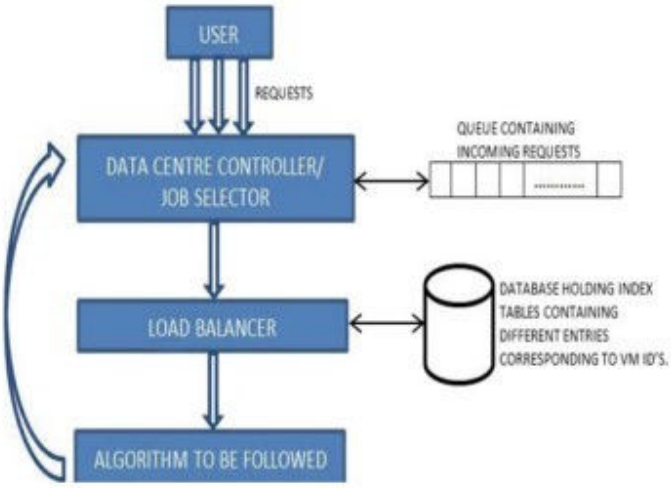

Fig. 2. Load Balancing Architecture

F. Challenges of Load Balancing in Cloud Computing

Cloud computing confronts several obstacles, with load balancing being one of the most pressing issues that need immediate attention. This covers challenges such as migration and virtual machine security; user QoS comfort and resource consumption are given equal consideration in the search for a better solution to optimise cloud resource utilisation. A list of significant LB concerns is provided below.

1) Geographically Dispersed Nodes: Cloud data centres are often dispersed throughout the globe for computing. These centres employ a centralized network of dynamically dispersed nodes to process consumer requests efficiently. Several systems with limited reach are known in the literature, and constraints such as network latency, communication delay, range among distributed computing nodes, client space, and resources are not taken into account. Because some methods are incompatible with this environment, nodes in very remote places provide a challenge.

2) Single Point of Failure: In the literature, certain LB algorithms have been presented where decision-making is not dispersed over numerous nodes and LB choices are determined by a single node. The complete computing system will be impacted if the essential devices fail.
3) VM Migration: Virtualization allows numerous virtual machines to be built on a single physical device. Those virtual machines have distinct configurations and are architecturally autonomous. If a physical device is overloaded, it is suitable to move all virtual machines to a distant location using the LB approach. Nodes In the first investigation, the authors recommended homogeneous nodes for cloud load balancing. Consumers of CC require a dynamic switch that runs on diverse nodes for an efficient network and lowers response time.
4) Heterogeneity of Nodes: In the initial investigation, the authors proposed homogeneous nodes for cloud load balancing. For an efficient network and reduced response time, CC consumers require a dynamic switch, which requires execution on heterogeneous nodes.
5) Data Handling: CC addressed the issue of outdated conventional storage devices that required a lot of resources and equipment. Consumers may store data in different ways on the cloud without losing control. Storage requirements are growing all the time, necessitating duplication of stored data for effective accessibility and data continuity.
6) LB Scalability: Accessibility and on-demand scalability cloud services let people to quickly downscale or scale up resources at any moment. A good load balancing should take into account quickly changing computing circumstances, memory, device architecture, and so on.
7) Algorithm Complexity: CC algorithms should be rapid and easy to implement. A robust algorithm's goal is to improve cloud system efficiency and quality.
8) Automated Service Provisioning: One of the most appealing aspects of cloud computing is its flexibility; resources may be delegated or deployed automatically. So, how do we utilise or discharge cloud services while retaining the same productivity as traditional systems and maximising resource use.
9) Energy Management: The advantages of energy management, which promotes cloud adoption, include scale economies. The most important thing that allows for a global economy where limited companies help the pool of global capital rather than each providing their own private services is power conservation.

G. Machine Learning for Load Balancer

Simulated Annealing, Tabu Search, Particle Swarm Optimization, Fish Swarm Optimization Algorithm, Cat Swarm Optimization Algorithm, and Cuckoo Search Algorithm are some of the ML scheduling techniques presented in this study work.

1) Simulated Annealing: Simulated annealing is inspired by annealing in solids, where annealing in solids such as metal or glass entails heating and gradually cooling to remove and tighten internal tensions. This approach is often locked with local limitations, undesired allotments are learned, and the algorithm is also dependent on request availability and bin volume. The approach works effectively at high temperatures.
2) Tabu Search: The tabu search algorithm is a global optimization approach that has a higher grade optimization capacity and is targeted at emulating human intelligence. It has been used to solve resource allocation and other challenges with optimising and is designed to direct other ways to avoid the regional optimality trap.
3) Partical Swarm Optimization: Is highly sophisticated bionic heuristic, smart optimization algorithms that copy the swarm-based behavior of animals. The PSO algorithm is not efficient in solving differential restriction issues. The merits of simultaneous allocation, extensibility, simple to recognize, powerful resiliency, with excellent characteristics in dynamic environments, PSO efficiently overcomes numerous issues related to pairing optimization.
4) Fish Swarm Optimization: Is influenced by population-based meta-heuristic smart optimization algorithm combinational issues from fish swarm behaviors to solving. This method adheres to the behavior of groups of fish swarm intelligence where the community finds a global level for the food to reach the upper concentrated areas.
5) Cat Swarm Optimization: A smart heuristic scheduling algorithm depending on cats' social behavior corresponds to the swarm intelligence family is cat swarm optimization. The result found improves the total amount of energy consumed. It also offers an optimized resource scheduling function which minimizes the scheduling costs. By decreasing the size of instances it is an enhancement over PSO.
6) Cuckoo Search: The cuckoo search technique is a meta-heuristic algorithm that models naturally occurring cuckoo genus behavior. This method provides the best remedy and efficiently balances regional and global investigation with the assistance of variable swapping. The values achieved are higher than the optimization of particle swarm.

H. Policies in dynamic load-balancing algorithms

Dynamic load-balancing techniques, as previously said, rely on the present state of the system. They use policies to do this. These are the policies:

- Transfer Policy : The criteria under which a task should be moved from one node to another are determined by the Transfer Policy. Incoming tasks are routed through the transfer policy, which decides whether the job should be transferred or processed locally depending on a set of rules. This rule is dependent on the workload of each node. Task rescheduling and task relocation are included in this policy.

- The selection policy decides which tasks should be delegated. It takes into account a variety of parameters when choosing a job, including the amount of overhead required for migration, the number of non-local system calls, and the work's execution time.
- Location Policy : The Location Policy detects which nodes are under-utilized and assigns tasks to them. It verifies whether the targeted node has the required services for task transfer or rescheduling.
- Information Policy: This policy collects all information about the nodes in the system, which is then used by the other policies to make decisions. It also specifies when the information should be collected. The following are the connections between several policies. The transfer policy intercepts incoming tasks and determines whether they should be sent to a distant node for load balancing. If the work cannot be sent, it will be completed locally. If a remote partner is not found, the task will be processed locally, otherwise, the task will be transferred to the remote node. The information policy offers the required information for both transfer and location rules, allowing the min to make informed decisions.

I. Cloud-based load balancing challenges

According to a review of the literature, load balancing in cloud computing has experienced certain difficulties. Despite the fact that load balancing has been extensively researched, the current scenario is far from optimal, based on load balancing criteria. We'll go over the issues of load balancing in this part, with the goal of building standard load balancing techniques in the future. Challenges for cloud-based load balancing have been noted in certain research.

a) Migration of virtual machines (time and security): The service-on-demand aspect of cloud computing requires that resources should be made available when a service request is made. Resources (often virtual machines) should occasionally be moved from one physical server to another, possibly in a different location. In such instances, load-balancing algorithm designers must consider two factors: migration time, which impacts performance, and attack likelihood (security issue).

b) Spatially distributed nodes in a cloud: Cloud computing nodes are geographically dispersed. The problem in this scenario is that load balancing algorithms should be devised to take into account network bandwidth, communication rates, distances between nodes, and distance between the client and resources.

c) Single point of failure: Some load-balancing techniques are centralised, as indicated in Section 2. If the node running the algorithm (controller) fails in such a circumstance, the entire system would crash due to that single point of failure. The task at hand is to create decentralised or distributed algorithms.

d) Complexity of the load-balancing algorithms: The load-balancing algorithms should be easy to construct and operate. The performance of complex algorithms suffers as a result.

e) Emergence of small data centers in cloud computing: Small data centres are becoming more common in cloud computing since they are less expensive and use less energy than large data centres. As a result, computer resources are spread around the globe. The task at hand is to create load-balancing algorithms that provide sufficient response times.

III. RESULTS

a) Response Time: The reaction times of the various load balancing methods show substantial variances. The servers' CPU processing power, not memory, is what limits performance. For the INVITE transaction, Figure 3 displays the average response time for each algorithm vs the provided load. It's worth noting that the Y axis is on a logarithmic scale. The load balancer distributes requests over 8 back-end SIP server nodes in this experiment. Transaction-Least-Work-Left is used in two ways. INVITE transactions have 1.75 times the weight of BYE transactions on the TLWL-1.75 curve. The weight is 2:1 in the curve labelled TLWL-2. The Hash curve employs the conventional OpenSER hash function, whereas the FNVHash curve employs FNVHash. On the graph, round-robin is symbolised by the letter RR.

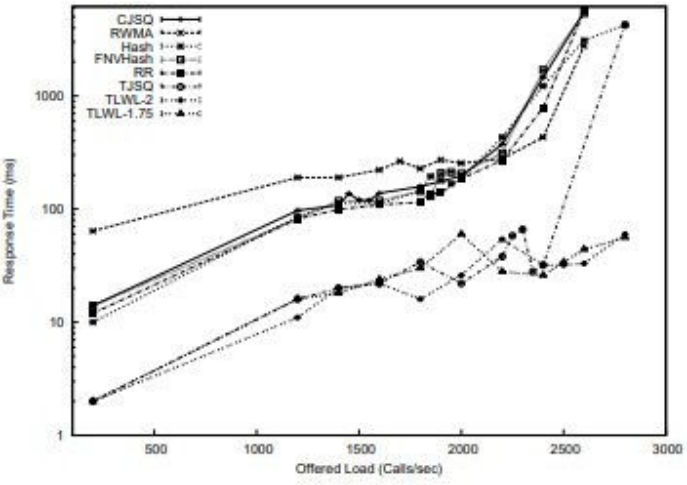

Fig. 3. Average Response Time for INVITE

The performance advantage of the first group of algorithms grows to two orders of magnitude as the system approaches peak throughput. Figure 4, which displays average response time for each algorithm vs. offered load for BYE transactions, again utilising eight back-end SIP server nodes, reveals similar tendencies. Because BYE transactions use fewer resources than INVITE transactions, the average response time is shorter. The abrupt increases in reaction times for the last data points in several of the curves in Figures 3 and 4 indicate that the system is approaching overload. Because of experimental error, the curves do not always grow monotonically with increasing load.

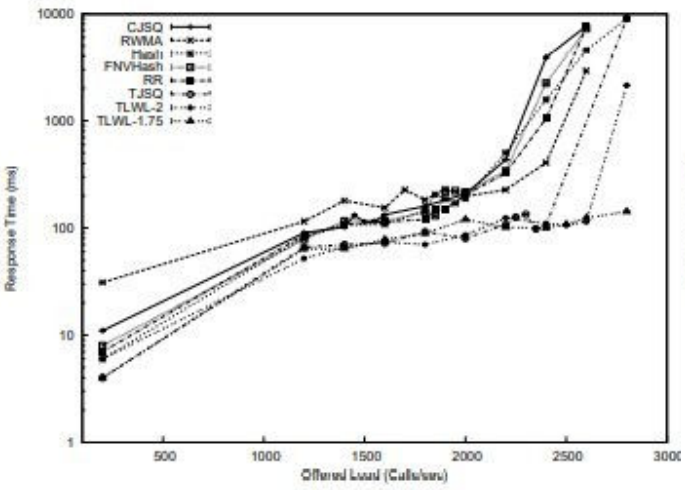

Fig. 4. Average Response Time for BYE

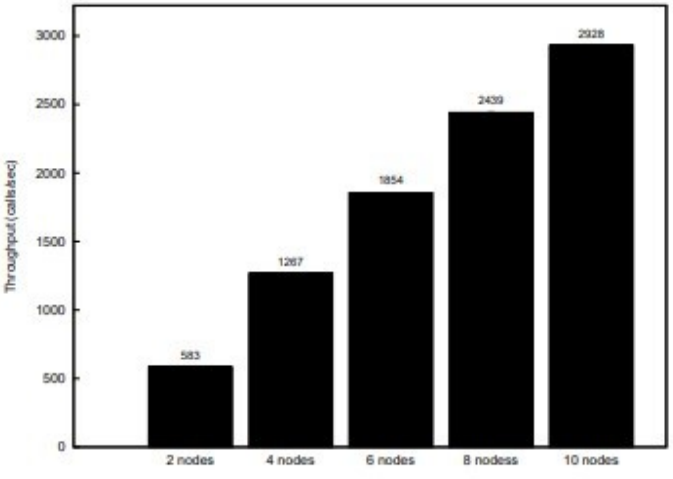

Fig. 6. Peak throughput vs. # of nodes $TLWL-1.75$

b) Throughput: We'll now look at how effectively our load balancing algorithms scale throughput as the number of back-end servers grows. In an ideal scenario, eight nodes would give eight times the performance of a single node. Remember that the peak throughput for a back-end SIP server node is roughly 300 cps, which is the highest throughput that can be sustained while successfully serving more than 99.99 percent of all queries. As a result of linear scaling, the highest potential throughput for 8 nodes is around 2400 cps. Using eight back-end nodes, Figure 5 depicts the peak throughput for the various methods. This graph shows a number of fascinating outcomes. TLWL-1.75 achieves linear scalability and results

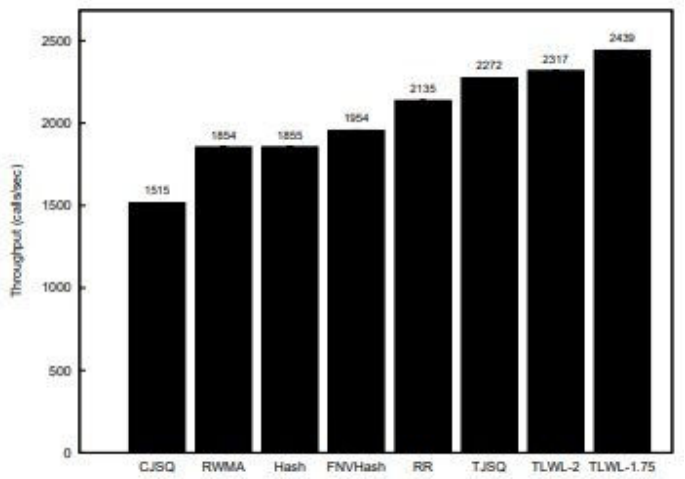

Fig. 5. Peak Throughput of Various Algorithms with 8 SIP Servers

in the highest peak throughput of 2439 cps. TLWL-2 comes close to TLWL-1.75, but TLWL-1.75 does better due to its better estimate of the cost ratio between INVITE and BYE transactions. The same three algorithms resulted in the best response times and peak throughput

c) Heterogeneous Back End: It is unrealistic to expect all nodes in a cluster to have the same server capacity in many deployments. Some servers may be more powerful than others, or they may have background operations happening that limit the CPU resources available for SIP. We examine how our load balancing algorithms function when the back end servers have varying capacities in this part. The load balancer is sending requests to two separate nodes in these tests. Another process is running on one of the nodes, which is using around half of its CPU capacity. The other node is solely responsible for SIP requests.

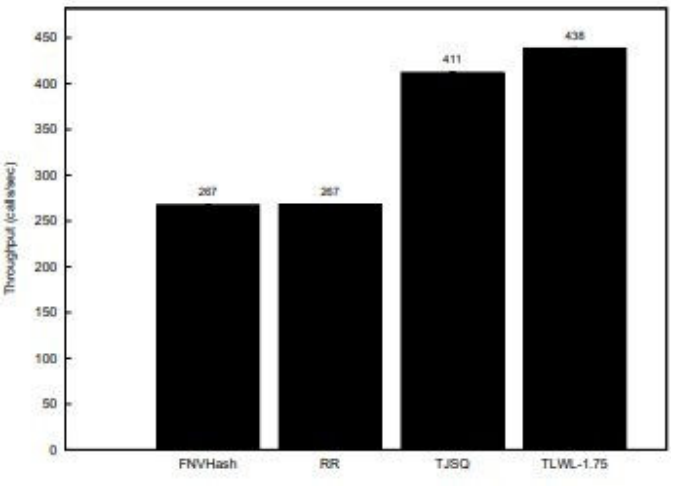

Fig. 7. Peak Throughput Heterogeneous Back-ends

IV. Conclusion and Future Works

We have modified an existing algorithm i.e. Transaction-Least-Work-Left-Modified. In this we have changed the hashing algorithm from FNV Hash to SIP Hash which is more secure. One of the most significant difficulties that cloud

systems face today is workload balancing among cloud nodes. We reviewed the academic literature in the domain of load balancing, which is a critical feature of cloud computing. Several metrics for load balancing strategies were discovered in the literature and should be used in future load balancing systems.

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Attitude Towards Carnivore-Livestock Conflict and It's Effect on Households Willingness to Pay for Organic Meat: A Contingent Valuation Approach

Abinet Tilahun Aweke

***Abstract*—** In Europe, there is a growing interest in food produced ethically and with a broader benefit for society. Consumers could consider numerous extrinsic and intrinsic quality attributes, including organically produced, when selecting meat to purchase. Many studies recorded various reasons why consumers may choose to pay the premium price for organic foods, although willingness to pay (WTP) for organic meat and motives behind the WTPs differ depending on the meat type/cut and place. Employing state of the art stated preference (SP) method, this study seeks to find out how environmental attitudes and health concerns shape the demand for organic agriculture in Norway. More specifically, this paper contributes to the existing knowledge on consumer preferences by exploring if consumer's attitude towards carnivore-sheep conflict affects the willingness to pay (WTP) for organic meat. This study will also have a methodological contribution by investigating whether having environmental attitude and carnivore-livestock conflict questions prior to the organic meat WTP question will significantly affect the will to pay and the amount paid. Understanding the effect of the content of the auxiliary questions posed before WTP questions will help to improve future CV survey designs and hence the validity of the results obtained.

***Keywords*—** attitude, consumer reference, contingent valuation, meat, organic, stated preference, survey design.

Abinet Tilahun Aweke is with the Norwegian University of Science and Technology, Norway (e-mail: abinet.t.aweke@ntnu.no).

Communities and Local Food Systems in the Post Pandemic world: lessons for Kerala

S. Hasnah, N. Radhakrishnan

***Abstract*—**Communities play a vital role in mobilizing people and resources for the benefit of all. Since time immemorial, communities have been spear heading different activities ranging from disaster management, palliative care, local economic development and many more with laudable success. Urban agriculture is one such activity where communities can prove to make a real difference. Farming activities in cities across different developed countries have proved to have favorable outcomes in the form of increased food security, neighborhood revitalization, health benefits and local economic growth. However, urban agriculture in the developing nations have never been prioritized as an important planning tool to cater to the basic needs of the public. Urban agricultural practices are being carried out in a fragmented fashion without a formal backing. The urban dwellers rely heavily on their far-off rural counterparts for daily food requirements. With the onset of the pandemic and the recurring lockdowns, the significance of geographic proximity and its impact on the availability of food to the public are gradually being realized around the globe. This warrants a need for localized food systems by shortening the distance between production and consumption of food. The significance of communities in realizing these urban farming benefits is explored in this paper. A case-study approach is adopted to understand how different communities have overcome barriers to urban farming in cities. The applicability of these practices is validated against the state of Kerala in India wherein different community centered approaches have been successful in the past. The existing barriers are assessed and way forward to achieve a self-sufficient localized food systems is formulated with the key lessons from the case studies. These recommendations will be helpful to successfully establish and sustain farming activities in urban areas by leveraging the power of communities.

***Keywords*—**Community-centric, COVID-19, Drivers and barriers, Local food system, Urban agriculture

S. Hasnah is a Research Scholar in the Department of Architecture and Planning, Indian Institute of Technology, Kharagpur, 721302, India (e-mail: salimah.hasnah@kgpian.iitkgp.ac.in).

N. Radhakrishnan is a Faculty in the Department of Architecture and Planning, National Institute of Technology Calicut, 673601, India (email: namratharadhakrishnan@gmail.com)

Soil Salinity mapping using Electromagnetic Induction Measurements

Fethi Bouksila[1], Nessrine Zemni[1,2], Fairouz Slama[2], Magnus Persson[3], Ronny Berndtsson[3,4], Akissa Bahri[5]

***Abstract*—**Electromagnetic sensor EM 38 was used to predict and map soil salinity (ECe) in arid oasis. Despite the high spatial variation of soil moisture and shallow watertable, significant ECe-EM relationships were developed. The low drainage network efficiency is the main factor of soil salinization

***Keywords*—** Soil salinity map, Electromagnetic induction, EM38, oasis, shallow watertable.

F.B. Author is with University of Carthage, National Institute for Research in Rural Engineering, Water and Forestry (INRGREF), LR20INRGREF04 Laboratory of Rural Engineering, , BP 10, Ariana, 2080, Tunisia (e-mail: bouksila.fethi@iresa.agrinet.tn).

N.Z. Author is with University of Carthage, National Institute for Research in Rural Engineering, Water and Forestry (INRGREF), LR20INRGREF04 Laboratory of Rural Engineering, BP 10, Ariana, 2080, Tunisia and with University of Tunis El Manar, National Engineering School of Tunis (ENIT),2LR99ES19 Laboratory of Modelling in Hydraulics and Environment (LMHE), BP 37, Tunis, 1002, Tunisia (e-mail: nessrine.zemni@enit.utm.tn).

F.S. Author is with University of Tunis El Manar, National Engineering School of Tunis (ENIT),2LR99ES19 Laboratory of Modelling in Hydraulics and Environment (LMHE), BP 37, Tunis, 1002, Tunisia (e-mail: fairouz.slama@enit.utm.tn).

M.P. Author is with Department of Water Resources Engineering, Lund University, Box 118, SE-221 00 Lund, Sweden (e-mail: magnus.persson@tvrl.lth.se)

R.B. Author is with Department of Water Resources Engineering, Lund University, Box 118, SE-221 00 Lund, Sweden and with Centre for Middle Eastern Studies, Lund University, Box 201, SE-221 00 Lund, Sweden (e-mail: ronny.berndtsson@tvrl.lth.se).

A.B. Author was with National Agronomic Institute of Tunisia (INAT), 43 Avenue Charles Nicolle, 1082 Tunis, Tunisia (e-mail: akica.bahri@gmail.com)

Sensory Analysis of the Conversion Process from Pisco to Brandy in the South of Peru

Juan José Milón Guzmán, Enit Sofía Zúñiga Díaz

***Abstract*—**A sensory study of artisanal brandy made in Arequipa has been developed. The analyzed liquor has been produced employing ancestral techniques used in the Majes Valley since 1775. In organoleptic terms, three characteristics were evaluated: smell, visual aspect and taste, considering as a baseline the organoleptic characteristics of pisco and its transformation after its storage in wood barrels to become brandy. Three varieties of grape were used for the experimental study: "Negra Criolla", "Mollar" and "Italia". The results indicate that wood-based aging transforms pisco into brandy with very different organoleptic structure from the original product, creating added value reflected in sensory qualities that define it as "made in Arequipa" yesteryear's brandy.

***Keywords*—**Pisco, wood, brandy, Arequipa, Peru.

I. Introduction

BRANDY is a hard liquor obtained from the distillation of wine that rests in wood [1], [2]. Traditionally, resting occurs in oak barrels during a period of time [3]-[5]; even though some recent techniques consider accelerated aging [2], [6] for the obtention of liquor with similar properties than the one that aged in barrels. In southern Peru, brandy is obtained by making mature pisco rest in oak barrels. Historically, wine has been produced and commercialized in Peru since the 16th century, and wine hard liquors from the beginning of the 17th century [7], [8]. At the end of the 17th century and the beginning of the 18th century, the Vítor, Majes, and Siguas valleys (Arequipa) became part of the most important wine and spirits producers in the entire Peruvian viceroyalty. The COMMERCIALIZATION ROUTE, WHICH BEGAN IN THE SOUTHERN COAST valleys and ended in Cusco, was called the "Route of the Viñateros" and later it was known as the "Route of the Majeños", due to the origins of the merchants (Majes valley in Arequipa). The route went from Majes to Caylloma, from where the muleteers continued to the city of Cusco. Then, this route arrived to the connection point with the "Camino Real" that kept on through the highlands to Potosí (currently Bolivia) [9]. According to local stories, transmitted among wine producing families (unreferenced information), to lighten the transportation load of pisco from Majes to Andean regions, the clay containers were changed for wooden containers, originating brandy "Arequipeño" (made in Arequipa), in a fortuitous way. This product was so successful that pisco started to be stored in oak barrels at a higher scale to obtain brandy and commercialize it as such.

Nowadays, one of the most emblematic and ancient wine and spirits production companies in Arequipa, in those valleys produces Brandy obtained through the aging of mature pisco in oak barrels. Pisco is made from the distillation of previously fermented grape musts, and brings to brandy complex aromas and flavors typical of the grape, which are highly appreciated among spirits

[10]-[13]. The aging of pisco in wood barrels adds new organoleptic characteristics that exclude it from the Pisco denomination origin. The exogenous contribution of the wood is provided through old artisanal techniques preserved from generation to generation, which give very particular characteristics to brandy "Arequipeño" [14]. Different brandy producers are found on the pisco Route, which is a tour around different vineyards and wineries in Peru during which the production process of different wine-related products can be observed. In Arequipa, the Pisco Route begins in La Joya, passes by Vitor, Santa Rita de Siguas, Majes, Uraca, Corire, Huancarqui, Camaná and ends in Caravelí [15], [16]. Since brandy "Arequipeño", is obtained from a noble fruit (grape) resting in wood, it has complex organoleptic properties (color, aroma and flavor) that distinguish it from other spirits [11] [13] [17]. Unfortunately, in Peru, in the last decades, regional grape spirits have been displaced by other foreign spirits, such as rum, tequila, whiskey, among others, causing many companies to close their wineries or change the agricultural production of their vineyards [18] [16]. There are several methods to add value to wine products: addressing environmental issues [19], promoting tourism [9] and historical-cultural diffusion [18] [9] [10]; however, the most important lever is government support, to ensure the protection and control of the denomination of origin.

This article seeks to share the knowledge and strengthen the culture of brandy «Arequipeño» made with artisanal and ancestral techniques inherited from generation to generation, unveiling its particular manufacturing process and the organoleptic characteristics that define it as such.

1.1. Brandy "Arequipeño" production process

Brandy is a type of spirit obtained by distilling wine [20]. The production of brandy in Arequipa is described in Fig. 1. The first stage begins with the harvest, the grapes are harvested by hand, and placed in 21-liter containers, the mass depends on the arrangement of the bunches. In the winery, the product is selected, weighed

and cleaned. In the second stage, the branches and leaves are removed (destemming) and then the fruit is broken in the

Juan José Milón Guzmán is with Universidad Tecnológica del Perú, Peru (corresponding author, e-mail: jmilon@utp.edu.p).

Enit Sofía Zúñiga Díaz is with Esneca Business School (e-mail: enitsofiazd@gmail.com).

controlled pressure press. In this process, it is important not to destroy the seed. In the third stage, the mixture of the juice with the skin and the seeds goes through the first fermentation at a controlled temperature. The time depends on the variety of grape. In the fourth stage, the product goes through the pressing and filtering process, separating the liquid (must) from the first fermentation from the solids or pomace (which is discarded). In the fifth stage, the must passes to the second fermentation in a closed tank where, after some time, the fermented "mosto yema" or free-run is separated for the distillation process. The sixth stage is called distillation, which is carried out in copper stills heated with firewood. During this process, the evaporation temperature is controlled by the addition of firewood. It is at this stage that the elaborated product is called grape brandy or pisco [21].

In the seventh stage, pisco is assembled, the alcoholic degree is regulated, mainly, and then is left to rest and mature. In the eighth final stage, pisco is aged in wood for its maturation, transformation into brandy, and finally, it is bottled and labeled. No sweeteners or caramel are added to this brandy.

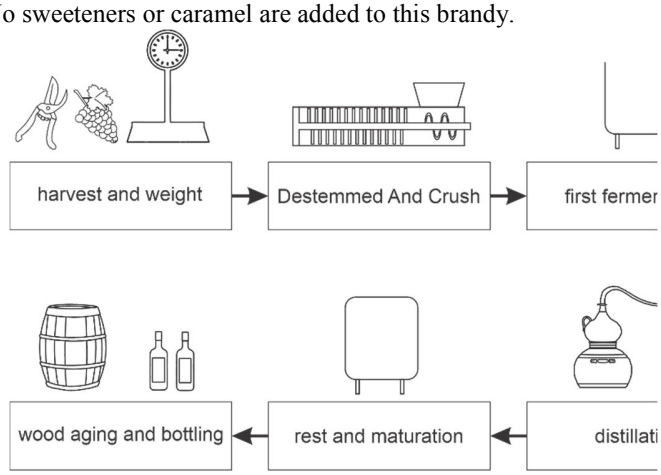


Fig. 1. Production process of brandy “Arequipeño”.

2. Materials and Methods

For the organoleptic structuring of brandy “Arequipeño”, traditional sensory characterization methods [17] [22] and some new techniques that provide important information to the evaluation panel, called “dynamic sensory stimulation” [14], will be followed. For the brandy “Arequipeño” production process, three types

of grapes will be used: “Negra Criolla”, “Italia” and “Mollar”. The pisco will be aged in French oak barrels with strong toasting.

2.1. Sensory analysis

The aroma and flavor wheel [1] [22], [23] is used with positive and negative descriptors. Reference standards based on natural extracts, essential oils and natural scents are considered. The compounds were elaborated based on the most common descriptors [5], [6] [17] [22] present in brandy “Arequipeño”.

The evaluation panel was a group of 13 judges (7 men and 6 women), previously selected and trained [24]. The judge selection process was carried out based on the aromatic and taste sensitivity in reference standards, establishing the maximum scale for the descriptor. For the present work, the scale went from 1 to 5.

The sensory analysis process was carried out in a comfortable environment, free from external influences (mainly aromas and noise) with appropriate lighting on an opaque white background. For pisco, the AFNOR glass was used, for brandy, the Snifter or balloon glass, both clean and sterilized.

The tasting began with the visual aspect, with the evaluators observing the clarity, brilliance, and color intensity. The olfactory evaluation followed, starting by the “first nose”, which is something more superficial, that is, the first impressions of the aroma. Then, the “deep nose”, where the evaluators approached the glass, almost introducing the nose in it, capturing other aromas. For the taste assessment, a sip is taken so that the liquid covers the entire tongue and eventually touches the palate, and air is softly inhaled with the mouth slightly opened. Finally, for the aftertaste, after having drunk the liquid, air is breathed through the mouth and exhaled through the nose.

2.1. Dynamic Sensory Stimulation

Dynamic Sensory Stimulation is a new technique, implemented in an experimental interactive room for pisco tasting in Arequipa, Peru [14]. The technique stimulates smell through controlled nebulization (liquid

fractioning into very small particles by ultrasound). Nebulization disintegrates the aromas allowing a different and "broader" sensory appreciation that could provide important information in the process of organoleptic structuring of brandy. For the dynamic sensory stimulation, 0.4 dm^3 of brandy were placed in a nebulizer (Elgin, model UNZN02N0NA, 18 W). For nebulization, which is carried out in a safe, closed and noiseless environment. the evaluator's head must be at the height of the nebulized brandy outlet (Fig. 2). The process ends when the brandy sample is consumed, then an extraction system renews the air within the environment.

Fig. 2. Sensory analysis through nebulization.

3. Results and Discussion

The results of the visual, olfactory and taste assessment are described. The pisco used for Brandy production (made in Arequipa, Peru) was considered the baseline for the evaluation of the organoleptic evolution. The aroma and flavor wheels shown below represent the average of all the evaluations submitted by the panel of evaluators. The tasting notes were prepared jointly by the four judges who obtained the best scores

during selection (expert judges) [24]. Finally, the results obtained using the dynamic sensory stimulation technique are presented [14].

3.1. Visual analysis

Pisco's visual aspect is clear, limpid, bright, colorless, regardless of the grape used to produce it. Brandy (from "Italia", "Negra Criolla" or "Mollar" grapes) has a limpid and bright appearance and its color is old gold with bronze shades.

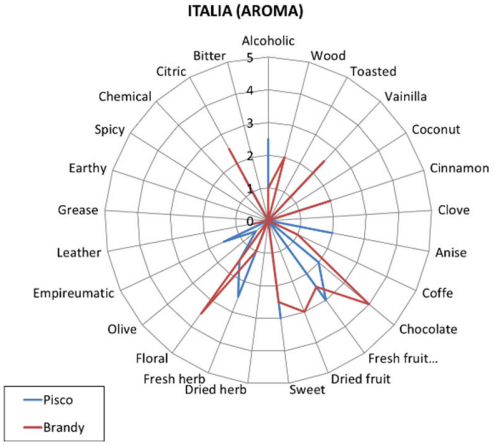
3.2. Taste and olfactory analysis

3.2.1. «Italia» grape

For pisco "Italia", during the "first nose" (Fig. 3a), making abstraction of the alcohol, it is possible to feel the aroma of the "Italia" grape variety, fresh fruits, and sweet elements. During the "deep nose", while moving the glass, the sample reveals other hidden aromas such as fresh herbs, anise, chocolate and toasted elements. In the mouth (Fig. 3b), after the first small sip, which serves to prepare the mouth, it is possible to feel a warm alcohol, toasted. During the second sip, fresh herbaceous and sweet flavors can be felt. The aftertaste delivers a smooth pisco, in which raisins, toasted and sweet elements can be felt.

Brandy from "Italia" grapes, on the nose (Fig. 3a), provides in the first impression pronounced aromas of wood, vanilla, chocolate and flowers. In a second layer of aromas, we find fresh fruit, cinnamon, caramel and citrus aromas. In the mouth (Fig. 3b), the wood explodes on the palate, as well as the chocolate, coffee and sweet flavors. Vanilla, herbal and floral aromas with citrus notes also appear. In the aftertaste, toasted almonds, vanilla and flowers are present.

After the analysis of the transformation of pisco "Italia" to brandy, we can comment that the "Italia" grape variety yields a pisco with a silky and aromatic base. The aging in the barrel has expressed all its complexity very well in powerful vanilla and chocolate from the nose to the palate, with a long aftertaste where almonds, flowers and citrus appear.



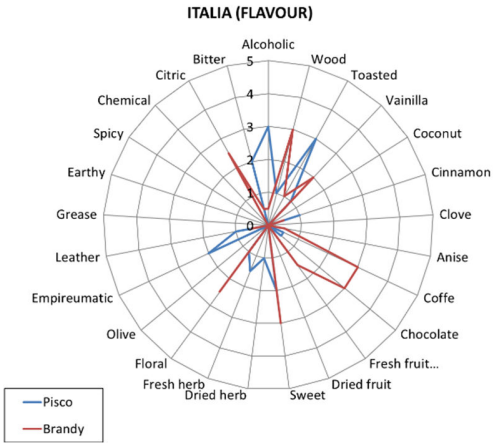


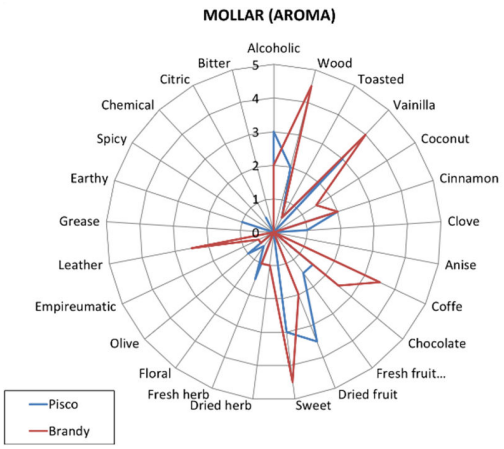
Fig. 3. Aroma (a) and flavor wheel (b) for pisco and brandy made from "Italia" grape.

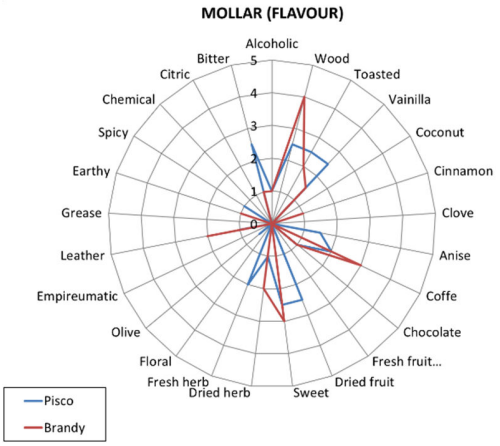
3.2.2. «Mollar» grape

For pisco from "Mollar" grape, on the nose (Fig. 4a), and making abstraction of alcohol, dried fruits, vanilla with a pronounced alcohol and sweet notes can be appreciated. The deep nose reveals earthy aromas and dry herbs, a very well balanced pisco. On the palate (Fig. 4b), it is unctuous and fine. Toasted wood, vanilla, nuts, sweet notes, aromas of coffee and dried fruits stand out. In the aftertaste, the alcohol is still present but it is not aggressive and the aromas of dried and toasted fruits are prominent.

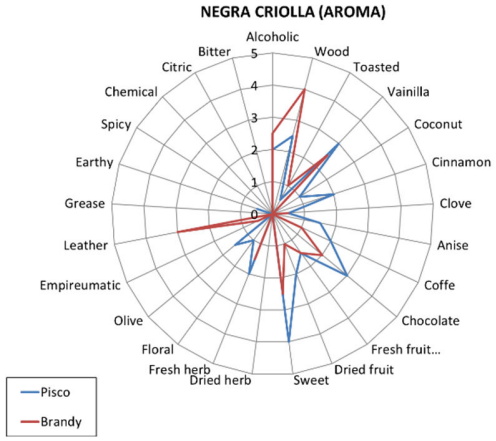
Brandy made with a "Mollar" pisco base) (Fig. 4a) is complex on the nose. Noble wood, vanilla, cinnamon, chocolate, notes of coffee, sweet elements and a leathery background are perceived. On the palate (Fig. 4b), a small sip leaves behind wood, coffee, sweet elements, complex and velvety elements, and a vanilla and leather background. The aftertaste provides a sweet note, vanilla and chocolate flavors.

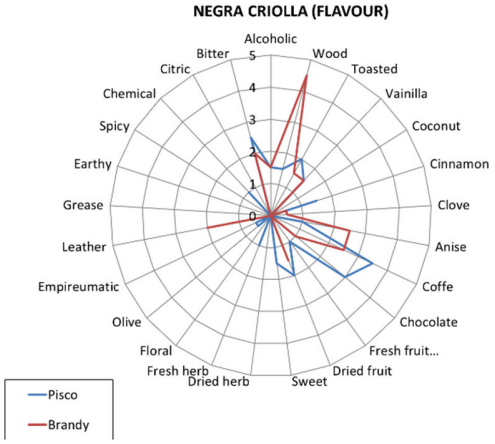
An analysis of the transformation of "Mollar" pisco to brandy, shows that in the "Mollar" variety, the pisco delivers a strong alcohol hit. Aging in the barrel, it evolves and provides a much smoother and more polished flavor. In the mouth, the pisco used as the base was already very well structured, and the transformation process has rendered it silky, highlighting the flavors provided by the wood and an additional sweetness.





(a)





(a)

(b)

Fig. 4. Aroma (a) and flavor (b) for pisco and brandy made from ”Mollar” grape.

3.2.3. «Negra Criolla» grape

On the nose, the “Negra Criolla” pisco (Fig. 5a) expresses the typical aromas of the “Negra Criolla” grape with a sophisticated structure, chocolate, cinnamon, vanilla, sweet and woody elements. On the palate (Fig. 5b), it expresses chocolate, coffee flavors, with a background of coffee, sweet elements and cinnamon, earthy and slightly bitter. The aftertaste delivers slightly spicy alcohol, chocolate, earthy flavors and hints of honey.

On the nose, brandy made with a base of “Negra Criolla” pisco, (Fig. 5a) is powerful, with wood, leather, vanilla and sweet elements, and notes of chocolate and fresh herbs, toast and cloves in the background. On the palate (Fig. 5b) it is very balanced, the wood and leather are enhanced, and coffee, anise, chocolate, dried fruit and vanilla stand out. The first nuances display tobacco, wood, vanilla, brown leather, and the second aromatic layer reveals cinnamon, cloves, chocolate, and a vanilla

background. In the aftertaste, the aromas of chocolate and vanilla are more present and rounder alcohol is perceived.

An analysis of the transformation of ”Negra Criolla» pisco to brandy shows that the aromas that we already found in pisco and those of the variety are enhanced. Now, the contribution of wood stands out, it is marked and it highlights the chocolate, vanilla, and toffee, which are notes that capture the senses. The spiciness of the alcohol perceived in the pisco is now soft and velvety.

Fig. 5. Aroma (a) and flavor (b) wheels for pisco and brandy made with ”Negra Criolla” grape.

3.3. Analysis with Dynamic Sensory Stimulation

Brandy made from ”Negra Criolla” grape was

nebulized for this experience. The tasting notes shown below are a consensus of the four expert judges who participated in the process individually. Initially, aromas of chocolate, vanilla toffee, sweet elements, and black treacle are perceived, very similar to the tasting but with greater intensity and clarity. Then, other aromas typical of wine before distillation appear, such as grapes, raisins, the acidity of fermentation, and fermented pomace (zupia). By performing a reverse aftertaste (inhaling through the nose and exhaling through the mouth), the nebulization provides information on new flavors, highlighting, in this case, the presence of fermented wine and pomace.

This analysis using nebulization shows the presence of aromas that were not perceived in the traditional tasting, displaying elements typical of wine and pisco production before they turn into brandy, such as the smell and flavor of grapes, fermented pomace, must during the distillation process, among others. The idea behind the sensory stimulation process is to mentally transport the taster to the winery, and make him or her perceive the aromas generated during the brandy production process. This perception would probably improve in a dark environment and with complementary acoustic stimulation.

3.5. Future research

Nowadays, experiments are being planned for the use of oak

wood fragments (chips), with different toasting intensities, to accelerate and improve aging. Wood of regional origin, other than oak, is also being used to produce aged spirits with unique organoleptic characteristics. These techniques are expected to result in very interesting aromas and flavors, different from those obtained with aging in oak barrels.

5. Conclusions

Brandy "Arequipeño" is made from mature pisco aged in wood, produced in Majes (Arequipa, Peru) since

the 18th century. Family traditions have been transmitted from generation to generation, preserving ancestral and artisanal procedures for the elaboration of this product. In the present work, the organoleptic transformation process of pisco into brandy has been analyzed. It is necessary to clarify that brandy is not pisco, since it loses the designation of origin at the time it begins to rest in wood. As a different product, brandy is appreciated differently than pisco. From the grape harvest, fermentation, distillation and resting in wood, new aromas, colors and flavors have been subtly integrated into a noble spirit. During the brandy tasting using the nebulization process, hidden aromas emanate, recalling its production process. As a conclusion, pisco, wood and time are the three factors that, wisely combined, give brandy "Arequipeño" a unique identity typical of southern Peru.

Author Contributions

Conceptualization and methodology, Juan José Milón Guzmán; research, formal analysis, writing—original draft preparation, writing—review and editing, Juan José Milón Guzmán, Enit Sofía Zúñiga Díaz.

All authors have read and agreed to the published version of the manuscript.

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Aerofloral Studies and Allergenicity Potentials of Dominant Atmospheric Pollen Types at Some Locations in Northwestern Nigeria

Olugbenga S. Alebiosu, Olusola H. Adekanmbi, Oluwatoyin T. Ogundipe

***Abstract*—** Pollen and spores have been identified as major airborne bio-particles inducing respiratory disorders such as asthma, allergic rhinitis and atopic dermatitis among hypersensitive individuals. An aeropalynological study was conducted within a one year sampling period with a view to investigating the monthly depositional rate of atmospheric pollen and spores; influence of the immediate vegetation on airborne pollen distribution; allergenic potentials of dominant atmospheric pollen types at selected study locations in Bauchi and Taraba states, Northwestern Nigeria. A tauber-like pollen trap was employed in aerosampling with the sampler positioned at a height of 5 feet above the ground, followed by a monthly collection of the recipient solution for the sampling period. The collected samples were subjected to acetolysis treatment, examined microscopically with the identification of pollen grains and spores using reference materials and published photomicrographs. Plants within the surrounding vegetation were enumerated. Crude protein contents extracted from pollen types found to be commonly dominant at both study locations; Senna siamea, Terminalia cattapa, Panicum maximum and Zea mays were used to sensitize Musmusculus. Histopathological studies of bronchi and lung sections from certain dead M.musculus in the test groups was conducted. Blood samples were collected from the pre-orbital vein of M.musculus and processed for serological and haematological (differential and total white blood cell counts) studies. ELISA was used in determining the levels of serological parameters: IgE and cytokines (TNF-, IL-5, and IL-13). Statistical significance was observed in the correlation between the levels of serological and haematological parameters elicited by each test group, differences between the levels of serological and haematological parameters elicited by each test group and those of the control, as well as at varying sensitization periods. The results from this study revealed dominant airborne pollen types across the study locations; Syzygiumguineense, Tridaxprocumbens, Elaeisguineensis, Mimosa sp., Borreria sp., Terminalia sp., Senna sp. and Poaceae. Nephrolepis sp., Pteris sp. and a trilete fern also produced spores. This study also revealed that some of the airborne pollen types were produced by local plants at the study locations. Bronchi sections of M.musculus after first and second sensitizations, as well as lung section after first sensitization with Senna siamea, showed areas of necrosis. Statistical significance was recorded in the correlation between the levels of some serological and haematological parameters produced by each test group and those of the control, as well as at certain sensitization periods. The study revealed some candidate pollen allergens at the study locations allergy sufferers and also established a complexity of interaction between immune cells, IgE and cytokines at varied periods of mice sensitization and forming a paradigm of human immune response to different pollen allergens. However, it is expedient that further studies should be conducted on these candidate pollen allergens for their allergenicity potential in humans within their immediate environment.

***Keywords*—** airborne, hypersensitive, mus musculus, pollen allergens, respiratory, tauber-like.

Olugbenga Shadrak Alebiosu is with the University of Ibadan, Nigeria (e-mail: olugbengaalebiosu@gmail.com).

AMF activates PDH 45 and G-proteins Genes to Alleviate Abiotic Stress in Tomato Plants

Deepak Bhardwaj, Narendra Tuteja

***Abstract*—** Global climate change is impacting large agrarian societies, especially those in countries located near the equator. Agriculture, and consequently, plant-based food, is the hardest hit in tropical and sub-tropical countries such as India due to an increased incidence of drought as well as an increase in soil salinity. One method that holds promise is AMF-rich biofertilizers which assist in activating proteins which in turn help alleviate abiotic stress in plants. In the present study, we identified two important species of (arbuscular mycorrhizal fungus) AMF belonging to Glomus and Gigaspora from the rhizosphere of the important medicinal plant Justicia adathoda. These two species have been found to be responsible for the abundance of Justicia adathoda in the semi-arid areas of the Jammu valley located in northern India, namely, the Union Territory of Jammu and Kashmir. We isolated the species of Glomus and Gigaspora from the rhizosphere of Justicia adathoda and used them as biofertilizers for the tomato plant. Significant improvements in the growth parameters were observed in the tomato plants inoculated with Glomus sp. and Gigaspora sp. in comparison with the tomato plants that were grown without AMF treatments. Tomato plants grown along with Glomus sp. and Gigaspora sp. have been observed to withstand 200 mM of salinity and 25% PEG stress. AMF also resulted in an increased concentration of proline and antioxidant enzymes in tomato plants. We also examined the expression levels of salinity and drought stress-inducible genes such as pea DNA helicase 45 (PDH 45) and genes of G-protein subunits of the tomato plants inoculated with and without AMF under stress and normal conditions. All the stress-inducible genes showed a significant increase in their gene expression under stress and AMF inoculation, while their levels were found to be normal under AMF inoculation without stress. We propose a model of abiotic stress alleviation in tomato plants with the help of external factors such as AMF and internally with the help of proteins like PDH 45 and G-proteins.

***Keywords*—** AMF, abiotic stress, g-proteins, PDH-45.

Deepak Bhardwaj is with the Central University of Jammu, India (e-mail: dbhardwajpmb@gmail.com).

Terror in the Workplace - Lessons Learned from the San Bernardino Survivor Experience

Suzanne Bernier

***Abstract*—** On December 2, 2015, one of the largest terror attacks on US soil occurred, killing 14 people and injuring dozens of others attending a San Bernardino County staff holiday party. What makes this tragedy truly unique is that it is considered not only an 'active shooter' incident, but also a workplace violence issue, as well as a terrorist attack, all rolled into one.

Since the attack, the presenter has met with and interviewed dozens of the San Bernardino survivors and bereaved families to follow and track their healing journey over the past 5 + years. The survivors and bereaved family members wanted to share their personal stories and experiences on what went well, what didn't go well, and provide recommendations on how companies and communities can better prepare for the psychological aftermath of workplace shooting incidents.

Upon the San Bernardino survivors' request, Suzanne acts as the group's voice and advocate to the external world.

In this presentation, Suzanne will highlight the findings, observations and recommendations found in her White Paper on the Lessons Learned from the San Bernardino Survivor Experience, which she sponsored and released in partnership with the University of Chicago.

While we may not be able to prevent or predict every active shooter, workplace violence, or terror incident in the future, we CAN help ensure communities and organizations are better prepared for such tragedies if or when they do occur.

***Keywords*—** active shooter, workplace violence, mass attacks, emergency preparedness.

Suzanne Bernier is with the University of Chicago, United States (e-mail: suzanne.bernier@qmenv.com).

Effect of Digital Technology on Students Interest, Achievement and Retention in Algebra in Abia State College of Education (Technical) Arochukwu

Stephen O. Amaraihu

***Abstract*—** This research investigated the effect of Computer Based Instruction on Students' interest, achievement, and retention in Algebra in Abia State College of Education (Technical), Arochukwu. Three research questions and two hypotheses guided the study. Two instruments, Maths Achievement Test (MAT) and Maths Interest Inventory were employed, to test a population of three hundred and sixteen (316) NCE 1 students in algebra. It is expected that this research will lead to the improvement of students' performance and enhance their interest and retention of basic algebraic concept. It was found that the majority of students in the college are not proficient in the use of ICT as a result of a lack of trained personnel. It was concluded that the state government was not ready to implement the usage of mathematics in Abia State College of Education. The paper recommends, amongst others, the employment of mathematics Lectures with competent skills in ICT and the training of lecturers of mathematics.

***Keywords*—** achievement, computer based instruction, interest, retention.

Stephen Amaraihu is with the Abia State College of Education, Nigeria (e-mail: amaraihustephen@gmail.com).

Punishment in Athenian Forensic Oratory

Eleni Volonaki

***Abstract*—** In Athenian forensic speeches, the argumentation on punishment of the wrongdoers constitutes a fundamental ideal of exacting justice in court. The present paper explores the variation of approaches to punishment as a means of reformation, revenge, correction, education, example, chance to restoration of justice. As it will be shown, all these approaches reflect the social and political ideology of Athenian justice in the classical period and enhances the role of the courts and the importance of rhetoric in the process of decision-making. Punishment entails a wide range of penalties but also of ideological principles related to the Athenian constitution of democracy.

***Keywords*—** punishment, athenian forensic speeches, justice, athenian democracy.

Eleni Volonaki is with the University of Peloponnese, Greece (e-mail: evolonaki2003@yahoo.co.uk).

Tackling Food Insecurity and Beyond: A Holistic Approach to Food Insecurity

Harleen Jhinger, Debra Abraham

***Abstract*—** INTRODUCTION: In 2020, Unique Get Together Society (UGTS) launched a new program, 'Essential Food Hampers', due to their clients' increased needs for food support. This program purchases and delivers food directly to those in need at no cost, while also developing supportive relationships with clients. During intake, UGTS learns more about the specific challenges and difficulties families are facing. Responses are tailored to encompass a holistic approach based on needs, in addition to providing food support.

AIM: The aim of this gap analysis is to explore the effects of a holistic food hampers delivery approach in relation to the Roberts' Seven Stage Crisis Intervention Model (Roberts, 2005), in comparison to traditional food bank systems.

METHODOLOGY: Using Roberts' Seven Stage Crisis Intervention Model Framework (Roberts, 2005), traditional food bank program models were compared to the Essential Food Hampers program. A gap analysis was conducted to explore the approach a holistic food program takes, in comparison to a resource that solely provides food assistance.

FINDINGS: A holistic program targeting food delivery and beyond is able to provide greater support to families in need by providing appropriate resources and supports, based on consultation. The Roberts' Seven Stage Crisis Intervention Model Framework (Roberts, 2005) describes the importance of developing rapport with clients, which the Essential Food Hampers program is able to do through continuous consultation and follow-up. Food insecurity can be layered during times of crisis for many individuals and families, so providing holistic support can strive to address some additional challenges clients may be facing.

CONCLUSION: Food scarcity is a distressing situation for many individuals and families, who may be facing additional challenges in their lives. Performing an initial assessment and consultation with these families can help ensure all applicable resources are provided.

***Keywords*—** food insecurity, social services approach, social change, systems change.

Harleen Jhinger, Debra Abraham are with the Unique Get Together Society, BC (e-mail: hjhinger@laurentian.ca).

Harleen Jhinger is with the Unique Get Together Society, BC, 2Laurentian University, Ontario.

Gods on the Water - the Assyrian Rock Reliefs of Faida

Hasan Ahmed Qasim

***Abstract*—** Introduction: The Faida reliefs are recorded in the Official Journal under no. 2269 (14 August 1983). In 1972, a British archaeologist of the British Museum, Julian E. Reade, discovered three rock reliefs along the canal. In August 2012, during archaeological survey work in the Duhok region, the Italian Archaeological Mission to the Kurdistan Region of Iraq of the Udine University, directed by Daniele Morandi Bonacossi, was able to identify six new rock reliefs. Assyrian rock reliefs are extremely rare monuments, which in the Duhok region are known only at Halamata, Khinis and Bandawai. Only the upper parts of the Faida reliefs emerged from the canal fill. The crowns and heads of a series of deities depicted in profile facing left (and thus pointing in the direction in which the channel's current flowed) were visible. The joint "Kurdish-Italian Faida Archaeological Project", co-directed by Dr. Hasan Ahmed Qasim (Directorate of Antiquities of Duhok) and Prof Daniele Morandi Bonacossi (University of Udine – Italy), has made an extraordinary discovery in the archaeological site of Faida (Duhok). Ten unique Assyrian rock reliefs of the eighth-seventh century BC were identified on the left side of an approximately 6.5 km long canal near Faida, south of Duhok. The Faida canal, which rounds the western spur of the Chiya-i Dekan mountain, was dug into the limestone of the hill and was fed by a series of karst springs – in part still active today – situated in several small wadis along the northern flank of the mountain. The canal has an average width of 4 m and is almost everywhere buried under deposits eroded from the hill. From the primary canal, several offtakes diverted water into secondary canals to irrigate the neighbouring fields. I will shed light on the sculpture in fine detail, its dimensions, figures, images, and symbols, in addition to a detailed explanation of the carved images on the light of Excavation.

***Keywords*—** Gods on the water, Kurdistan Duhok Assyrian rock reliefs of Faida, arts, sculptures.

Hasan Qasim is with the Directorate General of Antiquities and Heritage, Iraq (e-mail: Jianekni@gmail.com).

Investigating The Use of Socially Assistive Robots to Support Learner Engagement for Students with Learning Disabilities in One-to-one Instructional Settings

Jennifer Fane, Mike Gray, Melissa Sager

***Abstract*—** Children with diagnosed or suspected learning disabilities frequently experience significant skill gaps in foundational learning areas such as reading, writing, and math. Remedial one-to-one instruction is a highly effective means of supporting children with learning differences in building these foundational skills and closing the learning gap between them and their same-age peers. However, due to the learning challenges children with learning disabilities face, and ensuing challenges with self-confidence, many children with learning differences struggle with motivation and self-regulation within remedial one-to-one learning environments - despite the benefits of these sessions. Socially Assistive Robots (SARs) are an innovative educational technology tool that has been trialled in a range of educational settings to support diverse learning needs. Yet, little is known about the impact of SARs on the learning of children with learning differences in a one-to-one remedial instructional setting. This study sought to explore the impact of SARs on the engagement of children (n=9) with learning differences attending one-to-one remedial instruction sessions at a non-profit remedial education provider. The study used a mixed-methods design to explore learner engagement during learning tasks both with and without the use of a SAR to investigate how the use of SARs impacts student learning. The study took place over five weeks, with each session within the study followed the same procedure with the SAR acting as a teaching assistant when in use. Data from the study included analysis of time-sample video segments of the instructional sessions, instructor recorded information about the student's progress towards their session learning goal and student self-reported mood and energy levels before and after the session. Analysis of the findings indicates that the use of SARs resulted in fewer instances of off-task behaviour and less need for instructor re-direction during learning tasks, allowing students to work in more sustained ways towards their learning goals. This initial research indicates that the use of SARs does have a material and measurable impact on learner engagement for children with learning differences and that further exploration of the impact of SARs during one-to-one remedial instruction is warranted.

***Keywords*—** engagement, learning differences, learning disabilities, instruction, social robotics..

J. Fane is with the Learning Disabilities Society, Vancouver, BC V5M 1Z8 CA (phone: 604-873-8139; e-mail: jennf@ldsociety.ca).

M. Gray, is with the Learning Disabilities Society, Vancouver, BC V5M 1Z8 CA (phone: 604-873-8139; e-mail: mikeg@ldsociety.ca).

M. Sager, is with the Learning Disabilities Society, Vancouver, BC V5M 1Z8 CA (phone: 604-873-8139; e-mail: melissas@ldsociety.ca).

Building on Resiliency: Recommendations for Schools on How to Provide Support and Affirmative Care for Trans and Gender Non-conforming Youth Experiencing Trauma

Sarah M. Wilson

***Abstract*—** This paper seeks to identify the kinds of trauma that trans and gender non-conforming youth experience and what schools and school counsellors can do to mitigate the harmful effects of such trauma. With an increase of trauma-informed practice in schools and key developments towards the inclusion and protection of trans and gender non-conforming youth throughout British Columbia it is essential for educators and practitioners to be aware of the risks for this population and be adequately prepared for the support of such vulnerable youth. Key aspects of the literature are the deconstruction of the neurology of trauma and its' effects on the body, outlining the issues that transgender individuals and youth experience, and subsequently the appraisal and identification of such experiences as trauma, or as causing similar neurological, physical, and emotional effects. Additionally, in the summarization of the literature this paper seeks to define trans-affirmative care for the purpose of determining the practices that have been shown to be most effective in fostering resiliency and supporting the healing of trauma for those within the transgender community. The Minority Stress Model (Meyer, 2003) is used as a theoretical framework for the analysis of the lived experiences of trans and gender non-conforming individuals, and addresses the implications of said experiences on their mental health and overall wellbeing. In addition to outlining the transgender community's likely vulnerability, the Minority Stress Model is also used as a framework for the identification of the inherent resiliency found therein. Using a strengths-based approach, recommendations for how to support trans and gender non-conforming youth are made by drawing upon the conclusions found in the literature concerning trans youth's vulnerability and resiliency, proposing a multifaceted and integrative approach.

***Keywords*—** gender non-conforming youth,minority stress,resiliency,trans-affirmative care,transgender youth,trauma,trauma-informed care,vulnerability.

Sarah Wilson is with the City University of Seattle, Canada (e-mail: swilsoncounselling@gmail.com).

Investigation of the Effects of Visually Disabled and Typical Development Students on Their Multiple Intelligence by Applying Abacus and Right Brain Training

Sidika Dilşad Kaya, Ahmet Selim Kaya, Ibrahim Erik, Havva Yaldiz, Yalçin Kaya

***Abstract*—** The aim of this study was to reveal the effects of right brain development on reading, comprehension, learning and concentration levels and rapid processing skills in students with low vision and students with standard development, and to explore the effects of right and left brain integration on students' academic success and the permanence of the learned knowledge. A total of 68 students with a mean age of 10.01±0.12 were included in the study, 58 of them with standard development, 9 partially visually impaired and 1 totally visually disabled student. The student with a total visual impairment could not participate in the reading speed test due to her total visual impairment. The following data were measured in the participant students before the project; Reading speed measurement in 1 minute, Reading comprehension questions, Burdon attention test, 50 questions of math quiz timed with a stopwatch. Participants were trained for 3 weeks, 5 days a week, for a total of two hours a day. In this study, right-brain developing exercises were carried out with the use of an abacus, and it was aimed to develop both mathematical and attention of students with questions prepared with numerical data taken from fairy tale activities. Among these problems, the study was supported with multiple-choice, 5W (what, where, who, why, when?), 1H (how?) questions along with true-false and fill-in-the-blank activities. By using memory cards, students' short-term memories were strengthened, photographic memory studies were conducted and their visual intelligence was supported. Auditory intelligence was supported by aiming to make calculations by using the abacus in the minds of the students with the numbers given aurally. When calculating the numbers by touching the real abacus, the development of students' tactile intelligence is enhanced. Research findings were analyzed in SPSS program, Kolmogorov Smirnov test was used for normality analysis. Since the variables did not show normal distribution, Wilcoxon test, one of the non-parametric tests, was used to compare the dependent groups. Statistical significance level was accepted as 0.05. The reading speed of the participants was 83.54±33.03 in the pre-test and 116.25±38.49 in the post-test. Narration pre-test 69.71±25.04 post-test 97.06±6.70; BURDON pretest 84.46±14.35 posttest 95.75±5.67; rapid math processing skills pretest 90.65±10.93, posttest 98.18±2.63 ($P<0.05$). It was determined that the pre-test and post-test averages of students with typical development and students with low vision were also significant for all four values ($p<0.05$). As a result of the data obtained from the participants, it is seen that the study was effective in terms of measurement parameters, and the findings were statistically significant. Therefore, it is recommended to use the method widely.

***Keywords*—** Abacus, reading speed, multiple intelligences, right brain training, visually impaired.

Sıdıka Dilşad Kaya is with the Cemile Erkunt Primary School Selcuklu/Konya/Turkey (e-mail: dilsatkaya@hotmail.com).

Ahmet Selim Kaya is with the University of York Toronto. Ontario. Canada. Student.

Ibrahim Erik is with the Selcuk University Faculty of Technology Mechanical Eng. Department. Konya/Turkey.

Havva Yaldız is with the Konya Science Center Education Specialist -Turkey.

Yalçın Kaya is with the Selcuk University Department of Physical Education Selcuklu/Konya/Turkey.

Balancing Grief and Survival: Experiences of Children with Brain Tumors and Their Parents

Ceilidh Eaton Russell, MSc, CCLS[a,b], Eric Bouffet, MD, FRCP (C)[c], John Beaton, PhD, RMFT[a], and Susan Lollis, PhD, C. Psych[a]

[a]Family Relations and Applied Nutrition Department, University of Guelph, Guelph, Ontario, Canada;[b]Dr. Jay Children's Grief Centre, Toronto, Ontario, Canada; [c]Neuro-Oncology Program, Haematology/ Oncology Department, The Hospital for Sick Children, Toronto, Ontario, Canada

ABSTRACT

Psychosocial research about childhood brain tumors is limited because of varied abilities and prognoses, with children's voices largely absent. Research has focused on the *impacts* on families and their *reactions*; this qualitative study used constructivist grounded theory methods to explore *experiences of* childhood brain tumors from the perspectives of 12 children and 12 parents using semistructured interviews. Their stories illustrated efforts to maintain positivity and normalcy as they faced grief and uncertainty. The substantive grounded theory of balancing grief and survival offers a lens through which to view children's and parents' complex experiences, struggles, and coping strategies as integrated, dynamic processes.

KEYWORDS

brain tumor; child; parent; family; communication; grief

Introduction

For ill children and their families, life is immediately and profoundly changed by the diagnosis of a brain tumor. Approximately 3,600 North American children aged 0–14 years are diagnosed annually with brain and spinal cord tumors(Canadian Cancer Society's Advisory Committee on Cancer Statistics, 2015; Ostrom et al., 2015), and between 2005 and 2009, 214 Canadian children in the same age range died from the disease (Canadian Cancer Society, 2013). Children with brain tumors are underrepresented in psychosocial research largely because their varied cognitive abilities, protocols, and prognoses pose challenges to researchers seeking large, homogeneous samples (Jackson et al., 2009). Although they have much in common with children with other serious illnesses (Deatrick, Mullaney, & Mooney-Doyle, 2009), children with brain tumors bear additional burdens (Jackson et al., 2009; Zebrack et al., 2012), such as cognitive, physical, or behavioral changes that lead to exclusion and bullying, undermining self-esteem

CONTACT Ceilidh Eaton Russell, MSc, CCLS ceilidh.eatonrussell@griefcentre.org Dr. Jay Children's GriefCentre, 82 Lombard Street, Suite 112, Toronto, ON M5C 2S8, Canada.

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and emotional health (Vance, Eiser, & Horne, 2004); increased risk of psychoses, lower likelihood of overcoming impairments in communication and social functioning (Bhat et al., 2005).

Managing the medical and psychosocial care for their child's evolving needs, in constant fear of relapse and the effects of treatment (Vance et al., 2004), parents are pulled in an emotional tug-of-war between uncertainty and grief over potential and actual losses on one hand and tremendous relief for the child's survival on the other (Deatrick et al., 2009; Forinder & Norberg, 2010). While these few studies shed light on some of the unique challenges and experiences of families of children with brain tumors, considerably more exploration is required to gain a deeper understanding of their lived experiences within families.

Children's perspectives have been conspicuously lacking in the literature; furthermore, the primary foci of these studies have been what the diagnosis and treatment of a brain tumor *do to* families (i.e., impacts) and what families *do about* brain tumors (i.e., management, coping, and supports). In-depth exploration of the *experiences of* childhood brain tumors from the perspectives of children and their parents is sorely needed.

Contrasting the paucity of psychosocial research specific to childhood brain tumors, a considerable body of literature has established that childhood cancer in general, and the myriad unknowns and strains associated with it place "a tremendous burden on the family" (Canadian Cancer Society, 2009). Physical and emotional suffering, uncertainty about the illness, treatment, and the future; struggling to manage health care, school, employment, and finances; adapting to profound changes to "normal life"; strained relationships among families and communities; and emotional struggles impact all family members (Björk, Wiebe, & Hallström, 2005; Clarke-Steffen, 1997; Hildenbrand et al., 2011; McGrath, Paton, & Huff, 2004; Patterson, Holm, & Gurney, 2004; Schweitzer, Griffiths, & Yates, 2012; Woodgate, 2006; Zebrack et al., 2002).

Previous findings suggest that after families return home, the illness continues to dictate their lives as the child's compromised immune system limits their activities, deepening their desires to feel, and to be treated as "normal" (Björk, Wiebe, & Hallström, 2009; Hildenbrand et al., 2011; Koocher, 1985; McGrath, Paton, & Huff, 2005; Patterson et al., 2004). Although many families adapt and create a "new normal" (Clarke-Steffen, 1997), Woodgate (2006) noted that families were never fully "free" of the cancer, even in remission; "it was like a shadow that was always following them" (p. 15).

Children and parents report a range of emotions across the illness trajectory (Björk et al., 2005; Hildenbrand et al., 2011; McGrath et al., 2004; Patterson et al., 2004; Woodgate, 2006), that, in the context of various other childhood health conditions, have been compared to bereavement, describing grief as ever-present, intensified by medical crises, missed milestones, losses of function, and hopes for the future (MacGregor, 1994; Pianta et al., 1996; Rentinck et al., 2009; Steele & Davies, 2006). Woodgate and Degner (2003b) identified cancer-related grief: "Loss

of independence and function, missing work or school, missing friends and family members, and the ultimate loss: Death" (p. 110). Yet, in the face of so much suffer- ing and uncertainty, children and families demonstrate remarkable capacities to cope, maintain a positive outlook and hope, seek information and support; advo- cating; planning, preparing; and expressing emotions (Fletcher, 2011; Grootenhuis & Last, 1997; Han et al., 2009; Hildenbrand et al., 2011; Jackson et al., 2009; Patter- son et al., 2004).

A great deal has been learned about the challenges facing families living with childhood cancer, including the suffering, grief, strained relationships, and lives ofall family members, and the coping strategies they invoke. While each of these ele- ments must influence the others, studies generally focus on individual or pairs of elements, rather than taking a broader view of their tangled web. Stroebe and Schut's (1999) Dual Process Model (DPM) of coping with bereavement, emphasiz- ing the dynamic process of oscillation between loss- and restoration-oriented stres- sors, thoughts and feelings, may help to conceptualize complex interrelationships between these emotional elements and their manifestations in the case of child- hood brain tumors.

The focus of this study was to explore experiences of childhood brain tumors from the perspectives of children and parents, to gain a richer understanding of how they experience and cope with their emotions; how their reactions are similar or unique; how family relationships are shaped by the illness and their responses; and how life with a brain tumor is similar, and different from life with other child- hood cancers as it is described in the literature.

Methods

This prospective, qualitative study was designed according to constructivist grounded theory methods outlined by Charmaz (2003, 2014), building on the foundational work by Glaser and Strauss (1967). Grounded theory uses comparative analysis and conceives of theory as "an ever-developing entity" (Glaser & Strauss, 1967, p. 32). A constructivist approach recognizes the coconstruction of meaning among participants and researchers, and values theorizing as a means to understand, rather than predict (Charmaz, 2014, 2015). A substantive grounded theory offers "a theoretical interpretation or explanation of a delimited problem" (Charmaz, 2014, p. 344).

Twelve children and their 12 parents were recruited from the brain tumor program at the hospital for sick children in Toronto following the approval of the institutional ethics review boards at the hospital and the University of Guelph. Families of eligible children aged 6–14 who had been diagnosed at least 3 months prior were identified and informed about the study at the brain tumor clinic, by a physician or nurse practitioner with whom they were familiar, and invited to speak with the student investigator. Prior to initiating

the interviews, parents, mostly mothers, and children signed informed consent and assent forms.

Purposive sampling was carefully used to include a balance of male and female children varying in age within our specified range, with varied diagnoses, malig- nancies, and illness trajectories to elicit a range of perspectives. However, families were not invited to participate if children were expected to die within 6 months orif clinicians involved in their care had concerns that children or parents were too overwhelmed to participate.

As the research team developed a "growing sense of confidence" in the explana- tion of the phenomena, suggesting theoretical saturation had been reached (Daly, 2007, p. 106), theoretical sampling was used to recruit a final parent–child dyad who could provide insight into developing constructs and the theoretical storyline. In preceding interviews, these constructs were explored with participants as they arose, seeking clarification about researchers' interpretations. According to Thomson's (2004) review of 50 qualitative studies, "saturation normally occurs between 10 and 30 interviews," while Daly (2007) suggests between 20 and 25 interviews. Based on these guidelines, the lack of new information being shared by participants and confidence in the theoretical framework, 23 interviews were deter- mined to be sufficient for this study.

Parents and children were interviewed separately, except for one child who pre- ferred to be interviewed with his mother. Two families chose to be interviewed in their homes, remaining interviews were conducted in private rooms at the hospital. Children's interviews lasted 10–65 minutes (average 30 minutes); parents' inter- views ranged from 30 minutes to 2 hours. Interviews were digitally recorded and transcribed, resulting in nearly 500 pages of transcripts.

Semistructured interview guides were developed based on the team members'

collective research and clinical experience, to elicit participants' experiences com- municating about the child's tumor (Appendix). Open-ended questions explored parent–child communication including what topics were most important, harder and easier to talk about, and what they had and had not discussed together. Open- ing questions asked participants to share "a bit about the illness" and "what that is meant for you and your family," eliciting rich stories about their paths from early symptoms through diagnoses and treatment. The intensity and centrality of thesenarratives inspired a shift in the team's analytic focus toward the experiences of grieving and coping as explored in this paper, returning to examine communica- tion in a forthcoming article.

A triadic coding scheme was used, aided by MAXQDA software, beginning withopen, line-by-line coding to ground analysis in participants' "views of their realities" (Charmaz, 2003). Constant comparative analysis within and across interviews informed focused and selective coding and the conception of a theoretical story line that illustrated relationships between variables and concepts identified throughout the process (Charmaz, 2014). Transcripts were primarily coded by the first author, Ceilidh Eaton Russell collaboratively with

Dr. Susan Lollis, as codes, concepts and categories evolved. All team members contributed throughout the process, to the developing model and shared understanding of relationships among concepts.

Results

Twelve children with brain tumors and their parents agreed to participate. Eleven children had siblings, ten lived with both parents and two lived primarily with their mothers but continued to spend time with their fathers. Two families identified themselves as East Indian, one as Middle Eastern; two identified as Canadian of Aboriginal descent, while the remaining families identified both Canadian and European backgrounds. The children's tumors were of varying malignancies; six children experienced at least one recurrence or new tumor growth, and at the time of writing, one child had died. See Table 1 for information about children and their parents; all names have been changed to protect participants' confidentiality.

Family members described unique paths to diagnosis; some children had a sudden onset of symptoms that were quickly recognized and diagnosed, while others' symptoms were more ambiguous, seemed to come and go, and were attributed to the flu or the weather. In the most extreme cases, children's symptoms were treated as behavioral or anxiety disorders for months before their parents' unrelenting advocacy led to further testing and brain tumor diagnoses. Some children recovered quickly from treatment with relatively few side effects, while others suffered permanent damage, including two children who had strokes secondary to their tumors.

Introduction to the substantive grounded theory of balancing grief and survival

Two contexts were particularly salient in each of the interviews: "Dealing with the illness," includes suffering with symptoms, enduring treatments, coping, and work- ing to overcome the impacts of the illness, both psychologically and physically; "normal life" refers to their changing lives, attempts to get "back to normal," and do "normal stuff." In both contexts, vivid stories illustrated a spectrum of emotions with profound grief and vulnerability at one end, alternating with hope, determina- tion and optimism at the other. These two polarities were strong and synchronous processes running through all of the interviews, that together, reveal the core pro- cess of "balancing grief and survival"—i.e., children's and parents' perpetual efforts to achieve a manageable equilibrium amidst uncontrollable and often overwhelm-ing circumstances.

Importantly, the term "balancing" should not imply that a state of perfect bal-

ance is possible, or that grief and survival act in equal and opposite directions. Rather, "balancing" is used to reflect the active and dynamic attempts of children and parents to counterbalance feelings of being pulled toward grief by experiences and circumstances, by pulling themselves toward survival. Overlaying processes of "grief" and "survival" across the contexts of "dealing with illness" and "normal

Table 1. Participant characteristics.

Parent's name	Child's name	Child's age (years)	Child's gender	Time from diagnosis to interview (months)	Type of tumor	Malignancy	Recorded chemo	Recorded radiation	Underwent surgery	In treatment at time of interview?
Sharon	Henley	8.5	F	10	High grade glioma	High	X	X	X	Yes
Carmen	Andrew	7	M	48	Low grade glioma	Low	X			Yes
Darla	Abbie	13.5	F	25	Pineoblastoma	High	X	X	X	No
Karen	Carter	13.5	M	16	Low grade glioma	Low	X		X	Yes
Nuhan	Davon	10	F	84	Low grade glioma	Low	X		X	No
Alison	Casey	11	F	3	Germinoma	Med	X	X	X	Yes
Sandra	Ricky	7	M	22	Low grade glioma	Med	X		X	Yes
Elizabeth	Collin	9.5	M	5	Medullo-blastoma	High	X	X	X	Yes
Asif	Nathan	14.5	M	69	Ependy-moma	High	X	X	X	No
Nancy	Melanie	10	F	60	Low grade glioma	Low	X			Yes
Lisa	Jordan	9.5	F	45	Ependy-moma	High	X	X	X	No
Ashley	Mitchell	12	M	4	High grade glioma	High	X	X	X	Yes

Figure 1. Model of balancing grief and survival.

life" created four main categories that delineate the ways that children and parents experience and respond to the illness. The circumstances that contributed to their grief, and the strategies and supports that helped them to focus on and feel capable of survival, are outlined in the category descriptions that follow. Figure 1 displaysan overview of the model.

Main category #1: Being on the edge

The first category, "being on the edge," captures participants' grieving processes in the context of "dealing with illness" as they suffered with illness and treatment, wrestling a myriad of unknowns and threats. Children characterized these circum-stances as sad, scary, and causing heartache and dread for them and for their parents, who also described a heightened sensitivity and vigilance about their children's conditions. Parents described being "always on duty," or "on the edge of drama," expecting something terrible to happen, monitoring their children extremely carefully in hopes of averting disaster. Two subcategories capture dis- tress related to present and potential struggles: "suffering with the illness and treat- ment," and "wrestling uncertainty."

Subcategory #1a: Suffering with the illness and treatment

Children's and parents' suffering began at the initial onset of symptoms. Despitethe benign nature of some symptoms or clear test results, parents acted on "gut instincts" that something was wrong. Lisa, mother of a 9-year-old girl, explained: "He told me to take her home and come back in 6 weeks. If I had done that she would have died." While some parents and children were upset with health-care professionals whom they felt had misdiagnosed their child, others reflected "it's nobody's fault."

Dreading the worst was common for children and parents, as were feelings of sadness, shock, feeling overwhelmed, and struggling to understand. Nuhan, the mother of a 9-year-old, explained, "when I hear tumor, I couldn't understand what they mean, tumor, 'cause I never hear about these things, sickness before. We live like a normal life, happy life, then this happened …. It is big thing, means like dying or death for us." Diagnoses led to a range of reactions, including guilt for parents who had suspected their children were "faking" symptoms to gain atten- tion, and for others, relief at finally having an explanation after a battery of tests and unsuccessful treatments. But diagnoses were only the beginning; parents and children continued to grieve as they learned more about the tumor and what itwould mean for their lives.

Treatments were often scary, invasive, caused new side effects and suffering, even while some felt symptomatic relief. Children and parents had vivid memoriesof painful treatments and feeling helpless and afraid. Repeated procedures posed their own challenges, as 9-year-old boy Jordan explained, "you know what's hap-pening so it's a little easier… but you know it's gonna

hurt and stuff, so it's still, it's hard." Undoubtedly, procedures were most difficult when they did not go as expected. Rarely, the treatment itself went wrong, as it had for Nuhan's daughterwho had a stroke during surgery, which she described as being "worse than that tumor itself." More often, the process changed unexpectedly, compromising child- ren's trust, and leading to parents' feelings of guilt, helplessness, and betrayal by the health-care professionals they depended on.

Subcategory #1b: Wrestling uncertainty

Children and parents' stories were riddled with "what ifs" that seemed most persis- tent following diagnoses, new or worsening symptoms, or in anticipation of test results. Tumor progression and recurrence were the most terrifying sources of uncertainty, as Sandra, the mother of a 7-year-old boy, illustrated: "[there's] always the chance that something's gonna show up again, y'know, 'cause they did tell us right from the beginning it can come back. It's not … you take care of it but there'sno guarantees, right?"

Most commonly, parents stated that they would not tell their child that the ill- ness could recur or be fatal, with some avoiding "the 'c' word" altogether. Believing knowledge of these threats would overwhelm their children, leaving them hopeless and afraid, many parents avoided topics that might lead to thoughts of mortality. Darla explained, "the only thing I didn't tell her all through the treatment… was about her friend she lost …'cause I didn't want her to think that could happen to her." Parents rarely shared information about treatment-related risks with infertil-ity perceived as a particularly devastating threat. Generally, children were only made aware of risks that they could help to minimize, such as infections or injuries. Children described it as "awful," "frustrating," and "sad" to have to avoid sports or groups, and parents felt badly about the missed opportunities, but clearly felt it was worth the sacrifice to minimize the risks.

In the face of so much uncertainty, children and parents sought to understand as much as they could. They searched for reassuring information by talking with other parents or health-care professionals and looking online. Especially while they were waiting for the diagnosis or results, parents and children developed their own explanations for symptoms, such as the flu, weather, genes, and stress. Chil- dren wondered what the tumor was made of, and looked like, how it caused symptoms, and why it had grown inside them. Although some suspected certain foods or behaviors, children like Andrew continued to wonder, "I wish it do not come, but it did. I don't know how it came, just came for no reason …. Well they must come for a reason, wouldn't they?"

Main category #2: Reclaiming health

Participants' survival processes animate the second category, "reclaiming health," as they were "dealing with illness." Children and parents countered their worries and uncertainty with reassurances about positive test results and improved symptoms. Literally and figuratively, efforts were aimed at preventing the tumor, the stress and grief it caused, from permeating their

lives. Two subcategories, "containing illness" and "focusing on the positive" illustrate efforts to shift the balance from grief and "being on the edge" toward survival.

Subcategory #2a: Containing illness

Children and parents used a range of strategies to reframe the tumor as something they could manage or "contain," often describing the tumor, treatments, and risksas, "not that bad." Like others whose experiences were better than worst-case scenar- ios they had anticipated, Sandra explained: "There is a light at the end of the tunneland it's not necessarily a death sentence because that's what you, right away you think [that], everybody does … but I was expecting a lot worse." When paths were not as smooth, more effort was required to minimize fears, with some parentsdiminishing the illness, referring to it as a "lump," "almost like cancer," or even "thegood kind" of cancer. A few children described themselves as "not sick," "gettingbetter," or "cured;" many referred to others as "sicker than me." Regardless of theirillness severity, most children and parents defined themselves as "better off" than families of other sick children, based on their symptoms or the burden of treatment.In their efforts to contain the illness and counter their feelings of helplessness, parents did everything they could to fight the tumor and strengthen their children. They sought medical help, advocated for further testing and second opinions, and pursued all available treatments including homeopathy, prayer groups, or othernonallopathic healers. Lisa explained, "I always feel better when she's in treatmentbecause then I feel like we're doing something, like right now I know that there's two spots in there and we're not doing anything… I hate the 'wait and see'."

Nearing the end of treatment was tremendously reassuring for children, helpingto balance their worries and uncertainty with the sense that "we can do this." As

Alison explained, "we know how to get there, it's just a matter of time." Children kept track of the shifting balance of treatment they'd completed compared to what lay ahead, gaining a sense of accomplishment and anticipatory relief, despite the myriad unknowns and considerable treatment that lay ahead.

Knowing what to expect was reassuring for children and parents, rebuilding a sense of order when things went according to plan. Casey recalled: "When they finallytold me that I had cancer, that was a super-nice conversation 'cause I knew what was happening," proving that even bad news was better than no news. Elizabeth explainedthe value of preparation for her son: "If I don't tell him what's coming then he's gonnaworry about what's coming and he's gonna make it up, it's gonna be worse, so I'm actually coming to [realize] he needs to know all of it … he needed to know what's coming next." Children who had not been prepared remembered being very scared, expecting to feel terrible pain, and wishing they had known what would happen.

Subcategory #2b: Focusing on positive

With all they had been through and so much uncertainty in their futures, a positiveoutlook required a focus on the present. Parents described accepting the way things were, taking it "day by day," trying not to dwell on "what if's"; doing

so helped to counterbalance grief by working toward and appreciating survival. Families had faith in positive outcomes, although some hopes were tenuous. Carmen explained "I get scared when he gets sick… But basically it's like I just believe that with all these impossible things happening around us, something good has to come out of it, it can't all be for nothing."

Several children and parents described their faith in a god, medicine, or for many, belief in the child's abilities to overcome the illness, illustrated by descriptions of their children as "strong" and "resilient." As Jordan expressed, "even if you feel like you can't keep on going, keep trying … You just keep thinking in your mind that you can do it." Some, like Sharon, cast a broad net: "It's a combination probably of everything… having awesome surgeons that know what they're doing and that are willing to do this kind of thing, and God overlooking everything at the same time, making sure that he has a steady hand… I think a lot of it is positive attitude."

At times, parents and children sought distraction from the stress and grief they faced. Parents found solace in their jobs or in talking with friends and family about "regular stuff," and many focused on their children's feelings instead of their own. Children used play as their primary source of distraction, both at home and in the hospital. Parents, siblings, and hospital programs helped, as Carter explained, "[they] keep your mind off of what, like 'what if?" and all that, and like, 'Oh no, I'm getting chemo.' You just sorta keep your mind off that."

Main category #3: Missing normal life

At the intersection of "grief" and "normal life," the main category labeled "missing normal life" refers to the losses in children's and parents' lives and relationships as a result of the tumor and treatment. Although some participants wished for things to "go back to normal," others, like Lisa, believed: "It affects your entire family and your life and there's no going back after that, y'know, 'cause it's always a constant concern … it's never gonna be the same way again, ever." Two subcategories, "missing feeling 'normal' and "missing doing 'normal' capture reflections about grief related to the child and family, in the past, present, and future.

Subcategory #3a: Missing feeling normal

Children longed to feel physically normal when they felt too tired or ill to partici- pate in activities, struggled with hair loss, or other effects, however, the stress on relationships hurt the most, as they wished to relate to others and to be treated as they had been, or "like everybody else." Although some peers were supportive, chil- dren who suffered with visible effects of their disease were often excluded and bul- lied, adding insult to injury. Davon explained, "when I want to play with someone they the kind of make fun of me and stuff … I think it's gonna be like that forever, probably." Parents were heartbroken; Nuhan expressed: "They get hurt not from the sickness, [but] from what the people are asking them or how they act with them. This is the important thing: How the people treat them."

Separation was an enormous strain, whether caused by the child's hospitaliza- tion or a procedure; parents felt helpless and guilty while the

children felt aloneand afraid. After 11 months in hospital, Abbie expressed, "it's been kind of bad because, we, we haven't really been together in so long." Siblings at home were described by parents as being sad, worried about the ill child, angry and jealous about the imbalance in attention and concern. Alison recalled her daughter expressing, "it's hard because there's three kids in this family and it feels like every- body's forgotten two of us." Parents were deeply concerned about their emotional well-being, maintaining as much contact as possible and trying to help them understand, as Nuhan explained, "he has to know: I love him as I love her but she needs me more 'cause she's sick."

Children and parents longed to feel understood, as Karen said, "it would be nice to connect with other kids or families to have, just, y'know, discussions and go 'Oh yeah that happens with us'." While a few families met others at the hospital or Ronald McDonald House, those with shorter hospital stays had fewer opportuni- ties to connect. Some felt isolated in spite of meeting other families; Alison expressed, "please tell me we are not the only divorced parents of a kid with cancer
… I have yet to meet any." A few parents chose not to attend support groups because they did not feel their children were "sick enough," or as Elizabeth explained, "I've got enough to deal with and I don't really wanna know everyoneelse's sad story."

Subcategory #3b: Missing doing normal

In addition to missing *feeling* the way that they had before, children struggled withno longer being able to *do* the "normal stuff" they had previously enjoyed, making them crave familiarity even more, perpetuating the cycle. They missed simple things: Their own shower, bed, family and friends, pets, privacy and their "stuff."They described how difficult it was to be away from home and to spend so muchtime waiting at the hospital, as Andrew explained: "I hate when I have to stay in the ward, even just for a day or an hour or two hours or five … there's nothing there, everything's different at home."

Participation in school, social activities, family trips, and parents' work were sig- nificantly disrupted by the logistics of treatment and the risks to their immune sys- tems. Elizabeth explained that it wasn't the illness itself but its impact that bothered her son: "He wants to have a sleepover with his friends and [I] said 'Ok, well, we gotta figure that out because of the, y'know, the hygiene protocols and things like that.' So he'll get upset about if he's missing something." Many parents quit their jobs or reduced their hours to support their children. Some, like Nuhan, sacrificed their social lives, "we don't go anywhere because Davon doesn't feel good. We don't havefriends because she's not good … we live with that, like our life depends on her."

Main category #4: Redefining normal life

Where the process of "survival" and context of "normal life" coincide, lies the main category "redefining normal life." This category encapsulates the ways that chil-dren and parents adapt to life since the tumor, and define their changing lives as normal, to shift from grief to survival, shaping and appreciating their lives together in a new way. Some talked about finding a "new normal" while others made every effort to "keep things normal"; efforts reflected by the subcategories "adapting nor- mal" and "maintaining normal," respectively.

Subcategory #4a: Adapting normal

Recognizing that life was irreversibly changed, children and parents were forced to adapt by expanding their definition of "normal," or shifting their perspectives. Although some elements of the illness and treatment never got easier, children and parents described getting "used to" the routine, the hospital and staff, gaining com- fort, familiarity, and decreasing preprocedural anxiety with time and experience. As Morgan expressed, "I'm not afraid no more … I almost feel like family now 'cause I've been here plenty of times." Several parents described "making the most of" their trips to the hospital, by giving children a small reward, or shifting the focus away from the illness, toward enjoyable activities.

Children and parents' perspectives and priorities were shaped by what they went through, most often by recognizing and valuing the family's strength and capacity to support one another. Casey explained, "I think it made us all not as scared for the things that happen all of a sudden …. Because this one was an all of a sudden thing and [we] even got through it so if there is another all of a sudden thing we can get through that one too." Parents described a double-edged sword of appreci- ating their children, which came hand-in-hand with recognizing the fragility of life. With their new outlooks, many children and parents opted out of social or work-related opportunities to spend more time together as a family. Children looked to their parents for encouragement, helping them to understand, to advo- cate on their behalf, and to help them cope with the myriad difficult situations they faced. According to parents, siblings also provided crucial support; even youn- ger siblings wanted to understand what was happening and be helpful. In spite of jealousy or frustration that some parents observed among siblings, they took on extra responsibilities on the ill child's behalf. Parents were careful to appreciate these efforts and to avoid "overshadowing the other kids … you have to keep a bal- ance within the family."

Parents were deeply grateful for support from family helping to care for siblings at home and visiting the hospital. Some parents described "learning who our real friends are," and amazement at the emotional and practical support provided by friends, colleagues, and communities. Accepting help was not easy, but Karen sug- gested: "Just be gracious and say, "thanks for this." It makes life easier right now. Don't worry, it's not something to worry about paying them back … accept help when it's offered and not feeling that you can do it by yourself."

Having friends with cancer helped children normalize and adapt to their experi- ences, sometimes using humor that others may not have understood in relation to the illness. Children and parents felt accepted within the hospital, whereas on the "outside," they were treated differently. Jordan explained: "If they ask me what's going on with me? I'm fine to tell them because they would understand and not make fun, because they are dealing with almost the same thing." A mother explained, "you become a family, or a family away from home." Health-care pro- fessionals provided a vital source of support. Although some parents recalled diffi- cult interactions, these were seen as anomalies; they expressed admiration and gratitude for staff's skills,

willingness to answer questions and help with medical, practical, and psychosocial issues.

Throughout the interviews, children and parents expressed their determination to help others in similar situations, by participating in research, befriending other sick children and families, or sharing resources, wishing to make it easier for others than it had been for them. Several children and parents were dedicated to raising awareness and funds that would support other families of children with brain tumors, with some even starting their own fundraisers.

Subcategory #4b: Maintaining normal

Although the children's tumors triggered many changes for families to adapt to, other aspects of their lives were able to continue as they had before. These were cherished opportunities for children and parents to maintain familiarity and con- sistency, which helped them to balance their grief over the impact of the tumor on their lives, shifting their focus toward persevering in spite of it. As Carter expressed, "It's a big deal, but then it's not at the same time because you can still live your life more or less normally."

School was frequently mentioned, as peers and familiar routines provided great comfort and support, even if they attended briefly and irregularly. Being treated "normally" by others, especially peers, was of the utmost importance to children, even among those whose classmates were nicer to them following their diagnoses. Carter suggested, to help a sick child, "just treat them like a normal person, and then be open if they wanna talk about it, but don't force them to," stressing, as others had, that they were the same person they had been before the illness.

Parents often referred to their children as "just a normal kid," wanting to maintain family norms and routines, and both the ill children's and healthy siblings' important roles within the family, capacities to participate and contribute. Eliza- beth explained, "we're keeping things as normal as possible and make him do as much as he is capable of doing and not let him get away with things I wouldn't let him get away with ordinarily. You know, still have expectations."

Discussion

In this study, the perspectives provided by children and their parents begin to shed light on the complexity of living with a childhood brain tumor, including relation- ships between grief, uncertainty, optimism, and the creation of a "new normal." The present study was intended to address these significant gaps, particularly the absence of voices of children with brain tumors, and to gain insight into those aspects of the experience that were unique to each individual, and those that were shared among family members. The stories shared by children and parents have begun to illustrate and integrate the range of challenges they face and their coping strategies.

The substantive theory of balancing grief and survival is grounded in partici- pants' experiences, and conceptualizes living with a brain tumor as a dynamic

pro- cess in which children and parents strive to cope with and overcome losses they've lived and those they fear, by focusing on positivity and living a normal life. Chil- dren and parents experienced grief in the context of "dealing with the illness," which they described as "being on the edge," focused on what was happening, and what would or could happen. Each instance of changing symptoms, hospitaliza- tions or recurrences reinforced worries and grief, consistent with earlier studies of parents of children with brain tumors (Forinder & Norberg, 2010; Vance et al., 2004), and Noojin et al.'s (1999) report that repeated experiences were more stress- ful than initial diagnoses.

Although the children's stories clearly illustrated instances of "being on the edge," they spoke less about these experiences than their parents did, which was also noted by Clarke-Steffen (1993). Whereas children in Björk et al.'s (2009) study were described as less anxious than their parents, the present study suggests child- ren's anxiety may have been as intense but more localized and with different foci than their parents. Children described being worried immediately, or a day prior to a procedure; before then, they distracted themselves from anxious thoughts. This may be partially explained by these children having less access to information about the potential risks, with their anxiety focused instead on specific procedures and associated discomforts. This is consistent with Stewart's (2003) observation that children's questions were concrete, based in their inability to predict what, when or if something was going to happen.

For some children, bouts of illness, hospitalization or recurrences were fewer and farther between, allowing greater opportunities for both children and parents to let their guards down, while others had their feelings of "being on the edge" rein- forced more frequently. In each case, it took some time after the crisis had passed before children and parents were able to shift their focus toward survival by "reclaiming health." They could not focus on survival as a means of avoiding "being on the edge." In fact, some parents highlighted important functions of their vigilance and protectiveness in that state: They noticed changes, trusted their instincts, and advocated for their children, in some cases saving their lives. Rather than avoiding "being on the edge," strategies described in the category "reclaiming health," helped children and parents begin to balance their grief with survival only after the immediate threat had passed.

When they were ready to shift their focus to survival, children and parents often defined themselves as being "better off" than other families of sick children, a phenomenon described in reports of childhood cancer (Hildenbrand et al., 2011; Patterson et al., 2004; Schweitzer et al., 2012). Parents described things as "better than they could have been" in light of the worst-case scenarios and risks they had averted. Shielded from this knowledge, children felt "lucky" compared to children who looked "sicker" or had longer treatment protocols.

Children and parents described several other coping strategies reflected in the childhood cancer literature, such as: "doing everything" including medical inter- vention and prayer (Jackson et al., 2007; Woodgate & Degner, 2003a); marking progress toward recovery (Hildenbrand et al., 2011; Schweitzer et al.,

2012; Stewart, 2003) contributing to a sense of control and capacity to manage cancer (Patterson et al., 2004; Woodgate & Degner, 2003a); and focusing on the positive, including faith in god, medicine, and the child's resilience (Björk et al., 2005; Fletcher, 2011), allowing families to "sustain their emotional energy" (Patterson et al., 2004).

Children and parents also grieved in the context of their "normal lives." Whereas, "being on the edge" was rooted in present suffering, risks and threats in the context of the illness, the category "missing normal life" primarily refers to grief over losses that had already occurred, or that would occur as a result of the ill- ness. The losses or strains most commonly expressed in this study related to rela- tionships with family members and peers. Separation from family members during hospitalization was a tremendous burden for those at the hospital and at home, a sentiment echoed by families of children with other cancers as well (Björk et al., 2009; Hildenbrand et al., 2011; McGrath et al., 2005; Patterson et al., 2004; Woodgate, 2006). ome children in this study described their "normal life" being affected only during bouts of illness or hospitalizations; others suffered from lasting, visible effects of the tumor and subsequent unrelenting struggles with peers. The lat- ter group expressed the wish to be "just like everybody else," and had fewer opportunities for respite in a familiar and enjoyable "normal life." Parents generally endorsed their children's perspectives, and longed for their own and their families' lives to "go back to normal" or to establish a "new normal." Consistent with the childhood cancer literature, participants described adapt- ing to a "new normal" as they became familiar with hospital processes and people (McGrath et al., 2004; Patterson et al., 2004; Woodgate & Degner, 2003b); connected with other children and parents (Fletcher, 2011; McGrath et al., 2004); felt the support of family and friends (Woodgate & Degner, 2003a); and perceived relationships as stronger and closer than before the ill- ness (Deatrick et al., 2009; Patterson et al., 2003; Schweitzer et al., 2012). These shifts in perspectives and priorities have also been noted among families of children with cancer, including an increased appreciation for life (Fletcher, 2011), prioritizing "family time" (Björk et al., 2009; Clarke-Steffen, 1997; McGrath et al., 2005), and wanting to "give back" by supporting others (Fletcher, 2011; Patterson et al., 2003; Schweitzer et al., 2012).

Although each child and parent had a unique story and perspective, they all experienced grief in the contexts of the illness and their normal lives, described as "being on the edge" and "missing normal life," respectively. They described *being pulled* in the direction of grief, and *pulling themselves* towards survival by using strategies defined as "reclaiming health" and "redefining normal," to balance their grief with a focus on survival. Grief was renewed with each instance or threat of ill- ness, demanding more effort from the children and parents in order for them to find a more comfortable equilibrium. Repeated struggles compounded the experi- ence of grief, while time between these bouts of illness allowed children and parents some respite, and opportunities to practice and strengthen their coping strategies and focus on survival.

When crises passed, even temporarily, some children and parents embraced their "new normal," making the most of their time at the hospital, and

developing relationships with other families with sick children. Other children and parents invested their energy and focus on retaining what was familiar, including their rou- tines and relationships with old friends, relying on them for understanding and support. Whether they turned to new or old friends and routines, everyone sought the same thing: A sense of belonging, familiarity, and, ultimately, normalcy.

Perhaps the combination of "special emotional empathy" and attunement

between parents and children (Lewandowski, 1996), their ongoing, reciprocal influences (Kuczynski & De Mol, 2015) and the amount and quality of time theyspent together contributed to grief and survival processes that were strikingly simi- lar for both children and parents in our study. As a result a single theoretical framework was constructed, however, two primary, important differences between children's and parents' unique perspectives must also be highlighted.

First of all, differences in their orientations to time and context reflect natural developmental differences between children and adults. Whereas parents longed for things to go "back to normal," or to find a "new normal" in a remembered past or imagined future, children's focus was on feeling and being treated normally in the present. Similarly, parents' concerns were relatively abstract, focused on long-term, potential risks, while children concerns were more concrete and specific, about whether the next procedure would be painful, or when it would end.

The latter example also illustrates the second important difference between parents' and children's experiences: Parents tended to have access to more medical information than their children (Young et al., 2003), that they are able to interpret based on their "evaluation of the context and personal past experience" (George & Solomon, 2008, p. 836). The majority of children in this study did not have thesame impetus as their parents did to fear long-term impacts or risks, as they wereless aware of those threats. While parents compared abstract "what ifs" and "could've been's," children made concrete comparisons with other sick children they met in the hospital. These unique perspectives shape the ways that children and parents perceive and orient themselves in relation to illness experiences, informing grief and survival strategies in subtle but important ways. Nonetheless, they all engaged in complex and dynamic processes of grief and survival that canbe understood within the proposed framework.

Overall, there is overwhelming resonance between the narratives of children and parents in the present study and the reports in the literature about living with childhood cancer, suggesting, as Deatrick et al. (2009) did, that the experiences share much in common. Yet, several of the children in our study bore the addi- tional burdens associated with brain tumors, such as changes in cognitive, physical, behavioral, communicative, and social functioning (Bhat et al., 2005; Jackson et al., 2009; Zebrack et al., 2012). They struggled with exclusion, bullying, and associated impacts on self-esteem and emotional health as reported by Vance et al. (2004). Although these struggles are not unique to children with brain tumors, these chil-dren are less likely to recover from these functional changes than children with other cancers (Bhat et al.,

2005). As such they are more likely to suffer with the related psychosocial strains for a longer, if not indefinite, period of time. Further exploration is needed to understand and develop effective interventions to support children in these circumstances, regardless of whether their struggles were caused by a brain tumor, cancer, or any other illness, injury or difference in ability.

The model of balancing grief and survival draws on the fundamental princi- ples of Stroebe & Schut's DPM (1999); both models describe evolving grief reactions as individuals oscillate between reflecting on the loss and rebuilding their lives, and between feelings of grief and hope (Stroebe & Schut, 2010). Although at their cores they are similar, their applications vary in that the DPM describes grief when a death has occurred (Stroebe & Schut, 1999), while families of children with brain tumors face different dimensions of grief, given their uncertain futures. Whereas the DPM's "loss orientation" focuses on stressors, thoughts, and feelings about the death and the person who died, "grieving" in the present model may be experienced both as a result of losses that have already occurred, as in the category "missing normal," as well as imminent and potential future threats, reflected in "being on the edge." Simi- larly, DPM's "restoration orientation" describes stressors, plans, and activities related to rebuilding life without the person who died; in this model, "sur-vival" refers to efforts to "reclaim health" as they face present threats as well "redefining normal" to overcome or minimize physical, practical, and psycho- logical impacts already endured.

By recognizing the multidimensionality of grieving and surviving in the face ofpast, present and future losses, and those that occur both within and beyond the med-ical realm, the model of "balancing grief and survival" offers a nuanced and flexible framework built on the crucial foundation of the DPM of coping with bereavement.

Limitations

Future research should seek to address several limitations of this study, namely, the under-representation of fathers which occurred despite our efforts to encourage their participation; the cross-sectional nature of the study which did not allow us to explore how individuals' experiences of balancing grief and survival evolve over time; and the absence of families of children who were ineligible for curative treatment.

Although purposive sampling was carefully conducted to include varying malig- nancies, and points along the illness trajectory, our sample may reflect a healthy volunteer effect. While some children had highly malignant tumors, their eligibility for treatment may have contributed to their own or their parents' perception of it as "curable" and a related sense of being "better off" than others. It is also impor- tant to consider the likelihood, in this and other studies, that participants who are willing to discuss their experiences may also be more optimistic or hopeful than their peers who decline participation, or who are not invited because of clinicians' or researchers' sense that they are "overburdened." These complex methodological challenges must be carefully considered and creatively addressed if we are to truly understand the varied experiences of families living with a child's life threateningillness.

Implications for research and clinical practice

This substantive grounded theory of grief and survival offers a new lens through which to understand and explore the ways that children and parents experience grief and uncertainty related to a brain tumor, combined with optimism, and the impacts on their normal lives. This study has begun to address the under-representation of children with brain tumors and their parents in the literature on childhood cancer, bringing to light the importance of doing, feeling and being treated as normal, and the impact of peer exclusion and bullying for this popula-tion. The relevance of this theory to the broader population of children with cancer merits exploration.

Factors contributing to their sense of normalcy or difference were described; however, future research is needed to understand how and why some children and parents strive to maintain normalcy through familiarity, while others seek new relationships and activities geared toward children with brain tumors and their families. These insights could help to shape support programs and suggest who might benefit or be most interested in participating.

Participants' descriptions of their experiences highlight the importance of clini-

cians' awareness of the intense uncertainty that children and parents face, and the ways that it can manifest. Although some parents may want to shield their children from certain information, clinicians can explore the benefits with them of childrenhaving access to the information they need, and common fears and misconcep- tions that arise when that access is not available. Familiarity and normalcy can be fostered in the hospital by helping families develop routines, encouraging them to bring familiar items from home, helping them access hospital, community- and web-based programs. Clinicians can assist parents in determining which activities their child can participate in, maximizing the child's opportunities while minimiz- ing the risks of infection. Finally, novel approaches to peer-support should be explored, including those that could be delivered in clinics, inpatient units, and online, to support families' access and opportunities to connect regardless of where they live or how much time they spend in the hospital.

Although there is much more to learn, the perspectives shared by children and parents have illustrated their experiences of grief in the contexts of their normal lives and dealing with the illness. They demonstrated their determination and capacities to balance their grief with a focus on surviving the tumor and its effects on their lives. They did so with positivity, strength and by coming together with family and community, supporting one another and adapting to the demands and limitations imposed by the tumor. The stories and insights shared by children and parents are important pieces of a puzzle, illustrating the ways that grief, uncer- tainty, optimism, and normalcy coexist and interact. Grounded in experiences of childhood brain tumors, this knowledge can inform future research and practice to help other families living with serious illnesses, to receive the support they need and the reassurance

that they are not alone.

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Unexpected Departures: Experiences of Grief and Epistemic Injustice within the Tamil Community

Faith Sundaralingam

***Abstract*—** This narrative based qualitative research study examined how grief (vastly defined) and epistemic injustice has been existent in the Tamil community since their time of mass arrival from Sri Lanka to Toronto and the Greater Toronto Area (GTA). The narratives shared by three Tamil participants discussed direct experiences of the civil war, loss, adapting to a new way of living, and describes how their knowledge has been taken up in Canada. Narrative research was conducted through the use of semi-structured interviews in order to better understand participant perspectives. Anti-colonial and anti-sanist frameworks were used to theorize the research, alongside literature on epistemic injustice. Data analysis involved thematic analysis. The findings highlighted the experiences of the war, adapting to living in Canada, overcoming barriers, racism, and resilience in the Tamil community.

***Keywords*—** Tamil,civil war,Sri Lanka,community

Faith Sundaralingam is with the Ryerson University, Canada (e-mail: faith.sundaralingam@gmail.com).

College Students and Grief Communication on Social Media

Samah H. Abaza

***Abstract*—** Online grief expression also known as social media mourning was examined in correlation with coping with grief following a significant loss among a population of undergraduate students reporting experience with loss. This study looks at the highly personal and individual experience of grief as it occurs in the context of a rapidly increasing digital world. The researcher administered via email to participants a survey instrument that collected demographic data, as well as data on experience with loss, social media use, online grief expression, and coping with grief. The types of loss reported ranged from minor to severe experiences that have triggered a grief journey for 40 respondents. Results revealed that online grief expression was positively correlated with success in coping with grief. Furthermore, when six different online grieving rituals were tested, results demonstrated that rituals involving grief expression online via written words were more significant in terms of coping with grief than other rituals that did not involve expressive emotional writing. Gender, residential status, and regular social media use were also examined in correlation with the tendency to grieve online. Results have shown that gender and residential status are both not significantly correlated with grieving online among undergraduate students experiencing trauma or loss. However, the frequency and intensity of social media use among students were positively correlated with the tendency to grieve online following a significant loss.

***Keywords*—**Bereavement, Grief, Social Media Mourning, Coping.

Samah H Abaza is a PhD Student in Media Studies at the College of Media, Communication and Information at University of Colorado Boulder. Boulder, CO 80305 USA (phone: 3033594560; e-mail: samah.abaza@coloardo.edu).

Investigating Social-Role concepts in Childhood using NLP Tools

F. Saïd, J. Villaneau

***Abstract*—** This study uses Natural Language Processing (NLP) tools to document gender and age differences in children's perceptions of three social-role concepts: "father," "mother," and "friend." The subjects were 200 first-, and fifth-grade children recruited in 4 elementary schools in the same French area. The experiment consisted of interviews with two open-ended questions for each concept about what words or things a father (resp. mother, friend) makes them think of and what they believe a father (resp. mother, friend) is.

The collected corpus was split into sub-corpora according to three dimensions: age (6-7 vs. 10-11 years old), gender (female vs. male) and school. In each corpus, we first lemmatized the transcriptions. We then extracted, for each concept, the most used terms (nouns, verbs, adjectives, and adverbs), considering children's everyday language and excluding highly polysemous words. We used word embeddings based on French textual resources (Larousse dictionary, Robert dictionary, CNRTL resources) to measure the semantic similarity between terms and group them into semantically coherent categories. We experimented with different unsupervised taxonomy generation tools to turn the collections of terms into topic taxonomies: hierarchical latent Dirichlet Allocation (HLDA), hierarchical Pachinko Allocation Model (HPAC), hierarchical clustering (HClus), and TaxoGen. The quality of the constructed taxonomies was evaluated in terms of relation accuracy (measures the proportion of true positive parent-child relations in the taxonomy), term coherency (quantifies the semantic coherence of the top terms of a category), and cluster quality (examines how well the categories are separated in the semantic space). We selected the best taxonomy for each corpus and compared them in taxonomy depth, number of categories, number of terms per category, and category overlap. The taxonomy of the "friend" concept revealed five main categories labeled: support (sharing; helping), intimacy (talking; sharing secrets; trusting), association (companionship; faithfulness), similarity (shared activities; mutual play; common interests), and affection.

We found out that younger children see their friends as playmates they like and spend time with; while, fifth-graders emphasize the qualities of a friend and the importance of intimacy and support in friendship. Companionship expectation is more prevalent in inner-city schools (vs. suburban schools), where loneliness feelings were reported, and girls are more represented in the intimacy category.

For both "father" and "mother" concepts, we found out four main categories labeled: executive functions (setting rules, supervision, and monitoring, household organization, planning activities), social/emotional functions (recreational activity; sharing ideas and conversation; providing verbal and physical affection; providing comfort and encouragement), care-giving functions (supervising or assisting; feeding; providing sick care; providing transportation); instructive functions (supervising and helping with homework; disciplining; counseling; moral training). We found out that executive functions are more associated with the "mother" concept, and for older children, social/emotional functions are more associated with "father". These findings are consistent with previous work in child psychology and development although we only rely on children's verbal skills. Using clustering-based taxonomies seems promising to investigate childhood stereotypes and we intend to dig further into children's perception of social roles by using sentiment analysis techniques.

***Keywords*—** clustering, taxonomy, social concepts, childhood

F. Saïd is an associate professor at University of South Brittany (France). She is with the LMBA Laboratory, Campus de Tohannic, BP 573, 56017 Vannes cedex, France (e-mail: farida.said@univ-ubs.fr).

J. Villaneau is an emeritus associate professor at University of South Brittany (France). She is with the EXPRESSION team at IRISA laboratory, Campus de Tohannic, BP 573, 56017 Vannes cedex, France (e-mail: Jeanne.villaneau@univ-ubs.fr).

Teaching L2 for Students with a Migrant Background in Portugal: Perspectives on Pandemic Context

Otília Sousa, Maria João Mogarro, Maria João Hortas, Ana Sofia Pinho, Teresa Costa-Pereira, Renata Jatoba, Gonçalo Henriques, Daniela Semião

***Abstract*—** In this communication, we present the results regarding a) the teaching of Portuguese as a second language, and b) the impact of the pandemic context on the educational paths of children and young immigrants. In other words, we will focus our analysis on the teaching of Portuguese language and the responses given by schools and families to the conditions resulting from the pandemic and the main challenges on children learning. We will give voice to immigrant children and young asylum seekers and will analyze the difficulties they experienced under the confinement in the pandemic context.

***Keywords*—** children and young asilum seekers, Portuguese, L2 teaching, pandemic context.

Otilia Sousa is with the Lisbon Polytechnic Institute, Portugal (e-mail: otilias@eselx.ipl.pt).

Language and Culture Diversity in World Languages Education

Mobina Sahraee Juybari

***Abstract*—** A significant proportion of Australia's population is bi/multilingual and born overseas, and the increasing population of migrant and international students contributes greatly to the diversity of this country. Although the multilingual and multicultural status of Australia has been acknowledged by the government in education policy, the strong focus on English in institutional settings threatens the maintenance and learning of other languages. This is particularly true of universities' language provision. The decreasing financial support that higher education has received from government has had a strong impact on the sector. Alongside these domestic events in Australia, international scholarship is increasingly focused on the use of multiple linguistic and cultural resources and advocate an applied understanding of languages and cultures as dynamic and complex notions. This scholarship has had a strong focus on linguistic hierarchies, and the hegemony of English as a language spoken internationally. Nevertheless, this is not the only widely spoken prestigious language. Set in the context of Australia's higher education in languages, this research intends to examine the operationalization of language and culture across two prestigous languages including Chinese and English. The research will explore the teaching of the the global languages through the theoretical lenses of translanguaging and transculturalism. A qualitative multiple case study approach will be adopted with teacher in-depth semi-structured interviews.This research hopes to provide insights for both the positioning and teaching of international language courses in tertiary language education in Australia and more widely.

***Keywords*—** Multlilingualism,World Languages,Language Education,Language and Culture,Higher Education.

Mobina Sahraee Juybari is with the Monash University, Australia (e-mail: mobina.sahraeejuybari@monash.edu).

Assessing Language Dominance in Mexican Signers using the Bilingual Language Profile

E. Mendoza, D. Jackson-Maldonado, G. Avecilla, A. Mondaca

***Abstract*—** Assessing language proficiency is a major issue in psycholinguistic research. There are multiple tools that measure language dominance and language proficiency in hearing bilinguals, however, this is not the case for Deaf bilinguals. Specifically, there are few, if not none assessment tools useful in the description of the multilingual abilities of Mexican Deaf signers. Because of this, the linguistic characteristics of Mexican Deaf population have been poorly described. This paper attempts to explain the necessary changes done in order to adapt the Bilingual Language Profile (BLP) to Mexican Sign Language (LSM) and written/oral Spanish. BLP is a Self-Evaluation tool that has been adapted and translated to several oral languages, but not to sign languages. Lexical, syntactic, cultural, and structural changes were applied to the BLP. 35 Mexican Deaf signers participated in a pilot study. All of them were enrolled in Higher Education programs. BLP was presented online in written Spanish via Google Forms. No additional information in LSM was provided. Results show great heterogeneity as it is expected of Deaf populations and BLP seems to be a useful tool to create a bilingual profile of Mexican Deaf population. This is a first attempt to adapt a widely tested tool in bilingualism research to sign language. Further modifications need to be done.

***Keywords*—**Deaf bilinguals, assessment tools, Bilingual Language Profile, Mexican Sign Language.

Elizabeth Mendoza is with the Autonomous University of Queretaro, Mexico (e-mail: liz.mendest13@gmail.com).

Visual Working Memory, Reading Abilities, and Vocabulary in Mexican Deaf Signers

A. Mondaca, E. Mendoza, D. Jackson-Maldonado, A. García-Obregón

***Abstract*—** Deaf signers usually show lower scores in Auditory Working Memory (AWM) tasks and higher scores in Visual Working Memory (VWM) tasks than their hearing pairs. Further, Working Memory has been correlated with reading abilities and vocabulary in Deaf and Hearing individuals. The aim of the present study is to compare the performance of Mexican Deaf signers and hearing adults in VWM, reading and Vocabulary tasks and observe if the latter are correlated to the former. 15 Mexican Deaf signers were assessed using the Corsi block test for VWM, four different subtests of PROLEC (Batería de Evaluación de los Procesos Lectores) for reading abilities, and the LexTale in its Spanish version for vocabulary. T tests show significant differences between groups for VWM and Vocabulary but not for all the PROLEC subtests. A significant Pearson correlation was found between VWM and Vocabulary but not between VWM and reading abilities. This work is part of a larger research study and results are not yet conclusive. A discussion about the use of PROLEC as a tool to explore reading abilities in a Deaf population is included.

***Keywords*—**Deaf signers, visual working memory, reading, Mexican Sign Language.

Ariana Mondaca is with the Autonomous University of Queretaro, Mexico (e-mail: ariana.mondaca@gmail.com).

An Indigenous Education Policy as the Panacea for Africa's Development: The Nigeria Case Study

Oluwafemi Oni

***Abstract*—** Education is the process by which any society through schools, colleges, universities and other institutions transmits its heritage (its accumulated knowledge, values and skills) from one generation to another. Nigeria was a colony of British imperialist until flag independence was granted on October Ist, 1960 and the conferment of a status of a Republic in 1963.

Notwithstanding the divergent views held by scholars of History, it can be rightly argued that the contribution of Britain in the civilization process of Nigeria is an indelible milestone that propelled Nigeria's march from a primordial and classically primitive antecedent into continental and global political relevance.

In pre-colonial times, education in Nigeria, although imparted through informal means, was very rich and teachers were very dedicated. The feet of the elders formed the classrooms and pupils were initiated into life and living majorly through proverbs and wise sayings. Education during the pre-colonial period up to the 1970's could be said to be organized.

Unfortunately, the 1980's till the present Nigeria has witnessed the desecration of education. These problems affecting the nation's education sector are serious when we take into consideration the fact that government regulations guiding the education sector are mechanical guidelines, entirely lacking in a sound philosophical footing. School curriculum are lacking in content. The study of indigenous languages is gradually being phased out from the school curriculum. All the policy orientations affecting and regulating schooling are not properly organized or efficient in packaging the desired quality of education.

Furthermore, in this age when the family, the basic and first social context for the child's socialization and training, has also been dislocated as both husband and wife enter into full-time occupations to make ends meet, the society now depends almost solely on the school as the social agent to prepare the child mentally, morally and socially to become a responsible citizen.

It is no gainsaying that the contemporary Nigerian environment therefore is thus ill-equipped to prepare children qualitatively to achieve the goal of education of search for an understanding of the meaning and the purpose of life, and discovering the right way to live. Already the nation has begun to witness the effect of this situation, which includes lowering of values and morals, and students' involvement in violent and wicked acts besides meaningless intellectual orientation and ideas.

***Keywords*—** education, curriculum, colonialism, development.

Oluwafemi Oni is with the University of Lagos, Lagos City Polytechnic, Nigeria (e-mail: speciela@yahoo.com).

Corporate Governance and Corporate Sustainability: Evidence from a Developing Country

Edmund Gyimah

***Abstract*—** Using data from 146 annual reports of listed firms in Ghana for the period 2013-2020, this study presents indicative findings which inspire practical actions and future research. Firms which prepared and presented sustainability reports were excluded from this study for a coverage of corporate sustainability disclosures centred on annual reports. Also, corporate sustainability disclosures of the firms on corporate websites were not included in the study considering the tendency of updates which cannot easily be traced. The corporate sustainability disclosures in the annual reports since the commencement of the G4 Guidelines in 2013 have been below average for all the dimensions of sustainability and the general sustainability disclosures. Few traditional elements of the board composition such as board size and board independence could affect the corporate sustainability disclosures in the annual reports as well as the age of the firm, firm size, and industry classification of the firm. Sustainability disclosures are greater in sustainability reports than in annual reports, however, firms without sustainability reports should have a considerable amount of sustainability disclosures in their annual reports. Also, because of the essence of sustainability, this study suggests to firms to have sustainability committee perhaps, they could make a difference in disclosing the enough sustainability information even when they do not present sustainability information in stand-alone reports.

***Keywords*—** disclosures, sustainability, board, reports.

Edmund Gyimah is with the University of York, Ghana (e-mail: edmundgyimah05@gmail.com).

Verbal Argumentativneness: A Study of Retail Store Managers

Brett a Winkelhake

***Abstract*—** The introduction includes the present quantitative study that addressed the potential benefits verbal argumentativeness could relate to the retail industry and determined the perception of verbal argumentativeness by retail store managers. The data collection method was a survey of retail store managers within San Diego County. A chi-square univariate analysis was conducted of these participants. The results of the study indicated verbal argumentativeness was somewhat of a healthy strategy to incorporate into business acumen as a new approach to contribute to the body of research for possible behaviors and plans retail store managers could adopt in relationships with employees. The discussion section shows an untapped source from the retail industry and how this industry can use this study to further research within the retail industry.

***Keywords*—** verbal, argumentativeness, retail,manager, management, communication.

Brett Winkelhake Winkelhake is with the College of Southern Nevada, United States (e-mail: brett.winkelhake@csn.edu).

A Forward-Looking View of the Intellectual Capital Accounting Information System

Rbiha Salsabil Ketitni

Rbiha Salsabil Ketitni is with the University of Algiers III, Algeria (e-mail: S.ketitni@yahoo.com).

Abstract—The entire company is a series of information among themselves so that each information serves several events and activities, and the latter is nothing but a large set of data or huge data. The enormity of information leads to the possibility of losing it sometimes, and this possibility must be avoided in the institution, especially the information that has a significant impact on it. In most cases, to avoid the loss of this information and to be relatively correct, information systems are used. At present, it is impossible to have a company that does not have information systems, as the latter works to organize the information as well as to preserve it and even saves time for its owner and this is the result of the speed of its mission. This study aims to provide an idea of an accounting information system that opens a forward-looking study for its manufacture and development by researchers, scientists, and professionals. This is the result of most individuals seeing a great contradiction between the work of an information system for moral capital and does not provide real values when measured, and its disclosure in financial reports is not distinguished by transparency.

Keywords—Accounting, Intellectual Capital, Intellectual Capital Accounting, Information System

I. INTRODUCTION

The Fourth Industrial Revolution led to the transformation of institutional work of all kinds into a knowledge industry, an industry that gradually became known as intellectual capital as a vital component in the growth and prosperity of companies, which shows that its percentage exceeds 50% of the value of the institution and specifically controls the institution by 87%[1] **.** By investing in human resources, which represent an outstanding moral asset and are important to the institutions, because they bring them great profits and constitute multiple capitals, and since the human resource is an indispensable asset, the world is largely based on the knowledge economy and this prompts us to explore accounting Of a new type of special emergence in the administrative and accounting literature, which is what is known as the accounting of intellectual capital-based on an attempt to present a forward-looking system for its accounting information system because this type of accounting system has never had an accounting information system of its own at all.

Institutions' interest in and application of intellectual capital accounting is an increasingly important factor in the realization of institutions.

[1] Tomo, O. (2017, April 17). *Intangible Asset Market Value Study.* http://www.oceantomo.com/intangible-asset-market-value-study/

In recent years, there has been a rise in interest in research related to intellectual capital and its accounting in multiple topics from a variety of fields. However, this research field is still complex in several accounting issues.

This survey paper aims to address an element of the research field that is characterized by complete ambiguity, and we have not yet found references that I have supervised to talk about. The research discussions mentioned in this article will attempt to provide a forward-looking view on the possibility of overlapping different sciences in a completely complex topic to form an information system that preserves everything within intellectual capital.

II.RESEARCH BACKGROUND

1- Intellectual Capital

A. Developments in the concept of intellectual capital

In the first historical stage of intellectual capital: (Lars Nerdrum, 2001) :

At this stage, intellectual capital was known as "human capital" and this is what several economists presented when they tended to pay attention to employees. William Petty was the first economist to speak of differences in the quality of labor when he defended the "value of workers."

In 1776, "Adam Smith" wrote in his book "The Wealth of Nations" about the knowledge and skills of employees regarding the production process and the quality of output. He also argued the issue of wages was determined by effort, time, and energy. He also stated that teaching and learning should be considered investments.

In the second historical stage of intellectual capital:

Hamel and Prahalad defined it in 1994 as follows: “It is a unique ability that institutions in various fields excel over their competitors, and this is achieved through the integration of the various skills of institutions so that they contribute to increasing the value provided to all investors and is a source of competitive advantage”[2]

“Stewart” defined it in 1997, when he discussed intellectual capital in three points: knowledge, ability, and strength of employees (Tarique Mahmood, 2020). And his definition of intellectual capital is as follows: “It is the intellectual material that has been formalized and utilized to create wealth through the production of an asset of higher value” [3]

In the third historical stage of intellectual capital:

James Chen, former director of investment and content trading for the financial website Investopedia, defined it in 2021 as: “The value of the company’s employees’ knowledge, skills,

[2] Hamel, G. P. (1994). Strategy as a field of study: why search for a new paradigm. *strategic Management Journal, 15*(2), 5-16. https://onlinelibrary.wiley.com/doi/abs/10.1002/smj.4250151002

[3] Stewart, T. A. (1997). Intellectual Capital: The New Wealth of Organizations. *Journal of management consulting, 10*(1), 61-63. https://www.proquest.com/openview/e9dfdcaedf391c9138c6af6f68af49db/1?cbl=46088&pq-origsite=gscholar

business training or other proprietary information that provides the company with a competitive advantage" [4]

2-components of intellectual capital :

Human capital: as defined by the Russian researcher "Kobzistaya Yu. G" as: "a complex category consisting of professional knowledge and capabilities of a person (employee), to obtain superior profits. It is like any type of capital that must be fueled by investments. Education and training are His investments in addition to many of them are a source of economic growth" [5]

Structural capital: "It is what remains in an organization when its employees leave after work" [6]

Relational capital: Relational capital is based on the idea that organizations are not considered as isolated systems, but rather as systems that depend to a large extent on their relationships with their environment, and it was defined by "Muammar Saddam"

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Muammar Saddam F, M. (2017). PENGARUH MODAL MANUSIA, MODAL STRUKTURAL, MODAL RELASIONAL, TERHADAP KAPABILITAS INOVASI DAN EFISIENSI OPERASIONAL MODAL SERTA IMPLIKASINYA TERHADAP KINERJA BISNIS. *DIPONEGORO JOURNAL OF MANAGEMENT, 6*(4), 1-12. doi:2337-3792

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Stewart, T. A. (1997). Intellectual Capital: The New Wealth of Organizations. *Journal of management consulting, 10*(1), 61-63. Récupéré sur https://www.proquest.com/openview/e9dfdcaedf391c9138c6af6f68af49db/1?cbl=46088&pq-origsite=gscholar

[4] CHEN, J. (2021, February 16). *Investopedia*. Investopedia academy: https://www.investopedia.com/terms/i/intellectual_capital.asp

[5] Yu. G, K. (2018). HUMAN CAPITAL: CONCEPT AND FEATURES. *ЭКОНОМИЧЕСКИЕ НАУКИ*(2), 118-122. https://s.fundamental-research.ru/pdf/2018/2/42085.pdf

[6] Edvinsson, L. R. (1998). Intellectual Capital-Navigating in the New Business Landscape. *Business Process Management Journal, 4*(1), 85-88. doi:10.1108/bpmj.1998.4.1.85.1

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as: "All the resources related to the external relations of the organization, from customers, suppliers and partners in research and development [7]

B-Intellectual Capital Accounting :

1- the concept of Intellectual Capital Accounting :

A means of measuring and reporting a set of knowledge-based human and cognitive factors that create sustainable economic value. It is also considered a management method that provides crucial information on the professional and organizational roles of this type of capital to exploit the tacit knowledge surrounding the institution that falls within the scope of intellectual capital" [8]

2- Intellectual Capital Accounting Characteristics :

Accounting concerned with the human resource: Intellectual capital accounting is concerned with the human resource, and this is after many researchers and economists discovered that the human resource is the most important element in the institution. Which made her interest in the human resource a characteristic of her, as the latter has complex features that make it difficult to make an accounting

Accounting is concerned with intangible assets whose true value is unknown: Intellectual capital accounting is concerned with matters that even experts cannot estimate their true value, starting from the complex issues that are present in the human resource from skills and experiences to external relations, to information systems and other structural intangible matters that are not It can be measured, even if it is measured. The metrics that depend on it are ineffective and do not provide real value for what is included in this accounting

Accounting subject to the financial accounting system and international standards: There is no complete standard that talks about intellectual capital accounting, there is only one standard that explains intangible assets, which is International Standard No. 38 (IAS 38) that may be applied to some matters that fall into intellectual capital only Not all of them, but most of them were not talked about. There are International Reporting Standards No. 400 (GRI 400) which is concerned with social disclosures, as it talked about the various points included in intellectual capital, but not all, including Standard 401 on employment, 402 on labor relations

[7] Muammar Saddam F, M. (2017). PENGARUH MODAL MANUSIA, MODAL STRUKTURAL, MODAL RELASIONAL, TERHADAP KAPABILITAS INOVASI DAN EFISIENSI OPERASIONAL MODAL SERTA IMPLIKASINYA TERHADAP KINERJA BISNIS. *DIPONEGORO JOURNAL OF MANAGEMENT, 6*(4), 1-12. doi:2337-3792

[8] Robin Fincham, R. R. (2010, May 17). Intellectual capital accounting as management fashion: a review and critique. *European Accounting Review, 12*(4), 781-795. https://www.tandfonline.com/doi/abs/10.1080/09638180310001628464

and management, 404 on training and education, 405 in which we find diversity Equal Opportunity and Other Standards of Intellectual Capital [9]

The lack of everything that serves intellectual capital accounting has forced the latter to follow standards that can solve its accounting economic events and are usually related to standards for intangible assets. At the same time, what is included in intellectual capital accounting usually does not have an account in the financial accounting system (SCF) and cannot even be entered into an account in the financial accounting system (SCF), and the latter forces accountants to subject economic events related to intellectual capital forcibly to the financial accounting system

Accounting that can distinguish one employee from another: Intellectual capital accounting is characterized by its interest in skills and competencies, and the latter makes it distinguish between one employee and another. The difference is evident from the employee's worksite and the skills he possesses. We may see that the employee's work appears in all accounting records and all institutions with credibility, but the difference that does not appear in all credible records and institutions lies in the skills and wages. One employee over another, whether they are in the same rank or different ranks

If intellectual capital accounting is applied as it should, the difference will be evident and everyone will realize that the difference between the wages of employee (A) from the wages of employee (B) lies in the skills and competencies that employee (A) possesses.

III. METHODOLOGY

This research presents a forward-looking study that can qualify researchers and scientists to participate in devising an accounting information system for intellectual capital. It is also analytical research that analyzes the idea of the system that we reached, at the same time it is considered descriptive

IV. An overview of the intellectual capital accounting information system

Once you read the term "capital", it will immediately come to mind that accounting will be part of the study, and we know that accounting in general needs its own information system that includes data, which are inputs in addition to information, which are the outputs of the system. As each system has its data and business, and if we look at the accounting information system, we will find a network of instructions and accounting procedures that provide information about its beneficiaries wherever it is included in the financial statements. And if we see the human resources information system, we will find it a network of elements of the organization that interact with each other to provide us with the outputs that turn them into reports that help other directorates.

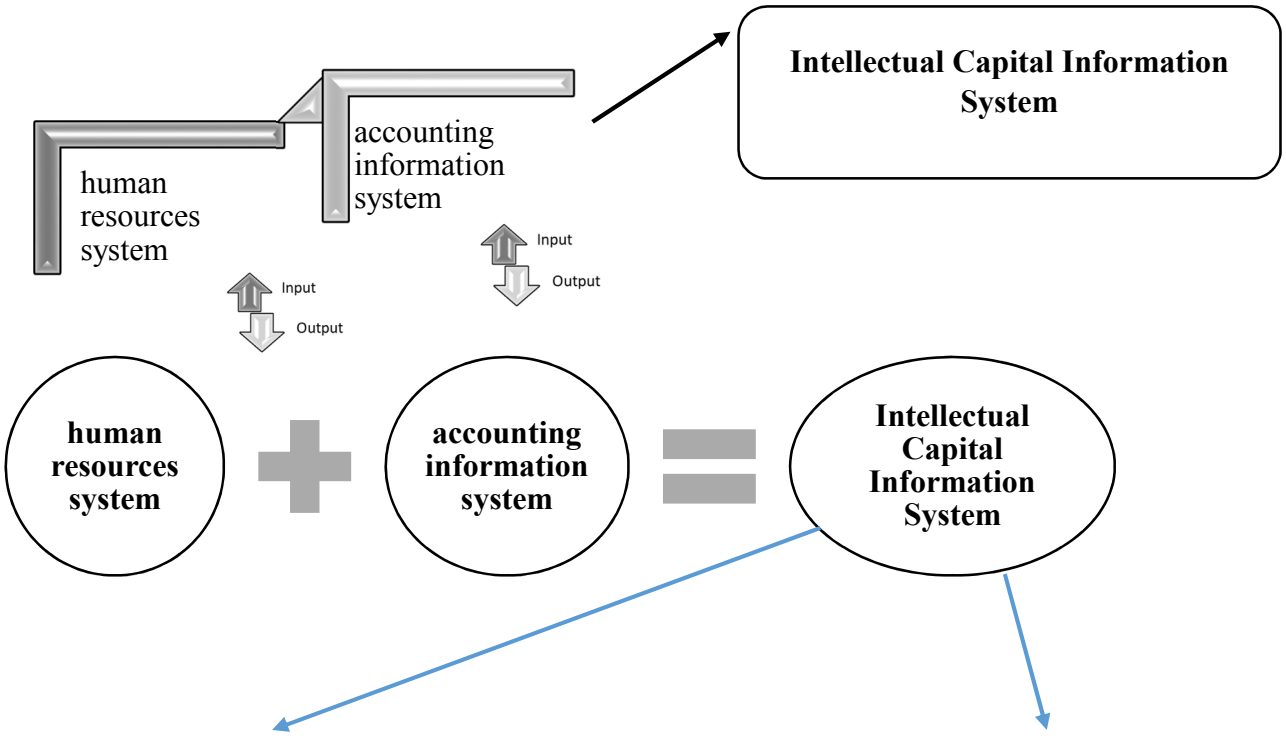
[9] GSSB. (2016). ENSEMBLE CONSOLIDÉ DES NORMES GRI DE REPORTING DE DÉVELOPPEMENT DURABLE. https://www.globalreporting.org/standards/media/1798/french-consolidated-set-of-gri-sustainability-reporting-standards-2016.pdf

But if we rely on the term “intellectual capital” at present, there is no fixed information system for this type of capital. Originally, we find accounting loopholes that prevent the unification of account numbers. From another view, the problem of measuring this intangible type of capital does not provide a real result for the institution, and this is what made the real value of the institution much greater than its market value, which made the evidence of its application end with billing and any economic event related to it is not recorded by most Algerian accountants on the basis that this The event whose real capital is "intellectual".

V-INTELLECTUAL CAPITAL SYSTEM ASSORTMENT

To be able to keep pace and facilitate the method of recording economic events related to intellectual capital, we can express the intellectual capital information system as a system that forms part of two systems, the human resources information system because the human resources department is the original interested in the human resource and all components of the intellectual capital we find prominent in This interest, as the work of human resources directorates finds it fulfilling the roles of the components of intellectual capital, especially the Directorate of Skills and Training. And the accounting information system, given that all economic events must be disclosed in the accounting information systems, is to know the inputs and outputs of the institution's funds. Each of these two systems contains inputs in the form of data, and the latter is either raw data or outputs (information) from another information system and outputs in the form of information analyzed by the applicable system, which are the results of its inputs, evidence, as well as means for those who need it. In general, the intellectual capital information system is a mixture of two independent systems: the accounting information system and the human resources system, and all of these systems are managed by a management information system.

Fig. 1 Formation of an intellectual capital accounting information system



Tab.1 Components of an Intellectual Capital Information System

Types of Intellectual capital	Example of Intellectual Capital Information System	information system
Human resources	• Job competencies • Professional training • enthusiasm and innovation	**1-Human capital**
Accounting	• Professional assessments • Employee insurance registration • Employee income	
Human resources	• Trade secrets • Philosophy of management • Process management	**2-structural capital**
Accounting	• Patents • Record the value of information systems purchased • Trademarks	
Human resources	• Customers • Business cooperation • Delayed orders	**3-Relational capital**
Accounting	• Brands • Favorable contracts • Agreements	

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Studying the Effectiveness of Using Narrative Animation on Students' Understanding of Complex Scientific Concepts

Abdullah. Atoum, Maj. Mary, Shine. Jessica, Felicia. Patrick

***Abstract*—** The purpose of this research is to determine the extent to which computer animation and narration affect students' understanding of complex scientific concepts and improve their exam performance, this is compared to traditional lectures that include PowerPoints with texts and static images. A mixed-method design in data collection was used, including quantitative and qualitative data. Quantitative data was collected using a pre and post-test method with a close-ended questions, whereas the qualitative data was collected through an open-ended survey. A pre and posttest strategy was used to measure the level of students' understanding with and without the use of animation. This test included multiple-choice questions to test factual knowledge, open-ended questions to test conceptual knowledge, and to label the diagram questions to test application knowledge. The results showed that students on average, performed significantly higher on the posttest as compared to the pretest on all areas of acquired knowledge. However, the increase in the posttest score with respect to the acquisition of conceptual and application knowledge was higher compared to the increase in the posttest score with respect to the acquisition of factual knowledge. This result demonstrates that animation is more beneficial when acquiring deeper, conceptual, and cognitive knowledge than when only factual knowledge is acquired.

***Keywords*—** animation; narration; science; teaching

I. INTRODUCTION

Learning science is multifaceted. According to many science educators [1], [2], [3] this is due to its content which includes abstract ideas, laws, and theories. Many scientific concepts require the understanding of processes that cannot be physically observed and often indirectly inferred with the aid of specialized scientific instrumentation [4]. As such, students often have difficulties visualizing these processes and teachers struggle to explain it. This fact makes science education particularly challenging for both teachers and students alike. Educators need to find new ways to help students better understand complex scientific concepts, and thus, improve test performance. Currently, the most common tools used in teaching and presenting scientific concepts is with the use of text and static images displayed on a screen to the students through a computer driven program. The most commonly used program is Microsoft PowerPoint. However, the addition of computer animation allows for simulation and real-time visualization of invisible and unobservable phenomena in science which enhances the student learning experience [5].

This research hypothesized that the use of animation and narrations is more effective at explaining complex scientific concepts compared to the use of PowerPoints with texts and static images. This research aims to provide evidence that the use of animation, shows a significant increase in students' understanding of complex concepts and thus it should reflect on their exam performance. The study findings and conclusion aim to contribute to a change in the traditional methods in teaching which ultimately should contribute to increase in students' success.

II. BACKGROUND

Since the rise of computer animation, many researchers have been studying the role of animation in enhancing the delivery of scientific information to students. Some investigators have compared the use of animation versus static graphics [6], [7], while other groups have studied the effects of animation on either: the students' conceptual understanding [8]; on students' retention and motivation [9]; or on knowledge transfer [10]. There have also been studies which look at improving the effectiveness of a previously viewed animation [4]. The preponderance of research utilizing pre and posttest data support the hypothesis that computer animation contributes significantly to students' understanding and retention of the information presented [6], [7], [8], [9], [11], [12] though a small number have investigators failed to show a correlation. The research of Ivarsson & Karlson [14] argues that animation may increase the cognitive load and thus hinder learning [13], [14]. Other studies found that static presentations can be superior to the animated format, thereby suggesting that other environmental factors may influence the outcome of a study such as ; thus, the relevant question is not "does animation promote learning?" but rather "why, when and under what conditions does animation promote learning?" [13].

A.Abdullah is a PHD student in Public Health Education at the American College of Education, Instructor at St. George's University, True Blue Campus, St' George's, GRENADA. Phone 1473 4585242. Email: aabdulla@sgu.edu

M. Maj is a professor in the Biochemistry Department at St. George's University, True Blue Campus, St. George's, GRENADA, phone 1473 392000 ext. 3169. E-mail: mmaj@sgu.edu

J. Shine is a professor at Cork Institute of Technology, Cork, Ireland

P. Felicia is a professor at Cork Institute of Technology, Cork Ireland

A. Review of cognitive load theory and dual-modality theory of multimedia

According to the cognitive load theory, working memory is very limited, it has short term and low capacity, however, long-term memory is considered infinite with a higher capacity to store information [15]. When the information is processed in working memory, it is then transferred to the long-term memory to be integrated with prior knowledge for learning to occur. It is due to the low capacity of the working memory, information can only be stored there for a few seconds before it is forgotten. Therefore, it will not be transferred to long-term memory. However, working memory capacity can be enhanced when information is processed by both the auditory and the visual channels, based on the dual coding theory [16]. By using both channels, the working memory's capacity is maximized. Although each channel has limited capacity, the use of both channels can facilitate the integration of new information in existing cognitive structures [16].

According to Mayer and Sims, when the information is presented in two or more formats such as visual and verbal, it is then processed by the learner at that moment and passed on to the long-term memory. However, when the information is passively presented, it is lost forever [17]. Sometimes, either channel can be overwhelmed by a high cognitive load. Thus, design strategies that manage the cognitive load for both channels in multimedia learning materials can be implemented to enhance learning [16].

Animation has shown superior effects on cognitive activities through the Dual Modality "Theory of Multimedia Learning. The modality effect refers to the positive impact of mixed presentation of information in visual and auditory modes, which reduces the cognitive load of acquired knowledge and results in an increase in the capacity of the working. These representations are not redundant information, rather, they are complementary, and each mode is essential to form a complete understanding of the concepts." [18] The framework has been modified from originally being a pictorial-based (Figure-1) to more advanced animation-based as it is shown in Figure-2 below:

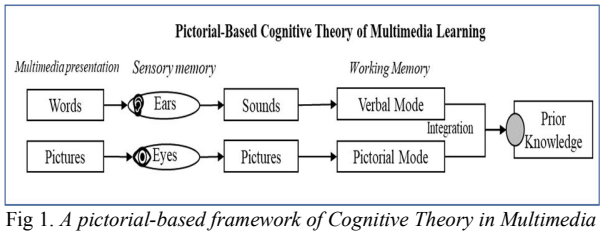

Fig 1. *A pictorial-based framework of Cognitive Theory in Multimedia* [19]

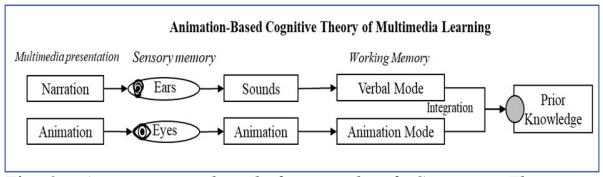

Fig 2. *An animation-based framework of Cognitive Theory in Multimedia* [19]

Multimedia products with different combinations of text, graphics, video, animation, and narration, if effectively combined within instructional material can reach its fullest potential for learning [20]

Paas, Renkl, & Sweller [21] identified three different forms of cognitive loads;

- Intrinsic load: is created by the difficulty of the material itself, mainly manageable with a proper instructions that breaks the material into simpler steps.
- Extraneous load: is created by the demands imposed on the learner by the teacher when using ineffective teaching methods, mainly managed by effective presentation of the material. The use of visual presentations or animations instead of lengthy paragraphs will reduced extraneous load.
- Germane load: is representing the effort input into processing the information and creating a permanent store of knowledge. Germane load can be enhanced by learning from experience to form understanding and anticipation of the future or a schema.

These cognitive loads, their meanings and managements are represented in the table below:

Table I. *Summary of different types of cognitive loads based on the Cognitive Load Theory*

Cognitive loads		
Intrinsic	**Extraneous**	**Germane**
Created by the subject difficulties (Nature of the information)	Created by the teaching methods (Nature of the instructional design)	Created by the way the information is processed and knowledge is constructed.
Should be managed by creating a balance between information and segmenting.	Should be minimized by reducing distractions and introducing effective teaching methods.	Should be maximized by proper course design and implementing proper learning techniques.

Paas et al. [21] suggested some required strategies to reduce cognitive loads. For example, intrinsic cognitive load can be reduced by breaking down complex concepts into smaller digestible chunks, so students are not overwhelmed with the content [21]. While extraneous load can be reduced by changing the methods in teaching and the way instructions are given to students. For instance, when lectures are taught using PowerPoints with excessive texts and static graphics, it generates excessive cognitive load and failure to remember or retain the information. By replacing the traditional methods in teaching with innovative and effective teaching methods that can facilitate learning, extraneous cognitive load can be reduced, and working memory capacity will be used for intrinsic and germane cognitive load instead [22]. Germane cognitive load is created by the way the learners process the information and construct the knowledge; it could be related to the strategies

that the learners used in their learning; germane load should be increased to facilitate learning.

Based on multiple empirical studies, Mayer & Moreno [23] suggested nine principles and recommendations for the effective use of multimedia in education (Table 2), they recommend the use of modality effect and temporal contiguity effect, suggesting that the use of animation and narration simultaneously plays an important role in reducing the overall cognitive load and facilitate learning. They consider that effective learning experiences can potentially minimize extraneous cognitive load, manage the intrinsic load, and optimize the germane load.

Table II. *Effective practices to reduce cognitive load adapted from* [23]

Principle	Load reducing method
Modality effect	Words are presented as narration rather than as on-screen text
Segmentation effect	The lesson is presented in learner-controlled segments rather than as a continuous unit
Pretraining effect	Students know the names and behaviors of system components
Coherence effect	Irrelevant and extraneous material is excluded
Signaling effect	Using cues to assist with the processing of the material to reduce extraneous load
Spatial contiguity effect	Words are placed near corresponding parts of graphics
Redundancy effect	Words are presented as narration rather than narration and on-screen text
Temporal contiguity effect	Corresponding animation and narration are presented simultaneously rather than successively
Spatial ability effect	High spatial learners benefit more from well-designed instruction than do low spatial learners

Lowe & Schnotz [24] suggested that animation has the potential to serve a cognitive function. Cognitive function refers to the effective presentation of the dynamic processes which allow learners to understand the information in an easier way [24], which ultimately leads to an increase in their performance.

B. Previous studies on the effect of using animation on students' performance

At the primary school level, Rosen performed a study on the effect of using BrainPOP animation (Animated Educational Site) on 5th and 6th graders in elementary science class, she found that learning with animation increases students' ability to learn the concept and transfer the knowledge to new and unfamiliar situations. She also found that there is an increase in students' motivation to learn science with technology [10]. However, this study remained limited to knowledge transfer and motivation without considering other aspects of knowledge, such as students' abilities and skills.

At the secondary school level, Trey & Khan [7] studied the use of computer animation to promote learning unobservable phenomena in science. They introduce animation to support the teaching of Le Chatelier's principle to 12th-grade students during science class. The students were divided into two groups, one group was given computer-based instructions and static images, and the second group was presented with computer-based animation that was dynamic and interactive. Their study revealed that most students achieved a higher understanding of the unobservable phenomena using animation compared to static images. However, their study was limited due to the small sample size (N=15) and the lack of students' feedback (qualitative data). Addressing these limitations would have revealed a greater insight into the contribution of animation to students' understanding [7].

At the university level, Lin & Atkinson [6] investigated the role of animation and visual cueing in supporting learners in understanding the rock cycle concept. Their study indicated that participants in the animated and visual cueing groups were able to understand more concepts than their peers in the control groups. Their study also revealed that the use of visual cues in addition to the animation, allowed for time efficiency, and quick learning of the concepts. Their study, however, may have failed to measure the cognitive load of the animation accurately. As a result, there was no distinction between concepts retention or process retention. Therefore, it is recommended that cognitive load be measured by specifying the task demands in learning concepts or processes [6].

Sanger, Phelps, & Fienhold [25] design a similar study using two groups of university students; one group was asked to explain the behaviors of gas particles after only receiving instructions via traditional methods; (i.e. board drawings) the second group was asked to explain the same concept after watching a computer animation. The results showed that students who watched the animation as a part of their instructions were able to provide a better explanation and demonstrate a greater understanding of the concept [25].

Wishart [4] indicated that the process of creating animation rather than watching it allowed students to be more engaged in the learning process and led to more understanding of the scientific process under study. The critical role of the teachers was also emphasized in creating stimulating animation and activities that support learning. It is due to the social interaction between students and teachers during watching, making and developing the animation, students spend more time discussing the scientific process and "discussing other groups' animation" which increased students' understanding of the scientific process involved [4].

In conclusion, using animation as a supplementary learning material while teaching science play an important role in helping students to understand complex concepts, in addition to increasing their motivation and interest in learning.

C. Design factors for educationally effective animation

How can we design educationally effective animations? What are the factors that make some animation more effective than others? As we know, the overall purpose of using animation is to lower the cognitive load and facilitate learning. For the animation to be effective, the design of the animation needs to facilitate the reduction of the cognitive load, without having to reduce the amount of information given. Researchers in this area have indicated that when using well-designed animation, the cognitive load can be effectively reduced [27], [28]. Probably the most common factor that can influence students' learning outcomes when using animation are the quality of the animation [29], the educational setting and the level of interactivity [30]. In addition, animation can be more effective when it is combined with narration [3], [28], due to its ability to engage auditory and visual channels. Therefore, designers and animation makers should have principled guidance on how some elements of the animation should be designed in order to maximize learning [5]. Researchers suggested several design principles for the visual design and the interaction design of dynamic visualizations of the animations. In addition, there are new and emerging principles with regards to the content design such as cueing principle, color-coding principle, interactivity design principle and learner control of pacing principle [31].

Despite the superiority of using animation over static pictures as a tool in teaching, it appears that under specific circumstances, the use of animation may increase cognitive load and processing demand than static pictures [32]. Due to the limitation of our memory, making connections between the presented visual animation and prior knowledge during the transient animation, and process loads of information in a short time can impose a challenge to our working memory [33]. Thus, improving the quality of animation has the potential to make it more effective, and therefore it can contribute to an increase in students' understanding of the concepts [34].

III. Summary of the Literature

Reviewing the literature made it clear that there is a consistent agreement on the benefits of using computer animation as a complement to traditional lectures when teaching complex concepts. However, other factors may affect the research findings, such as the quality of the animation and its cognitive function.

Although several studies showed that animation has a positive effect on students' understanding, other studies showed no effects or even negative effects. Thus, it can be concluded that animation is not intrinsically more effective than static graphics; it is rather the design of the animation and how it is used play a key role in their effects on learning [34]. Consequently, more research and testing are required in this area to gain a better understanding of the role of animation in science teaching. The following research study is designed with the aim to find answers for the following research question: (To what extent does the use of animation affect students' understanding of complex scientific concepts, and consequently improve their test performance?) Meaning, will there be a significant difference in students' test performance before and after the use of animation? To find the answers; the following research methods were used.

IV. Research Methods

This study investigates the effects of using animation on students' understanding of complex scientific concepts through the analysis of their exam performance. A pretest was administered to students (after teaching the concept using PowerPoints with texts and static images), followed by a posttest (after presenting a computer animation about the same concept). It was hypothesized that the effective use of animation and narration during lectures, allows students to increase their level of conceptual understanding, and retention of the information more than using PowerPoints. Testing the hypothesis required the development of the following research design.

V. Research Design

When Krathwohl (2002) reviewed Bloom's taxonomy, he distinguished four different kinds of knowledge; factual, conceptual, procedural, and metacognitive knowledge.

In this study, pre and posttest strategies were used to measure the four different levels of students' understanding. The test included multiple-choice questions to test factual knowledge, open-ended questions to test conceptual knowledge, and label the diagram questions to test application knowledge, administered before and after the use of animation.

An experimental design approach was used; experimental design by definition is the use of scientific methods to establish the cause-and-effect relationship among a group of variables, in this type of research, all variables will be controlled except the ones understudy which we call the independent variables. This way we study the effects of the independent variables (traditional vs animated assisted teaching method) and the dependent variable (students' performance) and we calculate and analyze the results and look for trends [36]. The independent variable in this experiment is the teaching method, while the dependent variable is the pretest and the posttest score for each level of knowledge acquired. This investigation employed a mixed-methods approach, including the collection and the analysis of quantitative and qualitative data.

Quantitative data were collected experimentally using a pre and posttest score and close-ended questionnaire, qualitative data were obtained through open-ended questionnaires, as summarized in the table below:

Table III. *Summary of research design*

<table>
<tr><td colspan="2">Quantitative</td><td>Qualitative and Quantitative</td></tr>
<tr><td>Pretest
Administered after traditional teaching using PowerPoints</td><td>Post Test
Administered after watching the animation and narration</td><td>Survey questionnaire
Administered after completing both experiments</td></tr>
<tr><td colspan="2">Five multiple-choice questions (to test factual knowledge)</td><td>Quantitative
Six close-ended questions</td></tr>
<tr><td colspan="2">Five open-ended questions (to test conceptual knowledge)</td><td rowspan="2">Qualitative
One open-ended question</td></tr>
<tr><td colspan="2">One label the diagram question (to test application knowledge)</td></tr>
</table>

An experimental design is used when the study includes different groups of participants under different conditions. In this experimental study, there was only one group, there was no control group. This type of experiment is referred to as repeated measures [37], in this type of design, the same participants take part in each condition of the independent variable (different teaching methods). This means that each condition of the experiment includes the same group of participants. The advantage of this method is that individual differences between participants are reduced, it also saves time during the recruiting process. However, the disadvantage is the order effect, which refers to the order of the conditions that may affect participants' behavior. For example, participants may perform better on the posttest just because they learned the concept better and not because of the intervention this is refer to as (practice effect), other times, participants may perform poorer on the posttest just because they may not be as motivated or tired this is referred to as (fatigue effect). These limitation can be overcome by switching the order of intervention [37].

A. Validity and Reliability

Validity and reliability increase transparency and decrease opportunities to insert researcher bias in research. Validity and reliability are two of the most important methods used to evaluate research instruments; Mohajan [38] defines reliability as "the degree to which an assessment tool produces stable and consistent results" [38].

The reliability of the assessment tool used in this research addressed through the use of mixed methods in data collection, such as quantitative and qualitative methods. The quantitative method in data collection utilized the same version of the assessment for the pre and posttest. The study was replicated for primary school students and secondary school students to establish relationships and identify stable and consistent results. However, selection may have impacted the reliability of test data- testing threat (i.e., type of questions selected), and selection- instrumentation threat (i.e., test implementation such as the chosen topic and the chosen animation).

Mohajan [38] defines validity as "the extent to which an instrument measures what it asserts to measure" [38]. In this study, test questions were created based on a judgment of the researcher in consultation with schoolteachers as the subject matter experts. It contained various types of questions such as multiple-choice questions, open-ended questions and labeling the diagram questions. It tests different aspects of knowledge acquired in the topic, such as fact recalling, conceptual understanding, memorization, and retention of information. Random samples of students were recruited from two different academic levels, primary and secondary. The use of various tools in testing and the random selection of subjects, in addition to the repeated experiments with two different academic levels, can contribute to the validity of the findings. The research findings can be applied to similar populations of students under a similar context of study; it may also be extended to different populations and another context of study.

B. Study Implementation

This research study was replicated with two random cohorts of students from two different academic levels (primary and secondary). An e-mail was sent to the school principal requesting permission for students to participate in this study. The principal e-mailed the parents informing them about this study and asking for their consent.

After a discussion with the class teacher, and for each group of students, the followings were developed:

(1) A scientific concept was chosen from the curriculum, with the following criteria:
- It is one of the concepts that students are familiar with.
- It is one of the concepts that is considered challenging for some students.
- It studies invisible phenomena in the real world.
- It contains multistep processes at the microscopic level.

(2) PowerPoints presentations were developed to present the concept traditionally, with the following criteria:
- It includes basic information about the chosen concept.
- It is short and concise, with no irrelevant information.
- It includes the same information presented in the animation.
- It includes static pictorial elements and minimum on-screen text.
- It was presented and explained by the class teacher.

(3) Animation explaining the concept was carefully chosen from YouTube library, with the following criteria:
- It contains the same information in the PowerPoint.
- It explains the concept under study with no irrelevant information.
- It doesn't exceed 5-7 minutes in length.
- It includes professional human voice narration.

(4) Pre and post-test questions covering the concept were developed, with the following criteria:

Each test included:
- Five multiple-choice questions (MCQs) to test recalling of facts.
- Five open-ended questions (OEQs) to test conceptual understanding of the concept.
- One or more "label the diagram question" to test the visual application of the knowledge.

(5) Clear, simple, and straightforward survey questionnaires, included six closed-ended questions, and one open-ended question, was used to collect students' feedback and perception about their own learning experiences, with and without the use of animation.

The recruited population in this experiment were students from Grade-6 (11 to 12 years old), and Grade-9 (14 to 15 years old).

Table IV. *Participants groups and assigned concepts.*

Class	**Topic**	**Animation**
Grade-6 (11 to 12 years old), N=24	Photosynthesis	Designmate's Eureka
Grade-9 (14 to 15 years old), N=24	Cell structure and function	Nucleus Medical Media
University (18-21 years old), N=24	Mitosis and Meiosis	

Instructions were given to each group about the process and the objectives of the experiment.

- During the first part of the experiment, the teacher reviewed the chosen concept using PowerPoint presentation with text and static pictures, followed by a paper-based pretest to assess students' understanding based on teacher's review and prior knowledge.
- In the second half of the experiment, students watched a narrated animation of the same concept, followed by a paper-based posttest to assess students' understanding based on the animation and the narration.
- At the end of both experiments, a paper-based survey questionnaire, including six closed-ended questions, and one open-ended question was administered to students to collect their feedback.

Data was collected for each age group in three stages:
(1) Pretest scores.
(2) Posttest scores.
(3) Survey feedback.

Test scores were analyzed using a two-tailed paired t-test. A paired t-test is used to compare two population means for two samples in which observation of one sample can be paired with the observation of the other sample on the same test (e.g. students' diagnostic test results before and after a particular module or course) [39].

VI. RESEARCH FINDINGS

A. Quantitative data analysis

1) Pre and posttest data analysis

Pre and posttest results were compared for multiple-choice questions (MCQs) versus open-ended questions (OEQs) for both primary and secondary school students.

At the primary school level, students showed a 10% increase in the average score on the MCQs posttest as compared to the pretest (84.2% to 94.2%). However, students showed a 28% increase in the average score on the OEQs posttest as compared to the pretest (68.3% to 96.7%).

At the secondary school level, students showed the same 10% increase in the average score on the MCQs test (80% to 89.2%). However, the increase in the average score for the OEQs test was 15% (67.5% to 82.5%).

The pre and posttest average scores for primary and secondary students with regards to the MCQs and the OEQs are summarized in the graph below.

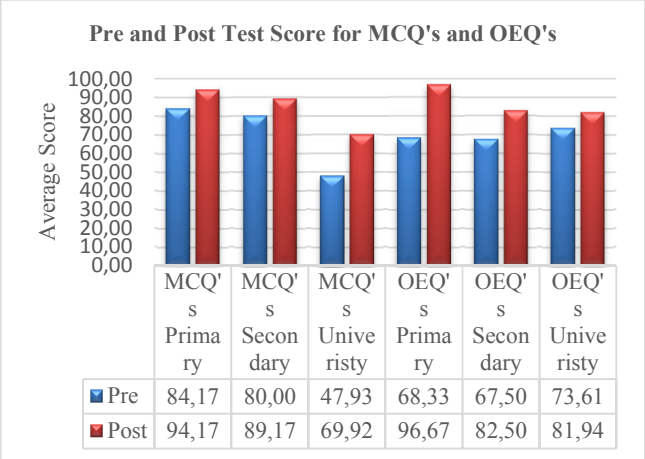

Fig 3. *Bar graph represents pre and post-test score for MCQs versus OEQs*

This data was analyzed using a two-tailed paired t-test, and the following graph was generated:

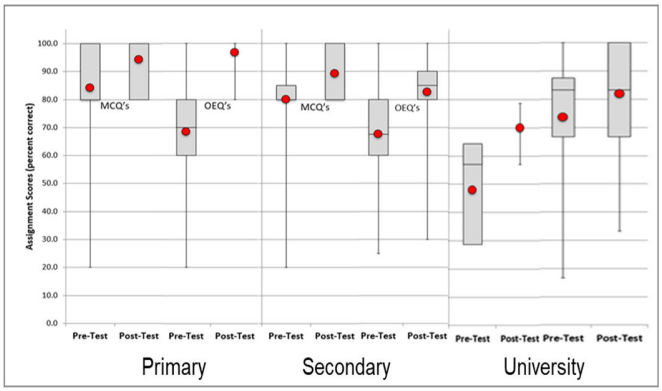

Fig 4. *Box-and-Whisker plot for pre and posttest score for MCQs versus OEQs*

A total of 24 students completed a 100-point assessment. One-factor t-tests were used to compare the pretest and the posttest score with the criterion of success (set at 70%). The table below represents the findings statistically analyzed using a two-tailed paired t-test.

a) Primary school

For primary school students, a two-tailed paired t-test was used to compare pre and posttest scores for MCQs versus OEQs, and the results are shown in the table below:

Table V. *Pre and posttest scores analysis for primary school students*

Percent scores	Pre-MCQs	Post-MCQs	Pre-OEQs	Post-OEQs
N	24	24	24	24
Average (mean ±95% confidence interval)	84.2 ± 7.8%	94.2 ± 3.7%	68.3 ± 7.8%	96.7 ± 3%
Std Dev	19.5	9.3	19.5	7.6
Criterion	70	70	70	70
Percentage of students met the criterion	20 (83.3%)	24 (100%)	12 (50%)	24 (100%)
p	0.0017 P<0.005	0.000 P<0.001	0.679 P>0.05	0.000 P<0.001
p description	Statistically significant	Statistically significant	Not statistically significant	Statistically significant
d	Cohen's d=0.7	Cohen's d=2.6	Cohen's d=-0.09	Cohen's d=3.5
d description	Medium effect size	Very large effect size	Tiny effect size	Very large effect
Class scores	Measurably exceeded the criterion for success.	Vastly exceeded the criterion for success.	Only met the criterion of success	Vastly exceeded the criterion for success

b) Secondary school

For secondary school students, a two-tailed paired t-test was used to compare pre and posttest scores for MCQs versus OEQs, and the results are shown in the table below:

Table VI. *Pre and posttest score analysis for secondary school students*

Percent scores	Pre-MCQs	Post-MCQs	Pre-OEQs	Post-OEQs
N	24	24	24	24
Average (mean ±95% confidence interval)	80% ± 8.2%	89.2% ± 4.1%	67.5% ± 7.5%	82.5% ±7.1%
Std Dev	20.4	10.2	18.8	17.8
Criterion	70	70	70	70
Percentage of student met the criterion	22 (91.7%)	24 (100%)	12 (50%)	22 (91.7%)
p	0.025 P<0.025	0.000 P<0.001	0.52 P>0.05	0.0022 P<0.005
p description	Statistically significant	Statistically significant	Not statistically significant	Statistically significant
d	Cohen's d=0.49	Cohen's d=1.88	Cohen's d=-0.13	Cohen's d=0.7
d description	Small effect size	Very large effect size	Tiny effect size	Medium effect size
Class scores	Slightly exceeded the criterion for success.	Vastly exceeded the criterion for success.	Only met the criterion of success	Measurably exceeded the criterion for success

c) University level:

A two-tailed paired t-test was used to compare pre and posttest scores for MCQs versus OEQs, and the results are shown in the table below:

Table 1. *Pre and posttest score analysis for university students*

Percent scores	Pre-MCQs	Post-MCQs	Pre-OEQs	Post-OEQs
N	24	24	24	24
Average (mean ±95% confidence interval)	47.9 % ± 6.8%	69.9 % ± 2.9%	73.6% ± 10.2%	81.9% ±8.1%
Std Dev			25.5	20.2
Criterion	70	70	70	70
Percentage of students met the criterion	0 (0%)	19 (79.2%)	14 (58.3%)	16 (66.7%)
P	-6.4 P<0.001	-0.05 P>0.05	0.49 P>0.05	0.0082 P<0.005
p description	Statistically significant	Not statistically significant	Not statistically significant	Statistically significant
D	Cohen's d=-1.31	Cohen's d=-0.01	Cohen's d=0.1	Cohen's d=0.6
d description	Very large effect size	Tiny effect size	Tiny effect size	Medium effect size
Class scores	Far short of meeting the criterion for success.	Met the criterion for success	Only met the criterion of success	Measurably exceeded the criterion for success

2) Labeling the diagram data analysis

The percentage of students who were able to label the diagram correctly was compared before and after watching the animation.

At the primary school level, only 8% of the students were able to label the diagram correctly before watching the animation compared to 96% after watching the animation.

At the secondary school level, 25% of the students were able to label the diagram correctly before watching the animation compared to 50% after watching the animation. The data of labeling the diagram question are summarized in the chart below:

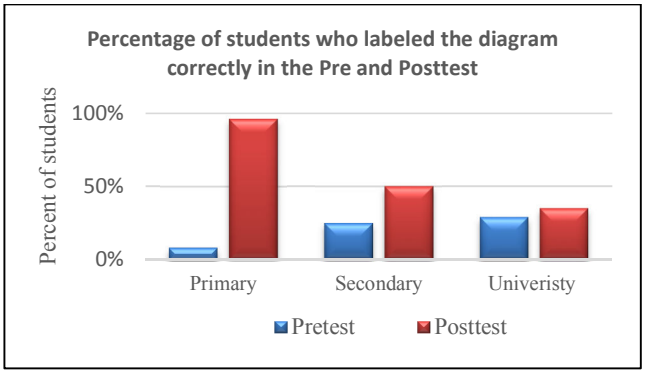

Fig 5. *Percentage of students who labeled the diagram correctly pre and post animation*

3) Survey data analysis

The students filled a survey questionnaire right after completing both experiments, and the results are shown in figure-6,7 and 8 below.

At the primary school level, 100% of students agreed that animation helps with memory and retention, 95% agreed that it helped them to understand the material, and 87% agreed that it helps them with test performance. However, 29% said it requires more time, and 37% said it requires more effort as compared to the traditional method.

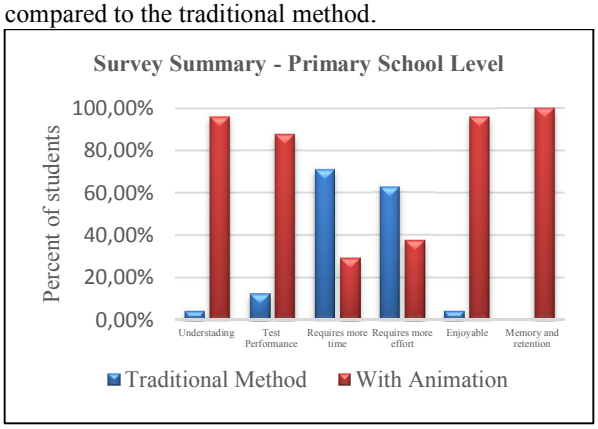

Fig 6. *Summary of survey questions - (Grade-6) (N=24)*

At the secondary school level, the results show 83% of this cohort of students said animation helps with understanding, 75% said it helps with retention and test performance, 41% said it requires more time, and only ~ 1% said it required more effort as compared with the traditional method.

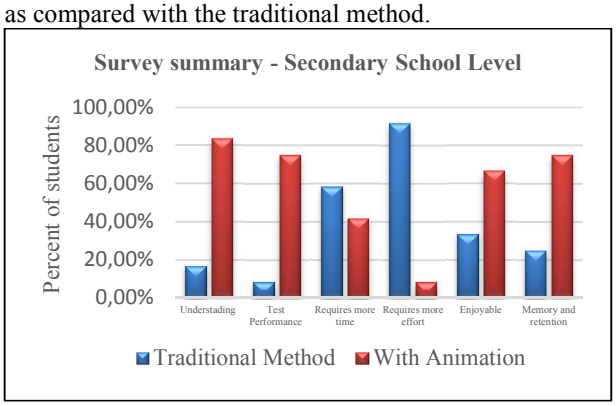

Fig 7. *Summary of survey questions - (Secondary School Students) (N=24)*

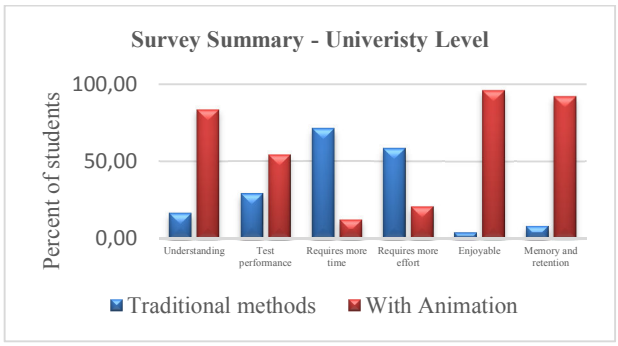

Fig 8. *Summary of survey questions - (University Students) (N=24)*

B. Qualitative data analysis

The survey questionnaire included one open-ended question which provided us with more insight into students' own perception of learning with both experiences. We asked: Which is your preferred method in learning (Traditional or Animation) And why? (Choose only one method). For the first half of the question, the results are summarized in the table below:

Table VIII. *Percentage of students preferring animation over traditional teaching.*

Primary (N=24)		**Secondary (N=24)**		**University (N=24)**	
Traditional	**Animation**	**Traditional**	**Animation**	**Traditional**	**Animation**
8%	92%	38%	62%	23%	77%

Some of answers for the second half of the question are summarized below:

- From primary school students: "*I prefer animation because it is fun. – The animation shows inside the plants. – I prefer animation because it is loud and less distracting. – Animation, because it makes everyone quiet. - Because animation is different. - Traditional because the teacher is explaining. - I like it more when the teacher explaining the lesson.*"

- From secondary school students: *"Animation, because it is clearer. – Animation, because it shows nice and colorful pictures. – Animation, because it keeps me focus. – Animation, because I remember it more. – Animation because it is more organized. – Animation because I see the video and hear the explanation at the same time. – Teacher's explanation, because I can ask questions. Traditional, to communicate with the teacher. Traditional because it is more fun. Traditional because the teacher can make jokes and talk to us."*

- *From University students: "Animation because it helps me to understand complex biochemical pathways and biological processes" "Animation shows the movement of molecules and makes it easier to visualize" "A mix of both will allow for a complete understanding of the material."*

This study attempts to answer the research question; to what extent does the use of animation and narration improve students' understanding of complex scientific concepts? An experimental study was employed using pre and posttest strategies to find answers to the research question. We assessed students' learning of factual, conceptual, and procedural knowledge to compare students' test performance when learning through traditional methods versus animation.

VII. Discussion

A. The significance of findings

Based on the pre and posttest data analysis (Table 7 and Table 8), we can see that the difference between pre and posttest regarding MCQs was 10% and 9.2% for both primary and secondary students, respectively. This increase is statistically significant using two-tailed paired t-test, which

means that both groups did slightly better on the MCQs posttest than they did on the MCQs pretest. However, the difference between the pre and posttest scores for OEQs was (28.3%) in primary and (15%) in secondary. This result is more statistically significant than the difference in MCQs scores, which means that both groups perform much better on the OEQs posttest than they did on the OEQs pretest. In other words, students in both groups have shown a tremendous gain of conceptual knowledge as compared to their gain of factual knowledge after watching the animation. This result demonstrates that animation can provide more assistance in understanding when acquiring deeper conceptual and cognitive knowledge related to processes under study than if only factual knowledge is acquired [40].

Open-ended questions are used to test a deeper understanding of the material because they require a higher level of thinking and activation of processing skills [41]. The increase in students' scores on OEQs indicates that teaching with animation allowed for deeper understanding, increase in knowledge implementation, reasoning, and retention ability.

Procedural knowledge or application knowledge was tested by assessing students' ability to label a diagram correctly pre and post the use of animation. Students' ability to apply the knowledge increased from 8% to 96% at the primary level, and from 25% to 50% at the secondary level (Figure 8). This result demonstrates that watching the animation increases students' ability to retain visual information and apply it correctly more than static diagrams.

When analyzing survey questionnaires, students indicated that animation helped them mainly in understanding the material, retention of the information and answering exam questions. Students also indicated that learning with animation requires less time and less effort to learn the material, so learning becomes easier. Similar studies confirmed that students are more motivated to learn from visualized material than reading information from paper-based instruction [42]. Because some people are lazy by character, they usually search for the easiest way to understand difficult processes [42]. Understanding concepts from traditionally based instruction needs concentration and requires more effort while studying with animation is easy. The study has also pointed out that using animation in the lesson helps to increase learning intrinsic motivation. It made difficult-to-understood problems more easily understandable [42].

Analyzing open-ended question's results from the survey revealed that there are more students at primary school level preferred animation over traditional methods in teaching. However, students at the secondary level showed more support for the traditional method in teaching because it allowed them to ask questions and build more teacher/student communication. Qualitative data showed that some students supported the use of animation, while others supported the traditional teaching method, which means that animation cannot be used as a replacement of traditional teaching, but rather to compliment.

B. Resonating results with the literature

The overall result of this study builds on the existing evidence of the dual coding theory in multimedia learning, which suggests that visual and verbal redundancy should facilitate learning, "assuming that these attributes are necessary for the learning of facts, concepts, or principles" [9]. The results also support the cognitive theory of multimedia in learning, which suggests the use of visually presented animation and verbally presented narration as a recommendation to reduced cognitive load [16]. Assuming that cognitive load can be measured through students' performance, then an increase in performance will attribute to a reduction in extraneous load [43]. Meaning students will show an increase in their performance when the material is presented in a way that facilitates the overall understanding of the concept. Thus, the increase in students' performance on the posttest in this study will attribute to the way the material is presented through the animation and the narration. However, the level of increase in students' performance between pre and posttest could be to a larger extent related to the instructional design and the content of the animation as well as to the presentation style [44].

C. Limitation

Like many other pieces of research, this study provided evidence supporting the use of animation as a tool for learning. However, this research is subject to several limitations such as the small number of participants (N=24), which limited the statistical value of the experiment. It was due to the difficulties in the recruitment process and the lack of available students willing to participate in this experiment during the last week of school. Therefore, the generalizability of the results may be limited by the small size; future studies may consider larger subject size. Test-selection bias and animation-selection bias could also be factors that affected the findings of the results; this could be avoided by discussing the study implementation with other colleagues and expert bodies.

VIII. CONCLUSION

In line with prior research studies, this study showed the positive effect of animation on students' test performance, however, the level of the increase in student's test performance may be to a larger extent related to the instructional design of the animation as well as the style of presentation [44]. Sometimes, a well-structured lesson-plan and a highly energized teacher can make a traditional classroom experience better than watching any animation, and other times, a well-designed and good quality animation can provide more benefits than attending any lecture. It is acknowledged that no one method alone, apart from the context and teachers' general attitude towards teaching science, can be seen as a proper solution for teaching. However, competency in using new technological media presentations, and knowing their limitations can be a promising way to enhance students' motivation to learn and understand science. Finally, it is relevant to mention that the production of high quality and well-designed educational animation and integrating audio narration requires the investment of so much time and money. Therefore, finding the balance between the cost and the benefits of integrating animation and narration in education imposes many

challenges on teachers and educators. Further research will possibly find supporting evidence to justify the cost and the benefits of good quality animation and its contribution to students' success.

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The Use of Authentic Videos to Change Learners' Negative Attitudes and Perceptions toward Grammar Learning

Khaldi Youssouf

***Abstract*—** This investigation seeks to inquire into the effectiveness of using authentic videos for grammar teaching purposes. In this investigation an English animated situation – Hercules- was used as a type of authentic multimedia to teach a particular grammatical structure, namely conditional sentences. This study also aims at investigating the EFL learners' attitudes toward grammar learning after being exposed to such an authentic video. To reach that purpose, 56 EFL learners were required, ultimately, to respond to a questionnaire with an aim to reveal their attitudes towards grammar as a language entity and as a subject for being learnt. Then, as a second stage of the investigation, the EFL learners were divided into control group and experimental group with 28 learners in each. The first group was taught grammar-conditional sentence- using deductive-inductive approach, while the second group was exposed to an authentic video to learn conditional sentences. There was a post-lesson stage that includes a questionnaire to be answered by learners of each group. The aim behind this stage is to capture any change in learners attitude showed in pre-lesson questionnaire. The findings of the first stage revealed learners negative attitude towards grammar learning. And the third stage results showed the effectiveness of authentic videos in entirely turning learners attitude toward grammar learning to be significantly positive. Also, the utility of authentic videos in highly motivating EFL learners can be deduced. The findings of this survey asserted the need for incorporation and integration of authentic videos in EFL classrooms as they resulted in rising effectively learners' awareness about grammar and looking at it from a communicative perspective.

***Keywords*—** Authentic videos,Multimedia,Grammar learning,Negative attitudes,EFL learners.

Youcef Khaldi is with the University of Mostaganem, Algeria (e-mail: khaldiyoucef86@gmail.com).

Engaging Students in Learning through Visual Demonstration Models in Engineering Education

Afsha Shaikh, Mohammed Azizur Rahman, Ibrahim Hassan, Mayur Pal

***Abstract*—** Student engagement in learning is instantly affected by the sources of learning methods available for them, such as videos showing the applications of the concept or showing a practical demonstration. Specific to the engineering discipline, there exist enormous challenging concepts that can be simplified when they are connected to real-world scenarios. For this study, the concept of heat exchangers was used as it is a part of multidisciplinary engineering fields. To make the learning experience enjoyable and impactful, 3-D printed heat exchanger models were created for students to use while working on in-class activities and assignments. Students were encouraged to use the 3-D printed heat exchanger models to enhance their understanding of theoretical concepts associated with its applications. To assess the effectiveness of the method, feedback was received by students pursuing undergraduate engineering via an anonymous electronic survey. To make the feedback more realistic, unbiased, and genuine, students spent nearly two to three weeks using the models in their in-class assignments. The impact of these tools on their learning was assessed through their performance in their ungraded assignments as well as their interactive discussions with peers. 'Having to apply the theory learned in class whilst discussing with peers on a class assignment creates a relaxed and stress-free learning environment in classrooms'; this feedback was received by more than half the students who took the survey and found 3-D models of heat exchanger very easy to use. Amongst many ways to enhance learning and make students more engaged through interactive models, this study sheds light on the importance of physical tools that help create a lasting mental representation in the minds of students. Moreover, in this technologically enhanced era, the concept of augmented reality was considered in this research. E-drawings application was recommended to enhance the vision of engineering students so they can see multiple views of the detailed 3-D models and cut through its different sides and angles to visualize it properly. E-drawings could be the next tool to implement in classrooms to enhance students' understanding of engineering concepts.

***Keywords*—** student engagement, life-long-learning, visual demonstration, 3-D printed models, engineering education.

Mohammad A Rahman is with the Texas A&M University at Qatar, Qatar (e-mail: marahman@tamu.edu).

Effectiveness of a Peer-Mediated Intervention on Writing Skills in Student with Autism Spectrum Disorder in the Inclusive Classroom

Siddiq Ahmed

Department of Learning and Developmental Disabilities, Arabian Gulf University at the Kingdom of Bahrain

Siddiqma@agu.edu.bh

Mohammed Al-Jaffal

Department of Special Education, King Saud University

moaljaffal@ksu.edu.sa

Abstract

The current study aimed to investigate the effectiveness of a Peer-Mediated Intervention (PMI) on writing skills for a student with autism spectrum disorders in inclusive classrooms. The participants in this study were two students, one as a tutor and another as a tutee who was diagnosed with autism spectrum disorder (ASD). The target participant struggled with writing skills and was paired with a student with high academic outcomes. The Tutor had a readiness to act as a tutor for his peer and was trained on how to assist his peer and how to identify and guide his peer's writing mistakes. Multiple baseline design across behaviors was implemented to monitor the student's progress in writing skills. The results of the present study showed that PMI yielded significant improvements in academic achievements for the target student. This study suggests that further studies should replicate the current study with an intensive focus on other academic skills such as reading comprehension, writing social stories, and math.

Keywords: Peer Tutoring, Writing Skills, Autism, Inclusion

Effectiveness of a Peer-Mediated Intervention on Writing Skills in Student with Autism Spectrum Disorder: Case Study in the Inclusive Classroom

Peer Mediated Intervention (PMI) is an effective strategy that enhances social skills deficits and academic performance accomplishment for students with Autism Spectrum Disorders (ASD) (Hart, & Banda, 2018). Educating children with special needs in the general education setting instead of the special education setting, has been promoted by the regular education initiative (Hart, & Banda, 2018). The most recent amendment of the Individuals with Disabilities Education

Act (IDEA 2004) commands that Students with Disabilities (SWD)s should be educated in general education classrooms with non-disabled peers to the maximum extent possible. Unless the nature or severity of the student's disability inhibits his or her learning as well as the learning of others (McCurdy & Cole, 2014). Extensive attention has been paid to inclusive education as an important issue in the education of students with ASD (McCurdy & Cole, 2014). This study focused on a peer-mediated intervention for a student with ASD in the general education classroom and aimed to improve his overall writing skills.

Inclusion of students with ASD

General education teachers have faced the challenges of providing effective instruction to children with special needs within their classrooms. The push for inclusion increased the complexity of teaching because teachers, who were once only responsible for educating students without disabilities, were suddenly asked to provide services to SWD with little or no training or professional development. In addition, the classroom teachers face instructional challenges that have grown as the number of students identified with a disability has grown. Teachers must design and provide instruction to large numbers of students, including those with and at risk for disabilities or who exhibit varying readiness levels and special needs (Ayvazo, & Aljadeff-Abergel, 2014. Additionally, educators should be able to provide appropriate individualized instruction by taking into consideration the diversity of classes (Ayvazo, & Aljadeff-Abergel, 2014). In addition to academic difficulties faced by students with and at-risk for disabilities, many of them display behavioral challenges (Ayvazo, & Aljadeff-Abergel, 2014). The potential advantages of including students with ASD in the general setting are the increase of opportunities to interact with fellow peers, the continued development/initiation of friendships through the strengthening of social and communicative skills, and the enhancement of participation in the classroom environment, which increases their academic outcomes (McCurdy & Cole, 2014).

Although there are some benefits of inclusion, there are challenges that arise during the implementation of inclusive practices (McCurdy & Cole, 2014). There are currently many strategies that help teachers/educators to assist students with ASD in inclusive classrooms, but all of these strategies involve a reliance upon adults to be achieved. During the adult-mediated intervention, teachers/educators had significantly less time to focus on students who do not have ASD. The limitations of adult-mediated intervention can be overcome through the implementation of PMI. However, peer-mediated intervention engages both students with and without ASD to work together to achieve academic goals (McCurdy & Cole, 2014.; Hart, & Banda, 2018).

Writing Skills for Students with ASD

Writing is an important tool for learning, but it is especially challenging for students with special needs, particularly in the area of constructing well-formed sentences (Saddler, Behforooz & Asaro, 2008). The writing skills of students with special needs are generally less syntactically complex, and sentences often contain grammatical errors (Saddler, Behforooz & Asaro, 2008). They usually produce writing with capitalization, punctuation, and spelling errors and the overall quality is lower than that of typical peers. Therefore, it is important to help them to overcome their writing weakness through strategies that showed evidence-based practice. Whitby, Travers, and Harnik (2009) stated that written expression is identified as a deficit for students with High Functioning

Autism/ Asperger's Symptoms and 60% of them may present writing learning disabilities. This weakness may be influenced by organization and attention deficits. Although there may be less concern about social and behavioral impairments for those with HFA/ AS, academic goals are within reach. Thus, teachers need to match interventions to the unique academic profile in order to increase the students' success. Furthermore, it has been shown that students with moderate and high-functioning autism exhibit significantly high performance in academic tasks when external support is provided to them (Whitby, Travers & Harnik, 2009).

Asaro-Saddler and Bak (2014) stated some characteristics of children with ASD that may affect their ability in writing essays. These characteristics include (a) a lack of theory of mind that prevents them to understand others or think differently than they do. (b) having weak central coherence causes difficulty to distinguish the important from unimportant details and potentially leads to the inability to create meaningful supporting details in their writing. (c) limited interest in topics that may seem unusual may affect them to select topics they find interesting, but not interesting to a majority of readers. As a result, they tend to produce short writings that lack important details and contain bizarre and irrelevant details. (d) lack of self-regulation skills, which include outlining, cognitive flexibility, and self-monitoring that impact their writing. (e) Difficulty in socialization and interaction deficits, which causes limited engagement in social activities when they interact with peers. As a result of this lack of social interaction, there may be a direct impact on their writing skills. These characteristics contribute to the weakness of writing skills for students with ASD. Thus, educators should use appropriate interventions when teaching students how to write, such as peer-mediated intervention approaches.

Effectiveness of Peer Mediated Intervention with Students with Autism

Many students with ASD, behavioral challenges, and multiple developmental disabilities attend general education classrooms without appropriate accommodations being provided (Carter et al., 2015). These students have been struggling with their academic performance and need substantial support to meet their academic expectations. One of the promised methods that showed the efficacy, best-practice approach and solve these problems and improve student proficiency and strongly and continuously growing, is using PMI (Heron, Villareal, Yao, Christianson & Heron, 2006). PMI means cooperative teaching between a pair of students where a student with high ability takes turns acting, coaching, and correcting errors as the tutor of a student with low ability is under the supervision of a teacher. PMI engages children with a variety of cognitive abilities to promote the optimal education for students with special needs without compromising interactive learning for other students (Ayvazo, & Aljadeff-Abergel, 2014). McCurdy and Cole (2014) stated several advantages of using peer-mediated intervention, such as (a) peer supporters are available across a variety of school settings and are willing to assist their peers with educational and behavioral tasks, naturally affecting each other's behavior. (b) Peers are present in many school settings, which promotes maintenance and generalization of positive behavior change. (c) The behavior of the peer mediators gives cues to the child with special needs to remind them of the appropriate behaviors learned during the intervention process. Additionally, peer mediators effectively meet the students' needs, allowing the teacher to spend more time teaching and programming for all students' educational needs. Finally, using peer mediators in classroom interventions provides students with increased opportunities to receive feedback and modify behaviors, resulting in a higher level of attention, cognitive response, and social gains.

Carter, Cushing, Clark, and Kennedy (2005), pointed out that PMI is an effective intervention and alternative to the traditional teaching strategy to reach efficient education for students with moderate and severe disabilities within general education classrooms. According to Carter et al. (2015), it is important to ensure that SWDs are provided access to the general education curriculum and learning opportunities together with nondisabled; however, this is challenging. The authors stated that PMI could be the practical, promising support for this inclusion to deliver the academic components and shared learning opportunities. PMI has been shown to provide increased accessibility to interesting curricular content, raised expectations for performance, and established new social and more positive relationships with classmates (Carter et al., 2015).

Ayvazo and Aljadeff-Abergel (2014), stated that class-wide PMI is an evidence-based practice approach that associates interactions between peers and holds promise for the education of learners at risk who display low academic achievement. Additionally, Carter, Moss, Hoffman, Chung, and Sisco (2011) widely recommended using peer support strategies to contribute to the social and academic participation of SWDs across an inclusive education, particularly in secondary schools. The study indicated substantial and significant increases in the occurrence of peer interaction when SWDs worked within peer support environments and a one-to-one paraprofessional. Determining the way in which peers provide support to SWDs using this strategy, especially at the high school level, would indicate the fidelity of implementation and offer substantial insights to the high school students who work cooperatively with SWDs within inclusive classrooms (Carter, Moss, Hoffman, Chung & Sisco, 2011).

Numerous studies have shown the effect and efficiency of PMI, whether within-group or individual settings (Bowman-Perrott, Davis, Vannest, Williams, Greenwood, & Parker, 2013; Hart, & Banda, 2018; Matthews, et al., 2018). Vukelich, Justice, and Han (2013) stated that typical students who tutor their peers have benefited substantially more than their untutored peers. Furthermore, many researchers have investigated the outcomes of students who work one on one with peer-mediated intervention. Those who received tutoring intervention outperformed the children who did not receive tutoring intervention.

Therefore, under well-structured, and organized conditions, low-performing students can learn effectively, regardless of being identified with a disability. Despite the fact that peer-mediated intervention has been used in many inclusive settings to help low academic achievers to increase their learning interests and positive academic outcomes, there are no studies that have been published regarding peer-mediated intervention specifically with regard to writing skills. This study focuses on peer-mediated intervention with a student with ASD who is a less-skilled writer with the ultimate aim to improve his writing skills in inclusive classrooms.

The study evaluated the impact of PMI on the participants in the study to contribute to the reinforcement of this intervention. Additionally, the study demonstrated that the use of the PMI improved the academic outcomes and social interaction of SWDs. The role of the tutor allows adaptation of classroom activities to enable student participation, provide instruction related to IEP goals, provide frequent feedback to the SWDs, implement relevant behavior intervention plans, and promote communication between the SWDs and their classmates (Carter, Cushing, Clark, & Kennedy, 2005).

Aims and rationale

Research has shown that peer tutoring intervention is an effective strategy to improve children and adolescents' academic and life skills. However, less attention has been given to its implications for writing skills. This research aimed to investigate the effectiveness of the PMI on writing skills in inclusive classrooms for individuals with autism.

Method

Participants

The target student in this study was selected after interviewing an English teacher in 7th grade who was 12 years of age and participated in this study (Table 1). The school principal helped to identify the student as well. The target participant was a male student diagnosed with ASD according to his individualized educational plan (IEP). In addition, the tutor was selected by the English teacher based on his academic achievement and his ability and willingness to help the tutee in writing activities. Written permission or consent was obtained from both students and their parents. Both participants were fluent in Reading and Speaking; however, the tutee's writing skills needed to be improved. The tutor was trained on how to assist his peer and how to record his peer's participation. These were the only requests that were made of the student participants. Additionally, they were interviewed and asked to express their opinion about this peer tutoring-mediated intervention. Furthermore, the training included underlining and making notes of the errors in the tutee's writing.

Participants' Demographics (Table 1)

Participants	Gender	Age	Grades	Races	Type of Disability
Tutors	Male	14	7	White American	None
Tutees	Male	13	7	White American	High Functioning Autism

Setting

The study took place in a nonprofit private school located in Pittsburgh, Pennsylvania in the United States. The school is committed to providing a safe and intellectually challenging environment that will empower students to become innovative thinkers, creative problem solvers, and inspired learners prepared to thrive in the twenty-first century. The study was conducted in a general education classroom setting, where students with learning and developmental disabilities, study together with students without disabilities. The school draws a very diverse background, who migrated to the United States and who are not native speakers of English. The participant in this study attended a seventh-grade English classroom and was paired with a regular student who was trained on how to use the rubric provided to assist the student with ASD during writing

sessions. In addition, the training included underlining and making notes of the errors in the tutee's writing. These were the only requests that were made of the student participant.

Research Design and Measurement

The measurement or the instrument of this study was the data collection sheets that record the students' responses during the baseline, during tutor support intervention, and during the maintenance phase according to the rubric of writing shown in Table 2, which was developed by the researchers. This rubric has been taken from Pennsylvania core standards writing, and tutors support intervention using this rubric to help students with ASD. Additionally, to ensure that the change in performance was not attributed to factors other than the experimental variables (the intervention), the research and classroom teachers observed the target student in the classroom during writing activities without any reinforcements.

The first phase involved collecting three days of baseline data (A). During this phase, no interaction occurred, or services were provided to the students to see the natural behavior and to assess the typical class performance of the target students. The measure of academic performance will be work accomplishment for classroom exercises. The second phase is PMI (B). For this intervention, the target students are notified of the specific procedures. To investigate the effectiveness of PMI to improve the writing skills of the target student, this study utilized a multiple baseline design across behaviors. This design aimed to assess the use of PMI as an independent variable to improve writing skills in the area of subject-verb agreement, spelling, and punctuation, which consider dependent variables.

Procedures

Based on the procedural recommendation of Jameson, McDonnell, Polychronis, and Riesen (2008), it is important to provide individual training sessions, a written manual, and verbal feedback to peer tutors. In addition, the peer tutor could be trained quickly and efficiently for the accurate performance of this technique in general education settings (McDonnell, Polychronis & Riesen, 2008). During the intervention phase, the student with ASD was given academic tasks including reading, writing, and spelling under two conditions: (a) Active Peer Tutoring, and (b) Passive Peer Tutoring. A multiple baseline design is implemented for the current study to examine the effectiveness of the intervention. The participant was paired for the intervention with a high academic achievement student who is skilled in writing. The tutor corrected the target student's writing errors by underlining the errors according to the measurement sheet. The first phase involved collecting baseline data (A). During this phase, no interaction occurred, or services were provided to the students, in order to see the natural behavior and to assess the typical class performance of the target students. The measure of academic performance was work accomplishment for classroom writing exercises. The second phase is PMI (B). For this intervention, the target students are notified of the specific procedures. The third phase (C) indicated the maintenance of the improvement of the PMI after post-intervention. The recording procedure that is used for Subject-verb agreement, spelling and capitalization, and punctuation are an event recording.

Collection of Data and Method of Data Analysis

The target students were assessed based on the number of non-accurate sentence structures (grammar usage and mechanics) including, (1) Subject-verb agreement and verb (tense and usage), (2) Spelling and Capitalization, and (3) Punctuation. The errors were recorded by the researchers and classroom teachers, then, a peer intervention support tutor was offered for target student. The role of peer tutors was to provide editing by underlining and coding the mistakes that the tutee made based on the rubric given to him. After the peer tutor intervention, the number of sentence structure errors was recorded in order to see the effects of the intervention. This section consisted of writing and spelling activities that are focused on academic performance in order to encourage desirable outcomes for the target students. The dependent variable of the current study was writing performance, including the number of times that the student wrote the words and the sentences accurately during classroom exercises. Furthermore, the student must also exhibit correct sentence structure that is free of grammatical errors. Data analysis is significant here in order to see whether the intervention was effective or not with the target student. In order to analyze the data, the proper conclusions were drawn using a graph where the X-intercept is the sessions of the day and Y-intercept is the number of errors in each area that the target student made during writing experiences.

Interobserver Agreement

An independent observer conducted frequency counts of the target behavior along with the tutor for 25% of the sessions and 95% agreement was achieved. In addition, the teacher and the researchers recorded this interaction in order to analyze the students' implementation of the intervention. Many types of work accomplishments the tutees performed with peer tutoring support included repetition of the dictation of the teacher's spelling tests and consistent writing with minor grammatical errors, such as completed sentences, and sentence structure.

The rubric of 7th-grade writing (Table 2)

GRAMMAR USAGE/ MECHANICS	Codes	Example of mistakes	Examples of corrected mistakes
Subject-verb agreement or (tense and grammar usage)	SV	I goes	I go
Capitalization & Spelling	Sp	my name is eric.	My name is Eric.
Punctuation	P	What is your name.	What is your name?

Findings

This study was undertaken to investigate the following research questions (1) What is the effectiveness of a peer-mediated intervention on writing skills in students with autism spectrum disorders in inclusive classrooms? (2) Would peer-mediated intervention be maintained when the intervention is withdrawn? It is essential to note that, for this study, effectiveness is perceived. In cases where the use of PMI has proven to be effective, what factors can be found to be the most relevant to their success? To start with, addressing the first question, the visual assessment of data shows that the peer-mediated intervention on writing skills for the student with autism caused an immediate decrease in mistakes in the student's writing skills. In addition, the peer-mediated intervention maintained the student's writing skills. Thus, the finding indicated the effectiveness of the peer-mediated intervention in improving the student with ASD's writing skills.

Behavior 1: Spelling and Capitalizations

The observations of this spelling behavior were recorded for a period of 40 minutes daily for four sessions. During four sessions of baseline, spelling and capitalization mistakes were in the range of 5-8 errors with a mean of (7) errors. After providing the intervention, which lasted for five days, spelling performance was in the range of 2 to 3 errors with a mean of (3) errors. The maintenance phase lasted for three days in the general education classroom, and the target behavior occurred twice in each session. Comparing the means of errors prior to peer-mediated intervention and post-intervention, it is obvious that the student showed a significant improvement in the area of spelling and capitalization (Graph 1).

Behavior 2: Punctuation

Baseline data for punctuation was recorded during class time for a period of 40 minutes daily. During 11 sessions of the baseline, the frequency of punctuation mistakes was in the range of 5 to

7 with a mean of 6 errors. After presenting the intervention, which lasted for 6 days, the level of punctuation mistakes was in the range of 1 to 4 errors with an average of 2.5 errors. Comparing the means of errors prior to peer-mediated intervention and post-intervention, it is obvious that the student showed a significant improvement in the area of spelling and capitalization (Graph 1). In the maintenance phase, which lasted for 2 days in the general education classroom, the punctuation behavior occurred in the range of 0 to 1 with an average of (0.5). Comparing the means of errors prior to peer-mediated intervention and post-intervention, it is obvious that the student showed a significant improvement in the area of punctuation (Graph1).

Behavior 3: Subject-verb agreement

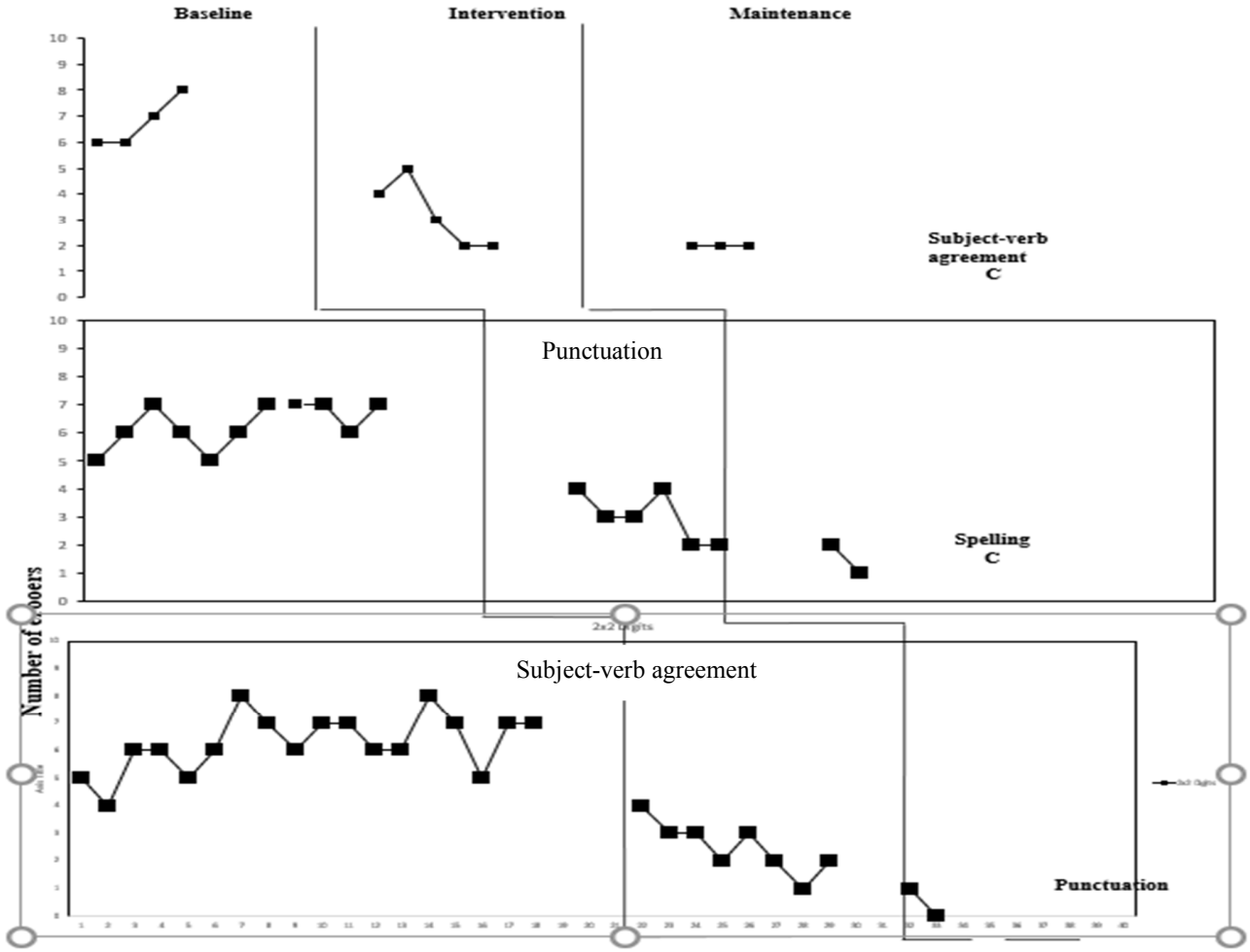
Baseline data were recorded during class time for a period of 40 minutes daily for four sessions. During 18 sessions of the baseline, the frequency of subject-verb agreement behavior was in the range of 3 to 6 with an average of 5 errors (Table 3). After delivering the intervention, which lasted for eight sessions, the range of errors in subject-verb agreement performance was 1 to 4 with a mean of 2.5 errors. In the maintenance phase, which lasted for two days in the general education classroom, spelling performance was a 0-1. Comparing the means of errors prior to peer-mediated intervention and post-intervention, it is obvious that the student showed a significant improvement in the area of Subject-verb agreement (Graph 1).

It is also noticeable that the number of his errors in all three areas (Subject-verb agreement, Spelling, and punctuation) in the maintenance phase has been considerably reduced, which means the PMI strategy was effective with the target student in this study. The various types of errors that occurred were also observed and noted throughout the intervention. The most errors occurred in spelling and capitalization, punctuation, and subject-verb agreement in order of greatest occurrence respectively. However, there were no errors that occurred in singular/plural noun agreement and verb tense and usage for the target students. These findings indicate that the student is fluent in spoken word agreement in terms of common verbal usage and singular/plural noun agreement, both of which occur naturally when speaking aloud. In contrast, the errors occurred specifically during the task of writing and consisted of grammatical and semantic techniques that are more profound when observing the written word.

Findings Pre and Post Intervention (Table 3)

Behaviors	Before Intervention		After Intervention		Maintenance	
	Errors' range	*Mean*	Errors' range	*Mean*	Errors' range	*Mean*
Capitalization & Spelling	5-8	7	2-5	3	2-2	2
Punctuation	5-7	6	2-4	3	1-2	1.5
Subject-verb agreement	3-6	5	1-4	2.5	0-1	0.5

Spelling & Capitalization



The Varied Errors Observed (Table 4)

The student with autism in 7th grade
Spelling & Capitalization
Punctuation
Subject-verb agreement

Note: No errors occurred for either student in singular/plural noun agreement and verb tense and usage

Social Validity

After the intervention, both the tutor, tutee, and the teacher reported their satisfaction with the intervention, which helped the teacher to focus on other students and granted the responsibility to students with high academic accomplishments. The satisfaction ratings of the tutor and tutee indicated a positive reaction and high-level motivation toward this intervention. Teacher and students report showed that all students experienced augmented validation within the classroom post-intervention. Jameson, McDonnell, Polychronis, and Riesen (2008) emphasized that the peer-delivered embedded instructional package has a positive about the social validity of the procedures and outcomes. Therefore, the student with high academic success was able to adopt the role of instructor, validating his previous efforts and established skills. The target student was given the one-on-one tutor dynamic that the teachers were previously unable to provide. These one-on-one settings enabled the target student to get the help and peer encouragement he needed to succeed in the classroom. Finally, the teacher was able to focus more so on the students in the class who were previously given less attention and validation due to the teacher's previous increased obligations to the student with ASD.

Conclusion and Future Directions

One aspect believed to have a strong impact on improving education is peer-mediated intervention. The advantages of using peer-mediated intervention include: the improvement of many aspects of education, the tutors benefit from studying and preparing the lesson before teaching tutees, providing useful practice and enhancement for both tutors and tutees, having positive feeling because tutees receive positive feedback, and the improvement of reciprocal peer-mediated intervention students' academic achievement and gaining more academic skills. This study aimed to evaluate peer-mediated strategies to support a student with autism in order to improve his writing skills while working with his peer who was of high academic standing. The researchers developed a measurement according to the core writing curriculum of 7th grade in Pennsylvania, focusing on grammar usage, semantic mechanics, and punctuation. Before the

intervention, the student with ASD exhibited a low writing ability with a high range of errors. After the peer-mediated intervention, the student showed a significant reduction in errors. The results of this study assure the effectiveness of using peer tutoring support. The tutor and individual with autism were satisfied with using this strategy and would use it again in other subjects and classes. The tutor reported that this strategy not only improved the writing abilities of the students with ASD but also it improved his writing skills by assisting others and helping him recognize the specific conventions used while writing. Both participants also reported that the intervention helped to foster a friendship between the tutor and tutee. In addition, the study emphasized the importance of using the rubric of the measurement to evaluate the students' abilities in writing, which made them more aware and able to recognize the strategies in their own writing. This study encourages the inclusion of students with autism in general education classroom settings.

Future research may address the generality of the findings reported in this research by including larger populations of students with ASD and incorporating other areas such as reading comprehension. Also, in this manner, the data that is collected may provide information that more accurately shows the benefits of peer mediation across a variety of groups and academic areas. Moreover, additional research is needed to address limitations in this investigation and to replicate the obtained findings. In the current study, students made progress through the short term, and the evaluation procedure generally focused on spelling and grammar usage. Additional measurements of the writing evaluation that focus on overall structural concerns may have yielded different results and, consequently, merit future investigations. The present investigation focused only on general writing; replication is clearly needed to include genres of writing, such as opinion essays and story writing.

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Integrating a Universal Forensic DNA Database: Anticipated Deterrent Effects

Karen Fang

***Abstract*—** Investigative genetic genealogy has attracted much interest in both the field of ethics and public eye due to its global application in criminal cases. Arguments have been made regarding privacy and informed consent, especially with law enforcement using consumer genetic testing results to convict individuals. In the case of public interest, DNA databases have the strong potential to significantly reduce crime, which in turn, leads to safer communities and better futures. With the advancement of genetic technologies, the integration of a universal forensic DNA database in violent crimes, crimes against children, and missing persons cases is expected to deter crime, while protecting one's privacy. Rather than collecting whole genomes from the whole population, STR profiles can be used to identify unrelated individuals without compromising personal information such as, physical appearance, disease risk, and geographical origin, and additionally, reduce cost and storage space. STR DNA profiling is already used in the forensic science field and going a step further benefits several areas including the reduction in recidivism, improved criminal court case turnaround time, and just punishment. Furthermore, adding individuals to the database as early as possible prevents young offenders and first-time offenders from participating in criminal activity. It is important to highlight that DNA databases should be inclusive and tightly governed, and the misconception on the use of DNA based on crime television series and other media sources should be addressed. Nonetheless, deterrent effects have been observed in countries like the US and Denmark with DNA databases that consists of serious violent offenders. Fewer crimes were reported, and fewer people were convicted of those crimes- a favourable outcome not even the death penalty could provide. Currently, there is no better alternative than a universal forensic DNA database made up of STR profiles. It can open doors for investigative genetic genealogy and fostering better communities. Expanding the appropriate use of DNA databases is ethically acceptable and positively impacts the public.

***Keywords*—** Bioethics, deterrent effects, DNA database, investigative genetic genealogy, privacy, public interest.

K. F. Author is with the University of Toronto, Toronto, ON M5S 1A1 (e-mail: kf.fang@mail.utoronto.ca).

Protection of Chinese Enterprises' Overseas Investments under Bilateral Investment Treaties under the Belt and Road Initiative

Bo Sun[1,*] Ni Zhong[2]

[1] the University of Sydney

[2] the University of Sydney

[*]Corresponding author: Bo Sun. Email: 530112738@qq.com

Abstract

Bilateral investment treaties have played a role in the construction of the Belt and Road, providing institutional protection for Chinese companies' overseas investments. However, such treaties between China and countries along the Belt and Road were signed in the 1980s and 1990s, and their provisions are outdated and insufficiently detailed to provide adequate legal protection for Chinese investors when they initiate investment arbitration against host countries. By studying cases involving China in international investment arbitration, this paper suggests that China should pay attention to further clarifying the identity of "investors", the scope of disputes that can be submitted to arbitration, and the concept of "indirect expropriation" when updating bilateral investment treaties in the future, in order to reduce the risk of losing cases for Chinese investors.

Keywords: *Belt and Road, Bilateral Investment Agreement, Investment Arbitration, Indirect Expropriation*

1.Introduction

In 2013, Chinese President Xi Jinping proposed the idea of "the Belt and Road" ("Silk Road Economic Belt" and "21st Century Maritime Silk Road"), which aims to promote the building of a community of human destiny and to safeguard the global free trade system. The "Belt and Road" is an economic road linking China with countries along the former Silk Road and an investment route through Asia, Europe and Africa. It brings investment opportunities to the countries along the route and stimulates ambitious plans for Chinese companies to invest abroad.[1] From the beginning time of "reform and open", China has been exploring opportunities to "go global". The Belt and Road involve more than 60 countries with a population of over 4 billion people and a market that accounts for more than one-third of global GDP. The "One Belt, One Road" strategy has accelerated the process of Chinese outbound investment as the Chinese government has pledged to invest US$1 trillion

[1]ZENG K. The Political Economy of Chinese Outward Foreign Direct Investment in 'One-Belt, One-Road (OBOR)' Countries[M]//China's International Investment Strategy. Oxford University Press: 360–361[2022–02–15].

abroad. [2] Overseas investment by Chinese companies will greatly enhance their international competitiveness and internationalize China's economy while balancing the country's national economy. However, the relatively short period time and inexperience of Chinese enterprises involved in overseas investment, coupled with the rapid development of international investment law and the continuous reform of international investment dispute settlement forms, make it impossible for Chinese enterprises to protect their interests promptly time through proper and reasonable means when they encounter international investment disputes, and even the country itself can become the subject of complaints. Although China is a major signatory to bilateral investment treaties (BITs) and other treaties with investment provisions, the use of BITs and investment treaties by Chinese companies is relatively infrequent and not sufficiently important. This reflects two problems: firstly, the BITs signed by China have many shortcomings, such as narrow definitions of investment and jurisdiction, which make them ineffective in protecting the investment interests of enterprises. Secondly, Chinese enterprises are not sufficiently familiar with international investment law and lack the ability to use international investment dispute settlement mechanisms to resolve problems they encounter.

The paper will be divided into four parts. Firstly, the paper provides a brief overview of the Belt and Road and discusses the importance of the Belt and Road in promoting the global economy and the globalization trend of Chinese enterprises. The second part discusses international investment arbitration cases in which China has participated, focusing on the use of BITs by both parties in the arbitration process and the determination of BITs clauses by arbitral tribunals. The third section analyses the disadvantages of BITs signed by China and the obstacles to investor protection. Finally, it proposes innovative solutions to BITs and ways for Chinese companies to protect their interests in overseas investments.

2. China's Investment in Countries along the "Belt and Road"

2.1. Current Status of China's Investment in the "Belt and Road"

Against the backdrop of the 2008 international financial crisis, China launched the idea of the "Belt and Road" to promote world economic growth, restoring the ancient Silk Road as a commercial bridge between East and West, promoting intercontinental connectivity, infrastructure development, steady economic growth and securing the region's energy supply for the region. [3]In 2015, China's economic restructuring and industrial upgrading yielded significant results, with outbound foreign direct investment surpassing inbound foreign direct investment (FDI) for the first time. China has become a net exporter of capital. [4]The Belt and Road was the 'turnaround' path during the COVID-19 epidemic. In2020, the world economy seemingly come to a standstill and business activity come to a halt because of the COVID-19 epidemic, but China resumed its own economic growth in March and growth also began with outward investment. Chinese companies invested US$17.79 billion in non-financial direct investment in 58 countries along the Belt and Road in the year, up from the previous year, while the global FDI shrank by almost 50% in the first half of

[2]PETER FERDINAND, 'Westward Ho—the China Dream and "One Belt, One Road": Chinese Foreign Policy under Xi Jinping' (2016) 92(4) *International Affairs* 941, 948–951 ('Westward Ho—the China Dream and "One Belt, One Road"').

[3] 丁一凡：相信吗？"一带一路"倡议拯救了世界经济 - 中国一带一路网[EB/OL]()[2022–02–18]. https://www.yidaiyilu.gov.cn/ghsl/gnzjgd/160001.htm.

[4]WANG H Y, MIAO L. China's Outward Investment: Trends and Challenges in the Globalization of Chinese Enterprises[M/OL]//China's International Investment Strategy. Oxford University Press: 41[2022–02–18]. http://oxford.universitypressscholarship.com/view/10.1093/oso/9780198827450.001.0001/oso-9780198827450-chapter-3.

2020, so the "Belt and Road " has played an important role in the global economic recovery.[5] According to the statistics of the Ministry of Commerce, 2020 China's outbound FDI is mainly in Asia and developing countries of which investment in Asia accounted for 73.1%, and Southeast Asian countries account for 7 of the top 20 countries in foreign direct investment flows. [6]China's outbound investment covers almost all industries. Electricity, heat, gas, water production, and supply and manufacturing are the main areas of investment.[7]

2.2. Globalization Trends of Chinese Enterprises

The "Belt and Road" consists of the Silk Road Economic Belt and the 21st Century Maritime Silk Road, which connect Central Asia, West Asia, the Middle East and Europe, as well as Southeast Asia, South Asia, Africa and Europe. The vast geographical coverage of this initiative has created tremendous opportunities for Chinese companies to explore new investment opportunities beyond their borders. [8] The Chinese government has actively signed various investment agreements with countries along the route while proposing the initiative. As of February 2022, China has signed more than 200 "the Belt and Road" cooperation documents with 32 international organizations and 148 countries around the world, which has laid a firm foundation for Chinese companies to go abroad. [9]For the enterprises themselves, as the competition in the domestic market is too fierce, it is a wise choice to "go out" to get a better market, such as Huawei, which has achieved great success through this path. At the end of 2020, Chinese mainland investors had 45,000 outbound investment enterprises in 189 countries around the world, with private and state-owned enterprises occupying an equally important position in outbound investment, and the trend of Chinese outbound investment continues to increase.[10]

3. International Investment Arbitration Cases Involving Chinese Investors

One of the main ways to settle investment disputes between international investors and host states in arbitration. The Investor-State Dispute Settlement ("ISDS") mechanism uses arbitration as the main means and the International Centre for Settlement of Investment Disputes ("ICSID") as the arbitration platform. Treaty-based international investment arbitration is the most common form, and generally, investors can initiate ISDS arbitration through BITs or regional investment agreements signed between countries. As of February 2022, ICSID had recorded 896 ISDS cases, of which 10 were filed by Chinese investors as plaintiffs and 5 as defendants. [11]The low level of Chinese participation in ISDS arbitrations contrasts sharply with the increasing number of ISDS arbitrations on a global scale. A few typical cases will be selected for discussion in this paper.

3.1. Tza Yap Shum v. The Republic of Peru

The case of Tza Yap Shum v. the Republic of Peru is the first investment arbitration brought by a Chinese citizen against a country to ICSID under a bilateral investment protection agreement. [12] On 12 February 2007, the

[5] 2020 年我国企业对“一带一路”沿线非金融类直接投资 177.9 亿美元 - 中国一带一路网[EB/OL][2022–02–18]. https://www.yidaiyilu.gov.cn/xwzx/gnxw/162412.htm.

[6]中华人民共和国商务部, *2020 年度中国对外直接投资统计公报* (September 2021).

[7]Ibid.

[8]Zeng (n 1) 360–362.

[9] 已同中国签订共建“一带一路”合作文件的国家一览 - 中国一带一路网[EB/OL])[2022–02–19]. https://www.yidaiyilu.gov.cn/xwzx/roll/77298.htm.

[10]中华人民共和国商务部 (n 6).

[11]Search Cases | ICSID[EB/OL][2022–02–19]. https://icsid.worldbank.org/cases/case-database.

[12] Tza Yap Shum v. the Republic of Peru: (ICSID Case No. ARB/07/6)[Z]

Secretary-General of ICSID accepted Tza Yap Shum's request to sue the Peruvian government under the 1994 China-Peru BIT ("China-Peru BIT"). Tza Yap Shum, a citizen of Hong Kong, China, argued that the Peruvian tax authority had violated the China-Peru BIT by taking unlawful measures against his company TSG. The Peruvian government, however, filed a defense to the arbitration arguing that ICSID did not have jurisdiction over the case. The final decision of the tribunal was that it had jurisdiction and found that Peru had acted in an indirect expropriation.[13] The case has been questioned and criticized by many scholars, most of whom have focused on the applicability of the BIT to Hong Kong and Macau residents and on whether the tribunal had jurisdiction over the expropriation issue. Firstly, the definition of "investor" in the BIT is "in relation to the People's Republic of China, means: (a) a natural person who possesses his nationality in accordance with the laws of the People's Republic of China; ..... "However, Hong Kong was not reunited with China in 1994 and the Constitution of the People's Republic of China granted Hong Kong a high degree of autonomy and allowed it to sign BITs on its own, so the China-Peru BIT should not be applied in terms of identity. Secondly, according to the Article 8 of the BIT "If a dispute involving the amount of compensation for expropriation cannot be settled within six months after resort to negotiations as specified in Paragraph 1 of this Article, it may be submitted at the request of either party to the international arbitration of the International Center for Settlement of Investment Disputes (ICSID), established by the Convention on the Settlement of Investment Disputes between States and Nationals of Other States, signed in Washington D.C., on March 18, 1965." The biggest problem with this clause was that the "dispute concerning the amount of compensation for expropriation" should include "disputes concerning expropriation" or not. Peru objected and invited Professor Chen An, a Chinese expert in international law, to give an expert opinion. However, unfortunately, the tribunal did not adopt Peru's opinion and gave an expanded interpretation of the BIT, ultimately ruling in favor of the claimant.[14]

3.2. Beijing City Construction Group v. the Republic of Yemen

In 2014, Beijing City Construction Group submitted an application to ICSID to formally sue the Republic of Yemen, and this case became the first case of a Chinese investor suing a host country over an outbound contracting project. [15]Beijing City Construction Group contracted for the construction of a new terminal building for the Yemeni Civil Aviation Meteorological Authority through a tender, however, the Yemeni side did not pay according to the payment schedule agreed in the contract. In addition, the government used military personnel to violently prevent the construction workers from working and even took the illegal action of detaining them. Under these circumstances, Beijing City Construction Group initiated arbitration under the 1998 China-Yemen BIT ("China-Yemen BIT "). The main issues in dispute in this case are: whether Beijing City Construction Group, as a state-owned enterprise, can have the status of an investor, and the determination of indirect expropriation in this case. Firstly, the Yemeni government argued that Beijing City Construction Group, as a state-owned enterprise, was both a commercial and a government agent and did not fall under the "national" status requirement of Article 25 of the ICSID Convention. Based on the Broches criterion (a state-owned enterprise is not considered to be

[13]Señor Tza Yap Shum v. The Republic of Peru, ICSID Case No. ARB/07/6 | italaw[EB/OL][2022–02–20]. https://www.italaw.com/cases/1126.

[14]陈辉萍, 'ICSID 仲裁庭扩大管辖权之实践剖析——兼评"谢业深案"' [2010] 国际经济法学刊 78, 93–95.

[15]Beijing Urban Construction Group Co. Ltd. v. the Republic of Yemen: ICSID Case No. ARB/14/30[Z].

an investor if it "acts as an agent of the government" or "performs essential governmental functions"), the Arbitration Tribunal, by analyzing the nature of Beijing City Construction Group's investment, held that the Beijing City Construction Group had the status of an investor because it was a state-owned enterprise but the contracted works were commercial and could not be classified as performing government functions or acting on behalf of the government. [16] Secondly, the act of expropriation includes direct and indirect expropriation. Generally, there is little dispute between the parties to a dispute about direct expropriation, which refers to a public declaration by the state to nationalize a foreign investment. However, it is uncommon for modern states to overtly expropriate foreign investment, more often through armed intervention, increasing tax rates and restricting imports and exports to disrupt the normal operation of foreign-owned enterprises. [17]The definition of expropriation in the BIT is vague and does not specify the specific acts that expropriation entails, but Article 4 of the BIT states that expropriation entails measures that have the same effect as nationalization and that are (i) in the public interest; (ii) in accordance with lawful procedures; (iii) non-discriminatory; and (iv) subject to the payment of compensation. Clearly, the Yemeni government's actions were not in the public interest and not in accordance with lawful procedures, and affected the normal construction work of Chinese companies and the personal safety of their workers. Drawing on Tippetts, Abbett, McCarthy, Stratton v. TAMS-AFFA Consulting Engineers of Iran, the tribunal held that "where an investor is deprived of control over its investment and that deprivation is not temporary", such conduct can be found to be "incompatible with the public interest". This could be considered an indirect expropriation. Although the parties ultimately chose to settle, based on the above analysis and the ICSID's tendency to protect investors, it is more likely that the tribunal will ultimately find indirect expropriation in Yemen. The case is a landmark for Chinese companies, especially state-owned enterprises, in contracting projects overseas.

3.3. Ping An of China v. Kingdom of Belgium

The case Ping An of China v. Kingdom of Belgium is important for ISDS case studies as it is the first ISDS arbitration brought by an inland Chinese investor and likewise the first case in which the Kingdom of Belgium was the respondent. [18]Ping An Life Insurance Company of China, Ltd. and Ping An Insurance (Group) Company of China, Ltd. (hereinafter collectively referred to as " Ping An of China ") had invested and held a 4.18% stake in Fortis Group since 2007, whose banking business was handled by subsidiaries in Belgium, the Netherlands and Luxembourg. As a result of the financial crisis, Fortis' banking operations experienced serious cash flow problems. Belgium intervened twice to acquire almost 50% of the shares of Fortis and exchanged them for €8.25 billion worth of shares in BNP Paribas, a series of actions that led to a significant loss of Ping An of China's interest in Fortis, while Belgium benefited from this "illegal expropriation" of over 14.11billion euros. [19] In 2012 Ping An of China filed an arbitration with ICSID pursuant to the 1986 and 2009 BITs between China and

[16]Mark Feldman, 'State-Owned Enterprises as Claimants in Inter national Investment Arbitration' (2016) 31(1) *ICSID Review - Fo reign Investment Law Journal* 24, 27–28.

[17]韩宝庆, 'ICSID 仲裁解决对外承包工程争议的可行性分析——以北京城建集团诉也门共和国案为例' [2015] (07) 国际贸易问题 168, 173–174.

[18]Ping An Life Insurance Company of China, Limited and Ping An Insurance (Group) Company of China, Limited v. Kingdom of Belgium: ICSID Case No. ARB/12/29[Z].

[19]戴正清 and 吴岚, '平安公司诉比利时案的裁决评析' (2016) 37(05) 国际商务研究 84, 84–85.

the Belgium-Luxembourg Economic Union ("1986 BIT" and "2009 BIT"). ("1986 BIT" and "2009 BIT"). The final outcome of the tribunal was that the tribunal did not have jurisdiction and therefore dismissed Ping An's claim, but the issue in the case was whether the dispute between Ping An and Belgium arose prior to the 2009 BIT and whether the new treaty was applicable during the transitional phase of the treaty. The tribunal adopted the view of the arbitral tribunal in ABCI Investments v Tunisia that the term "dispute" in Article 8 of the 2009 BIT could only be limited to present or future occurrences and could not be interpreted in an extended explanation. 2009 BIT Article 10.2 provides that " This Agreement shall apply to all investments made by investors of either Contracting Party in the territory of the other Contracting Party, whether made before or after the entry into force of this Agreement. However, this Agreement shall not apply to any dispute or claim relating to an investment that has been the subject of judicial or arbitral proceedings prior to the entry into force of this Agreement." The tribunal interpreted this provision broadly, holding that the absence of an express provision in the treaty that Ping An of China had notified under the 1986 BIT but had not entered into judicial proceedings should be tacitly understood to mean that it could not rely on the 2009 BIT, and furthermore that allowing the Applicant to apply the 2009 BIT would result in a right for Ping An of China to invoke the broader dispute resolution provisions available under the new treaty, which would be unfair to Respondent would be unfair. [20]This case, as a representative case of Chinese companies in the ICSID, provides two lessons for future Chinese companies participating in the ISDS: firstly, the tribunal failed to interpret the BIT rigorously and in good faith in accordance with the Vienna Convention on the Law of Treaties, and Ping An of China failed to use the BIT reasonably in its decision making in the face of such a situation. Secondly, there are still many problems with the BIT signed by China, and the details need to be improved and the wording needs to be more precise when the treaty is updated in the future.[21]

3.4. Zhongshan Fucheng Industrial Investment Company Limited v. Nigeria

This case involves the first arbitral award on Chinese investment in Africa and is of great instructive significance. In 2013, Zhongfu International Investment Company Limited (" Zhongfu ") signed a joint venture agreement with the State of Ogun, Nigeria and a local enterprise to operate and manage the "Ogun Guangdong Free Trade Zone" in Lagos, Ogun State, Nigeria. In 2016, the State of Ogun reneged on the concession agreement, terminated it and evicted Zhongfu. Having unsuccessfully sought local remedies, Zhongfu initiated UNCITRAL arbitration pursuant to Article 9 of the China-Nigeria Bilateral Investment Agreement ("China-Nigeria BIT"). In this arbitration, the Nigerian government challenged the lack of jurisdiction of the arbitral tribunal for four main reasons: firstly, the acts against which Zhongfu were not acts of the Nigerian state. Secondly, the Chinese company had not given Nigeria sufficient time to negotiate and the time for filing the arbitration had not yet expired. Thirdly, the Chinese side had already opted for domestic remedies under the "fork in the road" clause. Fourthly, the Chinese party's claim was based on court proceedings and was not arbitrable as it had not appealed. The Arbitral Tribunal, drawing on ICSID Case No. ARB/13/20 and in accordance with international customary law, held that the acts of Ogun State should ultimately be the responsibility of the State as an act of local government. At the same time, the tribunal held that Nigeria could not refuse to arbitrate on

[20]Claire Wilson, 'Protecting Chinese Investment Under the Investor–State Dispute Settlement Regime: A Review in Light of Ping An v Belgium' in *China's International Investment Strategy* (Oxford University Press, 2019) 462, 472–473.

[21]刘勇，'"中国平安诉比利时王国投资仲裁案"——以条约适用的时际法为视角' (2016) 38(04) 环球法律评论 162, 176–178.

the grounds that it had not accepted the request to negotiate. The Court's proceedings had been severely and unreasonably delayed which was grossly unfair to the parties and therefore the present action was not brought on the basis of the Court's proceedings and the anti-suit injunction and the Tribunal had jurisdiction. The interpretation and application of the "fork in the road" clause will be discussed in more detail below. Ultimately, the tribunal found that Nigeria had infringed Zhongfu's legitimate interests under the treaty and ordered Nigeria to pay the plaintiff US$55.6 million, as well as US$75,000 in moral damages. It is worth noting that Zhongfu also initiated another arbitration under the UNCITRAL Arbitration Rules at the Singapore International Arbitration Centre (Case No. ARB300/16/JCL), which greatly enhances the confidence of Chinese companies to use international treaties and ISDS mechanisms to defend their legitimate rights and interests.

4. Discussion on the Current Situation and Problems of BITs in China

China's "Belt and Road" initiative is in line with the basic policy of opening up to the outside world, promoting China's outbound investment as well as geo-economic development. 2013 was also the year when China's outbound investment entered a period of deepening, with each subsequent year exceeding US$100 billion.[22] BITs are a great boost to the construction and development of the 'Belt and Road', and they do two things for China: firstly, they provide preferential investment treatment and legal protection for foreign investors, thereby attracting foreign investment. Secondly, it provides legal protection for Chinese investors abroad. Over the past three decades, China has signed bilateral trade agreements and regional trade agreements at an alarming rate. Prior to 1982, China was not a party to an investment treaty, but as of February 2022, China had signed 145 bilateral investment agreements, making it one of the largest signatories to BITs after Germany. [23] The development of China's investment treaties can be broadly divided into three generations: 1982-1988 was the first generation of investment treaties. China and Sweden signed the first BIT in 1982, which opened a new era of attracting foreign investment through BITs. However, due to China's lack of experience, the first generation of BITs was rudimentary in terms of investor protection. For example, the 1986 BIT in the Ping An of China case provided extremely limited dispute resolution content for investors, reflecting China's caution in signing BITs. [24] 1989-1997, China began signing the second generation of BITs, a period when China acceded to the ICSID Convention and began to focus on investment arbitration. However, the treaty contains more restrictions on international investment arbitration, such as "only disputes over compensation resulting from expropriation and nationalization will be considered for submission to ICSID".[25] The third generation of BITs was established after 1997 to provide more comprehensive protection to investors by including a more extensive investment dispute resolution mechanism and comprehensive MFN and national treatment principles. The academic community has also divided China's BITs into four generations (2008 to the present). This generation of BITs is still more open, as this phase of the process involves negotiations between China and the US and many treaties are in the process of being negotiated, and it is not yet possible to draw specific features of the fourth generation of investment

[22]杨波 and 柯佳明, '新中国 70 年对外投资发展历程回顾与展望' [2019] (09) 世界经济研究 3, 4.

[23]China | International Investment Agreements Navigator | UNCTAD Investment Policy Hub[EB/OL][2022–02–21]. https://investmentpolicy.unctad.org/international-investment-agreements/countries/42/china?type=bits.

[24]Matthew Hodgson and Adam Bryan, 'Investment Treaty Arbitration in Asia: The China Factor' in *China's International Investment Strategy* (Oxford University Press, 2019) 430–433.

[25]Ibid.

agreements. [26]China has signed BITs with most of the countries along the "Belt and Road" route, but there are still shortcomings in the treaty function.

4.1. Unclear Identification of Investors

Article 25 of the ICSID Convention describes the status of a "national of the other Contracting State", but obtaining ICSID jurisdiction on the basis of "mutual written consent" also requires that the parties meet the definition of an investor in the BITs. In the case of China, the issue of investor status in the BITs is mainly in two areas: whether state-owned enterprises are eligible to participate in ICSID arbitrations, and the extent to which residents of Hong Kong and Macau SARs or legal entities can benefit from the protection of Chinese BITs.

Chinese companies can be seen more and more frequently in the international investment arena, and the issue of SOE status has never gone away when China is involved in negotiations, especially with the United States. Although SOEs are not unique to China, and China does not even have the largest number of SOEs among the top 500 companies in the world, there have been instances where Chinese companies have been challenged as investors in investment arbitrations, and even Huawei has been labeled as a SOE and deemed ineligible to initiate ICSID arbitrations.[27] There are three main types of BITs between China and Belt and Road countries: no public-private distinction between investor status, the public-private distinction between investor status by the foreign party only, and the public-private distinction between investors by both parties. Among the 58 BITs signed with the "Belt and Road" countries, 55 BITs have no distinction between the two sides, 2 BITs include state-owned enterprises (China-UAE BIT 1993 and China-Qatar BIT 1994), and 1BIT includes state-owned enterprises (China-Uzbekistan BIT 2011). This shows that the BITs signed between China and the Belt and Road countries are ambiguous as to whether the investors include SOEs, which has caused problems for Chinese companies participating in ICSID arbitrations.[28] In the case of Beijing City Construction Group v. the Republic of Yemen, for example, the Yemeni government alleged that Beijing City Construction Group did not meet the "national" requirement of Article 25 of the ICSID Convention and argued that a company exercising governmental functions should attribute its actions to the state and thus not be eligible for arbitration. In addition, the WTO Agreement on Subsidies and Countervailing Measures provides for three types of subsidies: governments, public bodies and private bodies entrusted by the former two. SOEs are often defined as public bodies in countervailing investigations by Western countries, especially during the US-China trade war, US-China countervailing investigations and litigation often put SOEs at the center of the dispute, which also served as a cautionary tale for future SOE participation in ICSID arbitrations.[29]

The representative cases on whether residents or legal persons of Special Administrative Regions can arbitrate their investments through Chinese BITs are Tza Yap Shum v. Peru and Sanum v Laos, both of which involve BITs concluded in China before the return of Hong Kong and Macau. From the point of view of territorial jurisdiction, according to the Article 29 of the Vienna Convention on the Law of Treaties, “Unless a different

[26]Matthew Levine, ‘Towards a Fourth Generation of Chinese Treaty Practice: Substantive Changes, Balancing Mechanisms, and Selective Adaption’ in *China’s International Investment Strategy* (Oxford University Press, 2019) 209.

[27]Ioannis Glinavos, *Which Way Huawei? ISDS Options for Chinese Investors* (SSRN Scholarly Paper No ID 3418929, Social Science Research Network, 12 July 2019) 5 <https://papers.ssrn.com/abstract=3418929> (‘*Which Way Huawei?*’).

[28]张晓君 and 曹云松, ‘“一带一路”建设中双边投资协定的功能发掘与范式构建’ [2021] (04) 国际经济评论 115, 120.

[29]沈伟, ‘国际经济活动中的国有企业身份困境——国际规则的分析’ [2021] (04) 华侨大学学报(哲学社会科学版) 103, 111.

intention is expressed in the treaty, or it is otherwise established, a treaty shall bind each of the parties in respect of its entire territory." In accordance with article 15 of the Vienna Convention on Succession of States in Respect of Treaties, "Treaties of the successor State shall enter into force for the territory to which the succession of States relates as from the date of the succession of States", Hong Kong and Macao, which were returned to China in 1997 and 1999 respectively, should undoubtedly be part of China. In addition, the first and second generations of Chinese BITs did not contain any restrictive territorial provisions, so jurisdiction over Hong Kong and Macau should not be excluded. However, the defense argued that China had signed the China-Britain Joint Declaration and the China-Portugal Joint Declaration respectively and that the Constitution and the Basic Law of the Special Administrative Region granted the Special Administrative Region a high degree of autonomy and the ability to sign BITs in its own name, and therefore should be treated as a "different expression of meaning" over the territory. Although the arbitral tribunals in both cases ultimately upheld the application of the Chinese BITs, Sanum v Laos, after the UNCITRAL tribunal confirmed the application of the Chinese and Lao BIT, the Singapore High Court quashed the arbitral tribunal's decision and rejected the application of the Chinese and Lao BIT, and the Singapore Supreme Court finally upheld the application of the Chinese and Lao BIT again, which makes the use of Chinese BITs in Hong Kong and Macau even more elusive, and the application of BITs will certainly continue to be tested by investment arbitration in the future.[30]

4.2. Scope of Arbitration Disputes and Indirect Expropriation Clauses

The BITs currently in force in China span a large period time, with each generation of BITs having its own focus. While most of the BITs signed with countries along the Belt and Road include ISDS provisions (with the exception of the China-Thailand BIT and the China-Turkmenistan BIT), the matters to be arbitrated are different. 37 of these BITs only allow for arbitration of "the amount of compensation for expropriation", 6 of these BITs allow for international investment arbitration of "disputes concerning the amount of compensation or other mutually agreed upon", and thirteen have no restrictions. [31] The rarity of ICSID arbitrations by Chinese investors is inextricably linked to the limited arbitration provisions in the BITs. [32]In Tza Yap Shum v. Peru, for example, a Hong Kong investor initiated arbitration against the Peruvian government in relation to expropriation matters, but the BIT only allows for arbitration of "the amount of compensation for expropriation", which is set out in Article 8(2) of the BIT, which states that "if the dispute is not settled by agreement within six months, either party shall be entitled to refer the dispute to the recipient of the investment". This means that disputes over expropriation must first be heard by a court, and if the parties are in doubt as to the amount of compensation, then the investment can be arbitrated. The two most important issues relating to this clause are whether the courts of the host country will take an impartial approach to the expropriation and whether the arbitral tribunal has jurisdiction over the expropriation. Clearly, the limited arbitration clause does not provide sufficient protection for the interests of Chinese overseas investors, but it is

[30]李妍婷, '中外 BITs 是否适用于"一国两制"下的澳门特别行政区?——以 Sanum 诉老挝政府案为视角' (2019) 25（00） 国际法与比较法论丛 102, 104.

[31]张 and 曹 (n 28) 123.

[32]Vivienne Bath, 'China's Role in the Development of International Investment Law - From Bystander to Participant' (2020)（2）(15) *Asian Journal of WTO and International Health Law and Policy,* 359, 371.

good that the tribunal in this case extended its interpretation of the clause to establish jurisdiction. The tribunal held that the word "involving" in BIT 8(3) "in the event of a dispute concerning the amount of compensation for expropriation" should be understood as "including" and not "excluding". The tribunal in Mr. Franz Sedelmayer[33] , Telenor[34] and Saipem[35] have adopted an expanded interpretation, not only to hear disputes over the "amount of compensation for expropriation" but also to hear the matter of "expropriation". It is important to note that the expansion of jurisdiction is not something that should be advocated, and with the trend of ICSID tribunals becoming more investor-protective, many of the victims in these cases are developing countries, so China should also be wary of the expansion of jurisdiction in expropriation clauses. However, different tribunals will give different interpretations, such as the tribunal that rejected the claims of Chinese companies in the 2017 case of Heilongjiang International Economic and Technical Cooperation Corporation and Others v Mongolia, holding that the tribunal did not have jurisdiction over the issue of whether expropriation had occurred.[36]

More often, indirect means, such as legislation, taxation or increased regulation, are used to gradually erode the legitimate interests of foreign enterprises. [37]The concept of indirect expropriation is not clearly defined in China's BITs, and unclear provisions may lead to different interpretations of indirect expropriation by arbitral tribunals, which may cause Chinese investors to bear the risk of losing their cases. The expropriation provisions in the 55 BITs with ISDS clauses signed between China and countries along the "Belt and Road" can be broadly divided into three categories: the first category is the China-Egypt BIT and the China-Azerbaijan BIT, which are expressed as "expropriation, nationalization or other similar measures ". The second category is the China-UAE BIT, which is expressed as "measures having the same effect as nationalization or expropriation". The third category clearly defines indirect expropriation, and in the 2006 China-India BIT, the concept was defined in more detail for the first time, drawing on the US BIT's definition of indirect expropriation. [38]Most of these BITs are of the first and second generation, with only the 2006 China-India BIT and the 2011 China-Uzbekistan BIT providing for indirect expropriation in detail. However, in many investment arbitration cases involving China, such as Beijing City Construction Group v. the Republic of Yemen, both parties have challenged whether governmental actions are expropriations, thus making the simple and cursory BITs provisions ineffective in protecting the interests of investors.

4.3. Transitional Provisions for Old and New BITs

The ICSID tribunal in Ping An of China v. Kingdom of Belgium rejected the claimant's claim for lack of jurisdiction. In accordance with Article 10.2 of the 2009 BIT, "This Agreement shall apply to all investments made by investors of either Contracting Party in the territory of the other Contracting Party, whether made before or after the entry into force of this Agreement. However, this Agreement shall not apply to any dispute or claim relating to an investment which has been the subject of judicial or arbitral proceedings prior to the

[33]Mr. Franz Sedelmayer v. The Russian Federation: Award[Z](1998–07–07).
[34]Telenor Mobile Communications A.S. v. The Republic of Hungary: Case No. ARB/04/15[Z](2006–09–13).
[35]Saipem S.p.A.v. The People's Republic of Bangladesh: Case No. ARB/05/7[Z](2007–03–21).
[36]*China Heilongjiang International Economic&Technical Cooperative Corp, Beijing Shougang Mining Investment Company Ltd, and Qinhuangdaoshi Qinlong International Industrial Co Ltd v Mongolia* (2017) award (PCA, 30 June 2017).
[37]黄世席, '投资协定"征收补偿款额仲裁条款"的解释分歧及中国应对' [2019] (02) 法学 165, 181–182.
[38]谷望舒, '"一带一路"视角下中国双边投资条约中间接征收条款的完善' (2019) 40(01) 海关与经贸研究 108, 112–113.

entry into force of this Agreement", arguing that the case had not been subject to dispute settlement procedures prior to the entry into force of the agreement and that the 2009 BIT should therefore apply. However, the tribunal interpreted the clause broadly, asserting that "access to dispute resolution procedures should also include cases where the notice was given under the old agreement but judicial arbitration proceedings had not yet been entered into, because the investor was aware of the length of the ICSID arbitration when it initiated the arbitration and the new BIT does not expressly provide for such cases, so the new treaty cannot be applied where the treaty does not expressly provide for notice but not judicial arbitration proceedings." Although the arbitral tribunal's decision was challenged by the academic community and the arbitrators' literal interpretation based solely on the literal meaning was not in line with the principle of good faith interpretation of the Vienna Convention on the Law of Treaties, the entry into force of the decision caused irreparable damage to the claimant. China's BITs are in the process of being renewed and the Ministry of Commerce has published data showing that China has signed old and new BITs with 11 countries, of which there are five models of transitional provisions. [39]Among them, the China-Portugal BIT and the China-Korea BIT have the most clearly expressed transitional provisions, which state that "the old treaty shall terminate on the date of entry into force of the new treaty, and the new treaty shall not apply to (investment-related) disputes occurring prior to its entry into force", while most of the other BITs only provide for a vague transitional model, leaving more room for interpretation by the arbitral tribunal. This is not conducive to the protection of investors' interests and increases the likelihood that the host country will be sued.[40]

5. Suggestions

International investment has become increasingly active in recent times, and while investment treaties are not the only way to protect investors and do not solve all investment problems, they still play an important role in promoting sustainable investment. [41] By 2020, there were 2,943 BITs worldwide and over 1,100 ISDS arbitrations brought by investors under various international investment treaties, with tribunals rejecting investor claims in more than half of these cases. [42]China is changing from being a traditional capital importer to a capital exporter, and with the “Belt and Road' initiative, more Chinese companies will be going abroad, so China should be prepared to do both to update BITs to reduce China's exposure to litigation and to protect Chinese investors in investment dispute resolution. Chinese companies should also change their mindset and take up the weapon of law to defend their interests.

5.1. Construction of a Model Bilateral Investment Agreement for China

With the changing global economic situation, the development of international investment law has undergone several changes, especially in the western developed countries, from the initial state protectionism focusing on the protection of host countries to the establishment of extensive free investment treaties to encourage overseas investment, to the current "return of the state" doctrine to return to the position of strengthening state regulation. [43] However, the

[39]我国对外签订双边投资协定一览表 Bilateral Investment Treaty [EB/OL] [2022–02–24]. http://tfs.mofcom.gov.cn/article/Nocategory/201111/20111107819474.shtml.

[40] (n 21) 173.

[41]Manjiao Chi, ‘Addressing Sustainable Development Concerns through IIAs: A Preliminary Assessment of Chinese IIAs’ in *China’s International Investment Strategy* (Oxford University Press, 2019) 100.

[42]UNCTAD, *WORLD INVESTMENT REPORT 2021* (2021) Chapter 3 – Investment Policy Developments.

[43]Shen Wei (ed), ‘Evolutionary Path of China’s BIT Law in the Return of the State Paradigm: A Statistical and Textual Approach’ in *Decoding Chinese Bilateral Investment Treaties* (Cambridge University Press, 2

development of China's BITs was different. The first two generations of BITs in China accounted for over 55% of all BITs, and although most BITs at this stage contained ISDS provisions, they were more restrictive and offered limited protection to investors. Starting with the China-Barbados BIT in 1998 China began a new generation of investment treaties that enhanced investor protection and included more extensive arbitration provisions. However, based on China's relatively little experience in international investment arbitration, some of the provisions of the new treaties on ISDS are not detailed and need further precision, such as whether they apply to Hong Kong and Macau investors and how investors can choose BITs for arbitration in the event of a change between the old and new treaties. In the construction of the new generation of BITs, it is crucial to balance the interests of the state and the interests of investors, and not to take too big a step that would lead to an "imbalance of interests". The following section focuses on the definition of "investor" and the expansion of the scope of arbitration.

5.1.1. Clarify the Identity of the "Investor"

Despite the growing importance of the private sector in international investment, Chinese SOEs remain the backbone of Belt and Road investments. In light of the experience of the Beijing City Construction Group case and the impact of the US security review on Chinese SOEs on their overseas investments, further clarification of the status of SOEs as "investors" has naturally become an important task in the construction of the new generation of BITs. There are two main expressions in Chinese BITs that explicitly include SOEs on both sides: the first summarises SOEs by listing them as "public institutions, companies, foundations, associations, etc.", and the second is "any entity, whether privately owned or not, owned or controlled by the government. " The definition of investor in the 2020 Regional Comprehensive Economic Partnership Agreement is "whether privately or government-owned", which could be used in future updates of the BITs to clarify SOEs as "investors" for the purposes of the treaty. In addition, the identification of "investors" should indicate whether it applies to Hong Kong and Macau investors so as to eliminate cases like the Tza Yap Shum case.

The identification of SOEs as investors is only the first step in the process of identifying the "investor", the determinations of the conduct of the SOEs are also necessary to establish the SOEs as an eligible subject of ISDS arbitration. Broches, the drafter of the Washington Convention, proposed a theory that distinguishes between public and private investment and argued that there are two types of conduct that would exclude an SOE as an "investor": the moment that the SOE performs basic government functions or acts as an agent of the government. Chinese BITs can use this as a criterion for identifying SOEs' investment behavior, thus preventing SOEs from participating in ISDS in a way similar to the US "ownership or control" approach that identifies SOEs as national public institutions.

5.1.2. Appropriate Expansion of the Scope of "Disputes" and Clarification of Indirect Levy Provisions

The use of ISDS by investors to assert their legal rights starts with the tribunal having jurisdiction over the dispute, and it is important to clarify the scope of investment arbitration in the investment agreement. The initial generation of BITs highlighted China's mistrust of ISDS, and despite its accession to the ICSID Convention, the scope of arbitrable matters was strictly limited. In the case of the China-Peru BIT, for example, as China gradually increased its outbound investment efforts, "disputes involving the amount of compensation for expropriation" could only be submitted to arbitration, which was no longer conducive to protecting the rights

021) 254, 254–256.

and interests of overseas investors. In practice, investors have sought to obtain the jurisdiction of arbitral tribunals by invoking the MFN clause or extending the interpretation of the arbitration clause, but this has led to increased uncertainty as to the outcome of the arbitration. It is worth noting that the shortcomings of international investment arbitration institutions have become increasingly apparent in recent years, and there are calls for their reform internationally. The tribunal's preference for investor protection is unfavorable to the host country, and China needs to balance the pros and cons of revising the terms of the BITs without completely removing the restrictions on the scope of the dispute, otherwise, national sovereignty and interests will be undermined by the "chilling effect". [44] The new BITs could include special provisions on expropriation and compensation. On the one hand, BITs can provide that investors can submit disputes arising from their investments to arbitration; on the other hand, expropriation matters can be compromised by providing that "disputes over compensation or other mutually agreed disputes that can be submitted to international investment arbitration are allowed to be arbitrated", such clauses not only provide protection to overseas investors without losing the state's jurisdiction over the expropriation but also prevents China from frequently becoming a respondent state.[45]

As mentioned above, indirect expropriation is becoming more and more insidious, which requires that the provisions of the BITs be as specific as possible so as not to expose Chinese enterprises investing abroad to more uncertain risks. In formulating the provisions, reference can be made to the US 2004 model BIT on indirect expropriation, which takes into account both the purpose and effect of indirect expropriation, for example, the China-India BIT is more rigorous in its indirect expropriation provisions, which are based on US standards. In other treaties signed by China, reference can also be made to the 2012 China-Japan-Korea treaty, which also provides for indirect expropriation in Article 11 based on the US model, but unlike the China-India BIT, the trilateral treaty provides for more rare cases of indirect expropriation, making the treaty more stringent. [46]In conclusion, when signing new BITs, China should make appropriate reference to the provisions on indirect expropriation in existing international investment treaties and provide more detailed provisions on indirect expropriation as far as possible, so as to provide a clearer legal basis for arbitral tribunals.[47]

5.2. Chinese Enterprises should Make Good Use of the Rules

When Chinese enterprises are involved in investment disputes abroad, they should not only rely on the treaty themself, but also make good use of the rules to fight for their interests. The ICISD does not currently have an appeal mechanism, and the finality of arbitration is a feature of arbitration that is also in line with the international law rule of pacta sunt servanda and res judicata. and res judicata), a rule of international law. Chapter 5 of the ICSID Convention provides for the interpretation, revision and annulment of awards. Firstly, if the award is not understood, the tribunal may be asked to interpret the award and, if this is not possible, the tribunal may choose to terminate the enforcement of the award. Secondly, Article 52 of the ICISD Convention provides for five grounds for setting aside an award: improper composition of the tribunal; excess of the authority of the tribunal; corruption of the arbitrators; serious deviation from the basic rules of procedure; and failure to state the basis of the award. In the Ping An case, however, Ping An of China failed to apply to the

[44]黄 (n 37) 179.
[45]张 and 曹 (n 28) 136.
[46]Won-Mog Choi, 'Substantive Provisions of the East Asian Tril ateral Investment Agreement and Their Implications' in *China's I nternational Investment Strategy* (Oxford University Press, 2019) 234–237.
[47]谷 (n 38) 118–119.

Secretary-General within the prescribed time after receiving the award and ultimately lost that opportunity. Investors should also be aware of the "exhaustion of local remedies" and "fork in the road" clauses when choosing how to pursue their rights. Exhaustion of local remedies requires the investor to exhaust domestic remedies, usually judicial and administrative, before submitting to arbitration. Fork in the road clause is the exclusion of other dispute resolution procedures after the investor has chosen one form of dispute resolution. In practice, there are many BITs that combine the two, for example, Article 9 of the China-Germany BIT provides that "if the dispute has been submitted to a Chinese court, the investor may withdraw it before proceeding to arbitration in accordance with the law." Therefore, investors need to carefully study the BITs provisions when they are in dispute and choose the dispute resolution method carefully.

6. Conclusion

China's Belt and Road Initiative has had a significant impact on international investment and trade, marking a change in China's foreign policy while establishing a more equitable, inclusive and opportunity-filled economic and trade platform for countries along the route, and reinforcing China's position as a major economic power. In 2015, President Xi Jinping put forward the concept of global governance for common development and sharing, which better combines China's "going out" and "coming in" strategies. China is committed to further establishing a more open economic system and implementing a unified negative list system for market access across the country. In the process of reforming its domestic policies, China has never slowed down in concluding international investment treaties and has gradually opened up its approach to investment arbitration. It is worth noting that China has completed its transformation from a traditional foreign investment importer to a two-way investment power. China has not yet become a regime maker in the field of international investment law and needs to learn more from the experience of developed countries such as Europe and the US, but it is also no longer a passive recipient of rules and is capable of taking a keen look at the risks that international investment treaties may bring to China.[48]

In an international situation where anti-globalization and regionalism are prevalent, China faces a number of challenges in continuing to improve its network of BITs. Firstly, as a two-way investment country, the focus of China's BIT policy needs to change to protect national sovereignty and regulatory rights while protecting Chinese capital abroad. Secondly, because most of the countries along the Belt and Road are developing countries, some of them are religionist states, with cultural, political and legal stability and transparency far from that of developed countries, the way in which treaties are formulated and negotiated will need to be adapted to their culture, where necessary, special provisions will need to be put in place to prevent dangers from arising. In some special situations, special provisions to prevent dangers are also necessary. Finally, it is important to build the Chinese paradigm for BITs as soon as possible and to elaborate on specific issues in specific provisions to prevent the interests of the state or investors from being compromised due to improper interpretation by arbitral tribunals. [49]China should also take on the role of great power and actively introduce sustainable development provisions while adhering to the ISDS and improving investor protection, so as to further optimize the business environment along the "Belt and Road" route and enable countries to achieve genuine win-win cooperation.

[48]Levine (n 26) 219–221.

[49]Shen Wei (ed), 'By Way of Conclusion: Chinese BIT Law and Practice in the Jungle' in *Decoding Chinese Bilateral Investment Treaties* (Cambridge University Press, 2021) 324, 326–328.

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Can Religious Tourism Make a Difference in the Tourism Sector in Sub-Sahara Africa?

Bismark Omane Asante

***Abstract*—** The growing impact of tourism on economic development within developing economies cannot be overemphasized. However, much attention among scholars, have not been given to religious tourism, one of the earlier forms of tourism. In a religiously diverse society such as in Sub-Saharan Africa, such studies have not been carried out to explore religious tourism among tourists in the country. The study would, therefore, seek to explore religious tourism in a pluralistic tourism sector within a developing economy sector and also examine the effect of religious tourism within the tourism sector in a developing economy such as Ghana. The study would adopt both a quantitative and qualitative research design to explore the objectives of the study and would use structural equation modelling to undertake a multiple regression analysis of the moderating effect of religious tourism in the tourism sector. A sample size of 300 and 20 respondents would be drawn for the quantitative and qualitative data collection, respectively. The study would use Amos and Nvivo data analysis software's analyzing the data. The study hopes to contribute to the development of a conceptual framework to guide the exploration of religious tourism activities with Sub-Sahara Africans. The study would also start discussions of religious tourism within the region as a conduit for development.

***Keywords*—** religious tourism, pilgrimage, actor network theory, secular tourism.

Bismark Omane Asante is with the Presbyterian Church of Ghana, Ghana (e-mail: bismarkasante20@gmail.com).

The Impact of Sustainable Packaging on Customers' Willingness to Buy: A Study Based in Rwanda

Nirere Martine
Sichuan Agricultural University
Chengdu, 611830, People's Republic of China

Abstract
Purpose –The purpose of this study aims to understand the intention of customers to adopt sustainable packaging and the impact of sustainable packaging on customers' willingness to buy a product using sustainable packaging. **Design/methodology/approach** – A new research model based on the technology acceptance model (TAM) and structural equation modeling are used to examine causality and test relationship based on the data collected from 251 Rwanda samples. **Findings** – The findings indicated that perceived ease of use positively affects perceived usefulness. However, perceived usefulness and perceived ease of use positively affect the intention to adopt sustainable packaging. However, perceived risk and perceived cost negatively affect the intention to adopt sustainable packaging. The intention to adopt sustainable packaging positively affects the willingness to buy a product using sustainable packaging. **Originality/value** – Many researchers have investigated the issue of a consumers' behavior to purchase a product. In particular, they have examined whether customers are willing to pay extra for a packaging product. There has been no study that has examined the impact of sustainable packaging on customers' willingness to buy. The results of this study can help manufacturers form a better understanding of customers' willingness to purchase a product using sustainable packaging.

Keyword: Consumers' behavioral, sustainable packaging, TAM

1. Introduction

As economies move progressively towards increased liberalization, certain undesirable business practices can emerge which act as a hindrance to development and economic growth. Majority of Rwandans live on agriculture and livestock (NISR, 2012). In 2008, a total ban of non-biodegradable plastic bags became reality (Kohls, 2011). However, many local manufacturers have struggled due to higher production costs (packaging) that followed the ban on plastics bag and also how they transport theirs goods to customers. Rwanda's plastic bag ban has been mentioned in several scholarly articles on the policy implementation of reduction of plastic bag consumption (Sharp et al, 2010; Clapp and Swanston, 2009), but in particular no study, to our knowledge, has considered specifically studying this case. There is a need to focus on the strategies for the enhancement of sustainable packaging. Can Rwanda's firms increase its packaging, meet both the customers' and distributors' needs and at the same time keep its business growing?

Packaging is defined in many terms and definitions throughout. The packaging facilitates the distribution and protection of the products, while they move from one participant to another in a specific supply chain management system (Verghese & Lewis, 2007). Packaging is much more than a simple container: packaging must satisfy protection, commercial, and logistics requirements from a sustainable perspective (González-Boubeta et al., 2018). To enhance the sustainability factor in packaging, manufacturers should look into the primary details such as whether the product actually needs to be packed and the minimum amount of packaging needed to retain its appearance and quality. Rwandan companies should look to these newer and proven technologies to track and trace their packages and ensure product security. The packaging performance, packaging quality, and packaging of the product must suit the customer's needs as well as satisfy environmental compliance guidelines. Sustainable packaging can be defined as packaging that has a comparatively low environmental impact as assessed by life-cycle assessment models (Glavic and Lukman, 2007). From a consumer perspective, sustainable packaging can be considered a packaging design that evokes explicitly or implicitly the eco-friendly of the packaging (Magnier and Crie, 2015). The concept of sustainability seems to be increasingly important to consumers (Bemporad et al., 2012; UNEP, 2005). The willingness of customers has changed over the years. Customers' interest to buy a product always depends on the willingness to buy and at the same time the intention to pay for the product. Many studies proved that purchase decisions always depend on the intention of the customers. The perception levels vary from one individual to another which may depend on need, influence, motivation, and finally how do they

perceive things to take decisions. The importance of knowing customers' willingness to buy, before launching a packaging product, enterprises, firms, organizations have to consider the customers' willingness to buy, various factors influencing them, quality. It makes them become successful in the market. So the willingness of customers can act as a powerful tool to develop strategies for achieving objectives of the enterprise in Rwanda.

To accomplish this aim of the study, the TAM (Davis 1989) was developed specifically for investigating the impact of sustainable packaging on customers' willingness to buy. A comprehensive research model that includes both enablers (perceived ease of use, perceived usefulness) and intention to adopt sustainable packaging (perceived risk and perceived cost) in order to understand the customers' willingness to buy a product using sustainable packaging was drawing.

A number of research questions are formulated, to facilitate the task of answering the more general question of how using sustainable packaging and its impact on customers' willingness to buy. First of all, this study investigates the effects on intention to adopt sustainable packaging in Rwanda. Secondly, this study explores the relationship between the intention to adopt sustainable packaging and willingness to buy products using sustainable packaging.

In remainder of this article, we begin by presenting the theoretical background regarding customers' willingness to buy. Then, we propose our research model and draw hypotheses. Next, we describe the research methodology and present the findings. The final section provides the discussion and conclusion of the study followed by, limitations and directions for future research.

2. Theoretical background

2.1 Modified TAM

A considerable amount of research has been dedicated to understand customer's intention and willingness in a wide range of settings related to new technologies and systems. In extant literature, the Technology Acceptance Model (TAM) by Davis (1989) emerged as the most popular models explaining the attitudes and behavior. According to Davis (1989), Chang (2018), and Tsai (2018), this study will adopt the perceived usefulness and perceived ease of use dimensions in TAM as the main dimensions from TAM that affect customers' willingness to buy a product using sustainable packaging. Based on the TAM, Davis (1989) also proposed that belief (perceived ease of use and perceived usefulness) are affected by customers' willingness to buy products. Davis (1989) argued that the adoption of a new technology depends on two belief variables perceived usefulness and perceived ease of use. Davis (1989) defined perceived usefulness (PU) as "the degree to which an individual believes that using the system will enhance his job performance". Davis (1989) defined perceived ease of use (PEOU) as "the degree to which an individual believes that using system will be free from physical and mental efforts". Based on the definition can be known that usefulness of using sustainable packaging is purposed to improve performance, and achievement of people who use them, also in this study is measured by customers' responses towards buying products packaging. PEOU has been considered as an important determinant in the adoption of information technologies (Wang et al., 2006). They only employed perceived usefulness and perceived ease of use as key factors for exploring the willingness to buy products. However, these two factors (perceived usefulness and perceived ease of use) are appropriate for evaluating the acceptance of sustainable packaging by the customer.

2.2 Intention to adopt SP

Paul et al 2016 proved that consumers will be more likely to purchase sustainable packaging of a food product if they believe that will have a positive impact on the environment. When it comes to sustainable packaging, knowledge might influence the intention to adopt and use sustainable packaging. If a consumer cannot clearly distinguish between two options a price premium of the sustainable product could easily affect the purchase decision in favour of a cheaper product (Yiridoe et al., 2005). Furthermore, sustainable packaging products do usually have a price premium which might influence customers' intentions to purchase those products. The theory of perceived risk has been used to explain customers behaviour and define factors that affect their decision-making (Taylor 1974). In general, during the decision-making process (i.e. willingness to buy a product), individuals often perceive significant risks (Holak and Lehmann, 1990). Risks are common in customers while buying any new sustainable packaging product. It is responsibility of manufacturers to take care of these kinds of risk and make sure that customers feel secured while purchasing their product. In turn, a higher level of risk perception may result in the strong display of intent to avoid such risks (Addo et al., 2020). Higher the cost of the technology, the lower its value to users, and lower its rate of usage (Premkumar, et al., 1997). Cost is one of the single most important factors that influence customers' willingness to buy a product using sustainable packaging. If customers are to use new technologies such as new products, the technologies must be reasonably priced relative to alternatives. Otherwise, the acceptance of the

new technology may not be viable from the standpoint of the customers. According to many researches it is found there is a direct and significant relationship between cost and the adoption of technology (Seyal, et al., 2006). Customers' intention to adopt sustainable packaging regarding the cost of the sustainable products is really sensitive.

2.3 Willingness to buy products using sustainable packaging

Consumer preference and willingness to buy or purchase products with environmentally friendly packaging was previously relatively well studied with conflicting results (Rokka & Uusitaloet al., 2008, Jerzyk, et al., 2016). The importance of knowing customers' willingness to buy, before launching a packaging product, enterprises, firms, organizations have to consider the customers' willingness to buy, various factors influencing them, packaging, quality. Consumers are continuously changing their attitudes, behavior, and approach in domains of consumption (Biswas & Roy, et al., 2015). Rwandans have become more aware of changes in the environment and the effect of their consumption behavior on it. According to Jerzyk, et al 2016 explored the attributes of sustainable packaging have a positive impact on consumer behaviour such as purchasing intention. Sustainable packaging is not the most important factor when buying a product and that customers are not willing to lose any of the functional and quality characteristics of the products because of the sustainable nature of the packaging.

As can be concluded from the number of existing studies on this matter, customers' willingness to buy is a mystery for manufacturers and retailers, about which much remains to be learned. In the literature there are numerous works that try to shed light on the way that customers plan and develop the purchasing process. This study has contributed to the understanding of the willing to buy products using sustainable packaging in the light of some factors influence the customers to make decision.

3. Research model and hypotheses

3.1 Perceived ease of use

As with new technology, a new packaging product must have PEOU to the intended customers towards the new product. Based on the TAM, Davis et al (1989), perceived ease of use is customers' willingness to feel that for him/her purchasing packaging or using sustainable packaging as a mode of trade does not require additional effort. Depending on TAM developed by Davis et al. (Davis et al., 1992; Davis, 1989), if a system is perceived as easy to use, it also provides more usefulness to its users (Davis et al., 1992). According to TAM, customers' intention to adopt sustainable packaging is determined by PEOU thus assumed to determine a person's attitude towards using the technology. For instance (Carroll and Thomas, 1988), objective and subjective are relevant to the customers performance and costumer decision. Customers would initially think that sustainable packaging is complex and difficult to use in Rwanda. At the same time, they would not expect that they can use sustainable packaging easily. The context of this study, PEOU refers to the extent to which customers' willingness to buy believe that their continued use sustainable packaging is free of effort. If a system is relatively easy to use, individuals will be more willing to learn about its features and finally intend to continue using it. There are many researchers (e.g. Moon & Kim, 2001; Aladwani, 2002) who have studied the relationship between perceived ease of use and perceived usefulness. In the context of sustainable packaging, both are surmised to be closely linked as the argument is such that a customer who perceives that purchasing use sustainable packaging through is effortless should in turn develop a tendency to perceive it as useful. In part, this is due to the fact that a costumer would inherently try to mould his/her perception of sustainable packaging based on his/her experiences in engaging to adopt sustainable packaging and the ease in which the task was executed (i.e. perceived ease of use).

Davis (1989) developed the TAM by exploring the impact of perceived ease of use and perceived usefulness on the acceptance degree of information technology. The results of the study found that perceived ease of use in the model would affect perceived usefulness and perceived usefulness also directly affects the intention to use. According to the literature review, we could infer that perceived ease of use has a significant positive impact on perceived usefulness, and perceived usefulness would also promote the use intention of green design packaging in the TAM. Consequently, the following hypotheses were proposed:

H1: Perceived ease of use has a positive effect on perceived usefulness.
H2: Perceived ease of use has have a positive effect on the intention to adopt sustainable packaging.

3.2 Perceived usefulness

A new technology such as sustainable packaging might be used to improve our everyday life. To benefit from this technology, customers have to accept them. According to the definition, Davis et al (1989) and Adams (1992) found that perceived usefulness was the main determinant of behaviour and

intention and use it. Since individual willing is determined, in part, by the perceived usefulness, it is logical to expect that intention to adopt sustainable packaging will have an influence on customers' willingness to buy. Thus, this study uses perceived usefulness as a factor affecting intention to adopt sustainable packaging. A system high in perceived usefulness, in turn, is one for which a customer believes in the existence of a positive use-performance relationship. Therefore, we suggest a hypothesis:

H3: Perceived usefulness has a positive effect on the intention to adopt sustainable packaging.

3.3 Perceived risk

Bauer (1960) introduced the concept of "perceived risk" and its determinants, namely, uncertainty and negative consequences. Additionally, Stone and Gronhaugh (1993) defined perceived risk as the subjective expectation of a loss. Perceived risk has long been considered to be a key factor influencing consumers' decision-making and behavior (Han et al., 2019; Quintal et al., 2010; Stone & Gronhaug, 1993). It can be defined as the subjective belief that a loss may occur when seeking desirable results from a product or service (Pavlou & Gefen, 2004; Tseng & Wang, 2016). It seems to be a common sense that when a customer perceives a packaging to be risky, their likelihood to purchase the packaging product would decrease. There are plenty of studies supporting the integration of perceived risk in TAM (Vasileiadis, 2014). Perceived risk is a matter of considerable reason why someone has an intention to adopt sustainable packaging. This study defines perceived risk as customers' willingness to buy of the uncertainties and negative results related to buying or selecting a packaging product. From the above definition of perceived risk, it can be clearly understood that intention to adopt sustainable packaging of risk is an inner experience that cannot be observed directly. In simple terms, perceived risk is the ambiguity that customers have before purchasing any product. Hence, we posit a hypothesis:

H4: Perceived risk has a negative effect on the intention to adopt sustainable packaging.

3.4 Perceived cost

In today's market, the cost point is such a powerful influence that environmental friendliness is something customers may not consider when purchasing a packaging product. Perceived cost is the extent to which an individual believes that using a particular technology will cost money (Luan and Lin 2005). A customer worries more the packaging product is a good price more includes hidden fees and the less they will be to buy them. If a sustainable packaging product satisfies these needs, then the consumer will be more eager to buy the product (Ottman, 1993). The customers would evaluate if the perceived cost have a significant relationships with customers' intention to adopt sustainable packaging in Rwanda. The customers need to have the knowledge or be willing to seek knowledge and information in order to buy sustainable packaging products. Nordin and Selke 2010) appreciate that consumers' perceptions are influenced by a lack of consumer knowledge about the concept of sustainability. For example, customers who want to use sustainable packaging have to pay additional fees because of the expensive materials used to produce the packages. Customers' choice in term of packaging is a purely economic decision. Indeed, customers make a balance between expected costs and quality of the products. As evidence reveals, perceived cost plays a more significant role in the judgment and decisions of individuals regarding investment than does the absolute level of cost. Hence, the current study proposes:

H5: Perceived cost has a negative effect on the intention to adopt sustainable packaging.

3.5 Intention to adopt sustainable packaging

According to Raza et al. (2014), purchase intention means, a condition between the customer and the seller when the customer is ready to make a deal with the seller. The overall product perception is created by the package having the high value for the customers. The new packaging is tested with the customers. The functionality in productions, package quality, and stability are also checked by the customers. Packaging is then almost more important than the products themselves so much. Choice to buy is considered as being derived from customers' willingness towards the product packaging, which in turn is based on an evaluative integration of benefits ascribed to the product by customers. The intention to adopt sustainable packaging are stronger predictors of willingness to buy a product using sustainable packaging when the amount of effort required for the willingness is high than when little effort is required. The sustainability of the package communicates the information about the product quality. Its material and ease of use can assist customers in choosing the particular packaging product which drive the customer's attention and influence the willingness to buy. The sustainable packaging has

different impacts on the customers. Some of them catch the customers' attention, the customers' willingness to buy; some of them stay ignored. Manufacturers are responsible not only for producing sustainable packaging but also for educating customers to be environmentally friendly. If strategically implemented, this solution should improve the willingness to buy a product using sustainable packaging in Rwanda. Therefore, intention to adopt sustainable packaging plays a vital feature in customers' willingness to buy a product using sustainable packaging. Accordingly, we set up the following hypothesis:

H6: The intention to adopt sustainable packaging has a positive effect on the willingness to buy products using sustainable packaging.

3.6 Control variables: gender, age, and education

We include age, gender, and education level as control variables in our research. Fig.1 shows the conceptual model with proposed hypothesizes, which are tested in the following section.

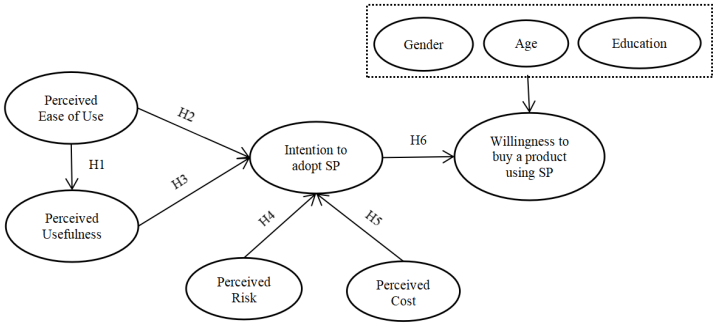

Fig.1 *Conceptual model*

4 Research methods

4.1 Construct measurement

The study has six constructs: perceived ease of use (PEOU), perceived usefulness (PU), perceived risk (PR), perceived cost (PC), intention to adopt sustainable packaging (ISP) and willingness to buy a product using sustainable packaging (WSBP). To measure the constructs, questionnaires are useful instrument of collecting the data. Respondents were asked to indicate the impact and importance of sustainable packaging on customers' willingness to buy according to the five constructs on a 5-point Likert scale with 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4= Agree, and 5= Strongly Agree. In doing so, since the respondents can read and then give responses to each item and they can reach a large number of subjects.

4.2 Data collection

To understand customers' willingness to buy, the data for this study were gathered from Rwandans, in the city of Kigali in 2021. This study followed a systematic of retrieving data from reliable sources. A structured questionnaire based primary survey was conducted using a stratified sampling technique and localities were divided into various stratum based on the sustainable packaging and, TAM model (Davis 1989), the intention to adopt sustainable packaging and customers' willingness to buy a product using sustainable packaging. Further details were provided when they had questions. To ensure the reliability of the questionnaire, we pilot tested it in more than 251 respondents. We discussed survey questions online with managers after they filled out the questionnaire and clarified the meaning of the questions with them.

5. Results

5.1 Measurement model

A measurement model was estimated to ensure the appropriate use of reliability, convergent validity, and discriminant validity. We used Cronbach's alpha to inspect reliability. As shown in Table 1, Cronbach's alpha (reliability) ranges from 0.716 to 0.859. The overall reliability of the measurement was above 0.7 and the measurement instrument shows enough internal consistency (Bagozzi and Yi 1988; Premkumar and Roberts 1999). For the purpose of confirmatory factor analysis, all the given constructs are allowed to correlate with each other (Byrne, 2010).

Table 1 AVE, CR and Cronbach's alpha

Variable	Cronbach's α	AVE	CR
PU	0.800	0.706	0.875
PEOU	0.859	0.589	0.746
PR	0.783	0.588	0.735
PC	0.716	0.560	0.726
ISP	0.774	0.535	0.774
WBSP	0.783	0.629	0.835

The confirmatory factor analysis (CFA) can be used to evaluate and establish evidence of sufficient construct validity (Creswell, 2003). Table 1 shows the average variance extracted (AVE), and the composite reliability (CR). As shown in Table 1, All AVEs exceed 0.5 and CRs exceed 0.7. Thus, the scale shows well convergent validity (Gefen et al. 2000).

As shown in table 2, to measure discriminant validity, the square root of AVE is significantly greater than its correlation coefficients of other factors for each factor. Hence, it reflects a well discriminant validity(Gefen at al.2000).

Table 2 The square roof of AVE and factor correlation coefficients

	PU	PEOU	PR	PC	ISP	WBSP
PU	**0.840**					
PEOU	0.568	**0.637**				
PR	0.260	0.592	**0.699**			
PC	0.433	0.510	0.557	**0.700**		
ISP	0.453	0.434	0.479	0.560	**0.732**	
WBSP	0.521	0.419	0.467	0.667	0.650	**0.793**

NOTE: *The diagonal numbers are the AVE square root value; Pearson correlation are shown below the diagonal*

5.2 Structural model

The model fitting indicators are used to test the overall fitting validity of the model. Generally, it is difficult for all indicators to meet the standard. In the study, GFI, RMSEA, RMR, CFI and NFI are used to judge the overall fit of the model. The specific results are shown in Table 3.

Table 3 Model fitting indexes

Indicators	χ^2/df	GFI	RMSEA	RMR	CFI	NNFI
Standard	<3	>0.9	<0.10	<0.05	>0.9	>0.9
value	2.230	0.963	0.095	0.036	0.915	0.928

The index values in the table are in line with the commonly used research standards, indicating that the model as a whole has a good degree of fitting.

The hypothesized relationships among the research variables were examined; see Table 4. The results show that PEOU has a significant positive effect on PU *(z=8.944, p=0.000<0.01)*, supporting H1. Also the results show that PEOU and PU have significant positive effects on ISP *(z=8.467, p=0.000<0.01; z=3.294, p=0.000< 0.01),* supporting H2 and H3. PR and PC are negatively related to ISP, while the effects are not significant *(z=-0.103, p=0.918>0.1; z=-0.193, p=0.947>0.1)*. Further ISP has significant positive effects on WBSP *(z =3.197, p=0.001< 0.01)*, supporting H6.

Table 4 Summary table of model regression coefficients

Summary table of model regression coefficients

X	→	Y	non-standardized path coefficients	HERSELF	z (CR)	p	standardize path coefficients
PEOU	→	**PU**	0.727	0.081	8.944	0.000	0.784
PEOU	→	**ISP**	0.273	0.186	8.467	0.000	0.308
PU	→	**ISP**	0.256	0.189	3.294	0.000	0.463
PR	→	**ISP**	-0.019	0.183	-0.103	0.918	-0.023
PC	→	**ISP**	-0.034	0.175	-0.193	0.947	-0.029
ISP	→	**WBSP**	0.362	0.113	3.197	0.001	0.412

note: → represent path impact relationships

5.3

Discussion

This study particularly investigated the impact of sustainable on customers' willingness to buy and the authors borrowed constructs from the technology acceptance model to explain the intention to adopt sustainable packaging. To accomplish this study, the research offers several findings. First, the current study states that perceived ease of use is found to have a positive effect on the perceived usefulness (H1). A possible explanation can be that when the customer perceives a sustainable packaging as easy to use and nearly free of mental effort he/she may develop a favorable attitude towards the usefulness of the system. The relationship between PEOU and PU was also found significant. This positive relationship could be attributed to the fact that customers are willing to adopt the system based on felt ease of use. Furthermore, perceived ease of use is found to have a positive effect on the intention to adopt sustainable packaging (H2). The more difficult to use of the sustainable packaging, the more useless the customers would feel the packing is. At the same time, customers would initially think that sustainable packaging is complex and difficult to use, then they are unwilling to spend more time and effort to learn how to do so. Second, the findings of this study show that perceived usefulness is found to have a positive effect on the intention to adopt sustainable packaging (H3). Such customers ultimately tend to identify usefulness of the technology itself. In addition, if customers think that is complicated to use a new system, then their intention of the usefulness of sustainable packaging in Rwanda would improve. This means that customers prefer sustainable packaging over others. Third, perceived risk is found to have a negative effect on the intention to adopt sustainable packaging. According to Bettman (1973), a consumer's purchase intention is affected by perceived risk. The findings of our study confirm that perceived risk and perceived cost negatively affect the intention to adopt sustainable packaging. A negative relationship between perceived risk and the intention to adopt sustainable packaging is found (H4). Consumer behavior is motivated to reduce risk (Bauer, 1960; Taylor, 1974). This study shows that perceived risk is a major obstacle for adopting sustainable packaging. Furthermore, perceived cost is found to have a negative effect on the intention to adopt sustainable packaging is found (H5). This research also further confirms the point that some customers are reluctant to adopt new technologies because they perceive additional costs. If customers want to use sustainable packaging, they must pay extra fees. If they think that these costs are too expensive and unnecessary, they are less likely to adopt sustainable packaging. Thus, one of the reasons customers decide to adopt a new technology (sustainable packaging) is to consider whether it can bring substantial benefits to their life or work. In comparison with traditional packaging and single use bag, the better the packaging is good the more product quality is more better which greatly improves the efficiency of customers. Moreover, it can be concluded that when customers think about the cost of the sustainable packaging products, it would impact their intention to adopt sustainable packaging. Finally, the findings of this study show that the intention to adopt sustainable is found to have a positive effect on customers' willingness to buy a product using sustainable packaging (H6). This study has shown that the intention to adopt sustainable packaging are stronger predictors of willingness to buy a product using sustainable packaging when the amount of effort required for the willingness is high than when little effort is required. We hope that these findings could call more researchers to conduct the impact of sustainable packaging research based on this specific country and market or any other contexts in the future.

6. Conclusion

6.1 Main findings

Studies have shown that the packaging plays a critical role in the purchasing decision. Silayoi and Speece (2007) deemed that in cases when the consumer is undecided, the package becomes a vital factor in the buying choice because it communicates to the consumer during the decision making time. Kupiec et al. (2001) indicated that the intention to purchase also depends on the degree to which

consumers expect the product and package to satisfy their needs and desires (Silayoi et al. 2004). As Rwanda is facing a variety of challenges, the sustainable packaging can contributed to overcoming these difficulties. Meanwhile, the advancement toward products and sustainable packaging has become a far-reaching agenda for institutions, society, and the government of Rwanda. Given the prevailing condition coupled with existence of a rift between customers' preference and willingness to buy for sustainable packaging, this study examines the impact of sustainable packaging on customers' willingness to buy. For example, given the increases in fast food, it may be that a significant portion of Rwandans are increasingly recognizing the value of sustainable packaging. In addition, the study has investigated how sustainable packaging influences on the costumer buying, willing and how customers' intention vary according to the product packaging. The usage of sustainable packaging as market segmentation can provide useful information to marketers about maximizing the package's impact in selling the products. The package is the components that provide an advantage for the products in a competitive environment. The cooperation between customers and companies provides package which could attract the potential customers and obtains successful results for the company. This study particularly investigated the impact of sustainable on customers' willingness to buy and the author borrowed constructs from the technology acceptance model it to explain the intention to adopt sustainable packaging. The findings reveal that perceived usefulness and perceived ease of use positively affects the intention to adopt sustainable packaging. Perceived risk and perceived cost negatively affect the intention to adopt sustainable packaging. Finally, the intention to adopt sustainable packaging positively affects the willingness to buy a product using sustainable packaging. The findings show that customers are moved by attraction and the way a product is packaged affects its appeal. The findings will be of great benefit to Rwandan policy makers, customers, and institutions and the country as a whole. Consequently, the packaging and the customer are two variables which should be always considered in the company's strategies to increase.

6.2 Implications

Results of this study contribute to advance and guide management relate to sustainable packaging from a number of ways. First, this study identifies the intention role of perceived risk and perceived cost in a modified TAM. In addition, this study attempts to integrate perceived risk and perceived cost into the TAM model and successfully confirms that perceived risk and perceived cost have important negative effects on the customers' intention to adopt sustainable packaging. Thus, this study enriches the existing literature on customers using sustainable packaging adopting willingness to buy, thus providing a new research perspective for those who are engaged in related research. Second, the findings show that the Rwanda's companies should put a lot of effort into creating an attractive sustainable packaging. Each package is made to meet customers' needs and wishes and to provide positive experience with the package and the actual product. During the purchasing, the package helps customers to evaluate the product. Our main findings indicate that well-educated young urban customers living in Rwanda base the perception of the environmental sustainability of packaging on customers' willingness to buy. Third, when launching a new packaging, manufacturers could address perceived ease of use and perceived usefulness in their business strategies. This study indicates that when we protect a product with packaging, we need to assess the environmental impact of lost product due to inadequate packaging and attract customers' willingness to buy a product using sustainable packaging. A sustainable business also increases efforts to build a strong and environmental impact through product packaging. The nature of most customer products makes it imperative for such products to be properly packaged. As can be concluded from the number of existing studies on this matter, customers' willingness to buy is a mystery for manufacturers and retailers, about which much remains to be learned. In the literature there are numerous works that try to shed light on the way that customers plan and develop the purchasing process. Fourth, on the other hand, in comparison with other developed countries, the price of packaging product in Rwanda is relatively high. Thus, manufacturers need to provide diversified sustainable packaging, especially products at different prices, to meet the needs of different groups and improve the utilization rate of packaging. Additionally, the packaging in Rwanda is not good but its fee is high. Manufacturers should take some measures to improve the raw materials used to produce packaging, reduce the costs and encourage customers to adopt sustainable packaging and willing to buy products using sustainable packaging.

The results will also allow practitioners to determine factors that can help increase customers' performance. The findings are very useful not only to the individual organizational but also to the government of Rwanda in presenting the important effects of information technology on quality of work. Therefore, information from these findings should encourage and support the formation of future policy, not only at the organizational level but also at the national level. If the government utilizes these findings to set up strategies to promote packaging, it may in turn improve professional practice,

personal development and quality of working life.

6.3 Limitations and future research directions

This research is limited itself to the capital of Rwanda, Kigali and lies in the limited size of the sample used for the online responses (n=251). It will be conducted through a survey questionnaire and therefore no qualitative perspective will be taken into account. Given the fact that technology has and will continue to rapidly change, and result in significant technology advancements in the future, the findings of this research will need to be used with care. Investigating how technological changes may influence learner willingness towards using sustainable packaging for future research.

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U_{11} Functionalised Luminescent Gold Nanoclusters for Pancreatic Tumor Cells Labelling

Regina M. Chiechio [1,2], Rémi Leguevél [3], Helene Solhi [3], Marie Madeleine Gueguen[3], Stephanie Dutertre [4], Xavier [4], Jean-Pierre Bazureau [1] , Olivier Mignen [5,6], Pascale Even-Hernandez [1], Paolo Musumeci [2], Maria Jose Lo Faro [2], Valerie Marchi [1]*

***Abstract*—** Thanks to their ultra-small size, high electron density and low toxicity, gold nanoclusters (Au NCs) have unique photoelectrochemical and luminescence properties that make them very interesting for diagnosis, bio-imaging and theranostics. These applications require control of their delivery and interaction with cells; for this reason the surface chemistry of Au NCs is essential to determine their interaction with the targeted biological objects. Here we demonstrate their ability as markers of pancreatic tumor cells. By functionalizing the surface of the NCs with a recognition peptite (U11), the nanostructures are able to preferentially bind to pancreatic cancer cells via a receptor (uPAR) overexpressed by these cells. Furthermore, the NCs can mark even the nucleus without the need of fixing the cells. These nanostructures can therefore be used as a non-toxic, multivalent luminescent platform, capable of selectively recognizing tumor cells for bioimaging, drug delivery and radiosensitization.

***Keywords*—** gold nanoclusters, luminescence, biomarkers, pancreatic cancer, biomedical applications, bioimaging, fluorescent probes, drug delivery**.**

1 Université Rennes 1, CNRS UMR 6226, Institut des Sciences Chimiques de Rennes, 35042 Rennes Cedex, France;
2 Dipartimento di Fisica e Astronomia, Università di Catania, Catania, 95123, Italy;
3 ImPACcell platform, Biosit, Université de Rennes 1, F-35043 Rennes, France;
4 Microscopy Rennes Imaging Centre, SFR Biosit, UMS CNRS 3480—US INSERM 018, Université de Rennes, 35000 Rennes, France
5 University of Brest, INSERM, Canalopathies et Signalisation Calcique, Brest, France;
6 University of Brest, INSERM, Lymphocytes B et auto-immunite´, Brest, France.

Corresponding Author:
* to whom correspondence should be addressed: valerie.marchi@univ-rennes1.fr

Diagnostic Accuracy of Core Biopsy in Patients Presenting with Axillary Lymphadenopathy and Suspected Non-Breast Malignancy

Monisha Edirisooriya, Wilma Jack,Dominique Twelves, Jennifer Royds, Fiona Scott, Nicola Mason, Arran Turnbull, J. Michael Dixon

Monisha Edirisooriya is with the University of Edinburgh, United Kingdom (e-mail: m.edirisooriya@nhs.net).

Abstract

Introduction

Excision biopsy has been the investigation of choice for patients presenting with pathological axillary lymphadenopathy without a breast abnormality. Core biopsy of nodes can provide sufficient tissue for diagnosis and has advantages in terms of morbidity and speed of diagnosis. This study evaluates the diagnostic accuracy of core biopsy in patients presenting with axillary lymphadenopathy. The study consisted of data from 165 patients referred to the Edinburgh Breast Unit between 2009 and 2019 for a total of 179 axillary lymph node core biopsies. The results show that 152 (92%) of the 165 initial core biopsies were deemed to contain adequate nodal tissue. Core biopsy correctly established malignancy in 75 of the 78 patients with haematological malignancy (96%) and in all 28 patients with metastatic carcinoma (100%) and correctly diagnosed benign changes in 49 of 57 (86%) patients with benign conditions. There were no false positives and no false negatives. In 67 (85.9%) of the 78 patients with haematological malignancy, there was sufficient material in the first core biopsy to allow the pathologist to make an actionable diagnosis and not ask for more tissue sampling prior to treatment. There were no complications of core biopsy. On follow up, none of the patients with benign cores has been shown to have malignancy in the axilla and none with lymphoma had their initial disease incorrectly classified.

The conclusions of this study show that core biopsy is now the investigation of choice for patients presenting with axillary lymphadenopathy even in those suspected as having lymphoma.

Keywords: Core biopsy**,** Axillary lymphadenopathy**,** Non-breast malignancy

Introduction

Isolated axillary lymphadenopathy is defined as either an increase in the size of at least one axillary node, an increase in cortical thickness of at least one node or both without any synchronous breast lesion. The options for obtaining a diagnosis in such patients are core biopsy or lymph node excision. Core biopsy appears safe, can be performed immediately and is a cost-effective method of tissue sampling [1], [2]. It can produce some post-biopsy local discomfort, but other complications are unusual [3]. Drawbacks to this method of tissue sampling include the requirement for a more extensive work up with immunohistochemistry/PCR/FISH; and the lack of fresh tissue for flow cytometry. The key concern with core biopsy is that it may fail to obtain sufficient tissue to achieve an actionable diagnosis, particularly in patients with lymphoma, where discerning heterogeneity is important. For this reason, excision biopsy has been traditionally used as the investigation of choice in patients who present with enlarged axillary lymph nodes. Recognised complications of lymph node excision include infection, bleeding, paraesthesia, scarring and lymphoedema [4], [5]. The National Institute of Clinical Excellence (NICE) recommends node excision as part of the diagnostic work up of a patient presenting with suspected non-Hodgkin lymphoma and only advocates core biopsy in unfit patients [6]. The National Comprehensive Cancer Network (NCCN) also advises node excision in patients with suspicion of Hodgkin and non-Hodgkin lymphoma [7]-[11].

A series of core biopsy from head and neck regional nodes have reported high rates of diagnostic specimens [12]-[14]. Two series combined core biopsies from nodes at multiple sites including the axilla, one of which reported that location of the node did not affect the result [15], whereas the other concluded lymph node location did affect diagnostic rate [16]. In these two series, there were small numbers of patients with axillary lymphadenopathy. In patients with lymphoma as their final diagnosis, core biopsy can provide sufficient material to diagnose the lymphoma type in between 66% and 74% of patients [17]. Ultimately, there remains doubt in the literature as to how often core biopsies from the axilla in patients with suspicion of lymphoma can provide accurate results. Hence, the aim of this study was to evaluate the diagnostic accuracy of core biopsies in patients presenting with isolated axillary lymphadenopathy to the Edinburgh Breast Unit.

Methods

A retrospective analysis of patients was performed of all patients seen in the Edinburgh Breast Unit between 2009 and 2019 with axillary lymphadenopathy, without synchronous clinical or imaging suspicion of breast malignancy and who underwent core biopsy in the Edinburgh Breast Unit. Patients were referred either from primary care, haematology or from physicians and surgeons following a CT scan that showed axillary lymphadenopathy. Patients had a clinical history taken and a clinical examination performed with results recorded on a Breast Unit proforma. Specifically, prior medical conditions and details of any previous malignancy were recorded. Clinical examination was performed of both breasts and regional lymph nodes (both axillae, supraclavicular and low cervical areas). If there was a history of, or imaging findings of other nodal enlargement, then these areas were also examined, and any abnormal findings recorded. All patients had axillary ultrasound performed and reported at a one stop breast clinic and were seen by or discussed with a consultant breast surgeon prior to a decision on biopsy. The clinician who completed the pathology request form provided full details of imaging findings, the working clinical diagnosis and any history of a prior cancer diagnosis. If TB was suspected, then the pathologist was made aware and cores were also sent fresh for TB culture.

Specific inclusion criteria guided the selection of cases for this study. Patients must have undergone a core biopsy of an axillary lymph node that was deemed abnormal on axillary ultrasound. Core biopsies were performed almost exclusively with ultrasound guidance with only a few cores performed freehand. A mix of breast radiologists, radiographers and breast surgeons performed the biopsies at the one stop breast clinic. Some patients had the core biopsy repeated on a second occasion. All but four core biopsies were performed using a 14 gauge spring loaded device. Two patients had 12 gauge cores and two had either an 11 gauge or 8 gauge vacuum assisted biopsy. One percent lidocaine with 1 in 200,000 adrenaline up to a maximum dose of 7 mg/kg was used to limit any pain and reduce potential bleeding. We try to inject local anaesthetic all around the node and wait a few minutes following infiltration, before performing the biopsy to ensure that the adrenaline and local anaesthetic have time to act.

A total of 165 patients who underwent 179 axillary core biopsies fulfilled the inclusion criteria. The final diagnosis was based on core biopsy or later node excision. The axillary core biopsy was classified as benign, malignant or uncertain. Comparison of diagnostic rates was performed by Fisher's exact test. An analysis was performed to determine how often the first core biopsy produced an actionable diagnostic result; this means that the core provided a diagnosis, including sub-classification of any malignancy where required, sufficient to proceed with any necessary management without requiring further tissue sampling.

Axillary core biopsies were repeated in 14 patients. The value of repeating core biopsies was evaluated by comparing the results of the two core biopsies. Twenty two patients had lymph node excision and the numbers where this was required to produce an actionable diagnosis was calculated as a proportion of both the total group and those patients with a final diagnosis of malignancy and lymphoma. Fig. 1 summarises the investigations performed in the 165 patients.

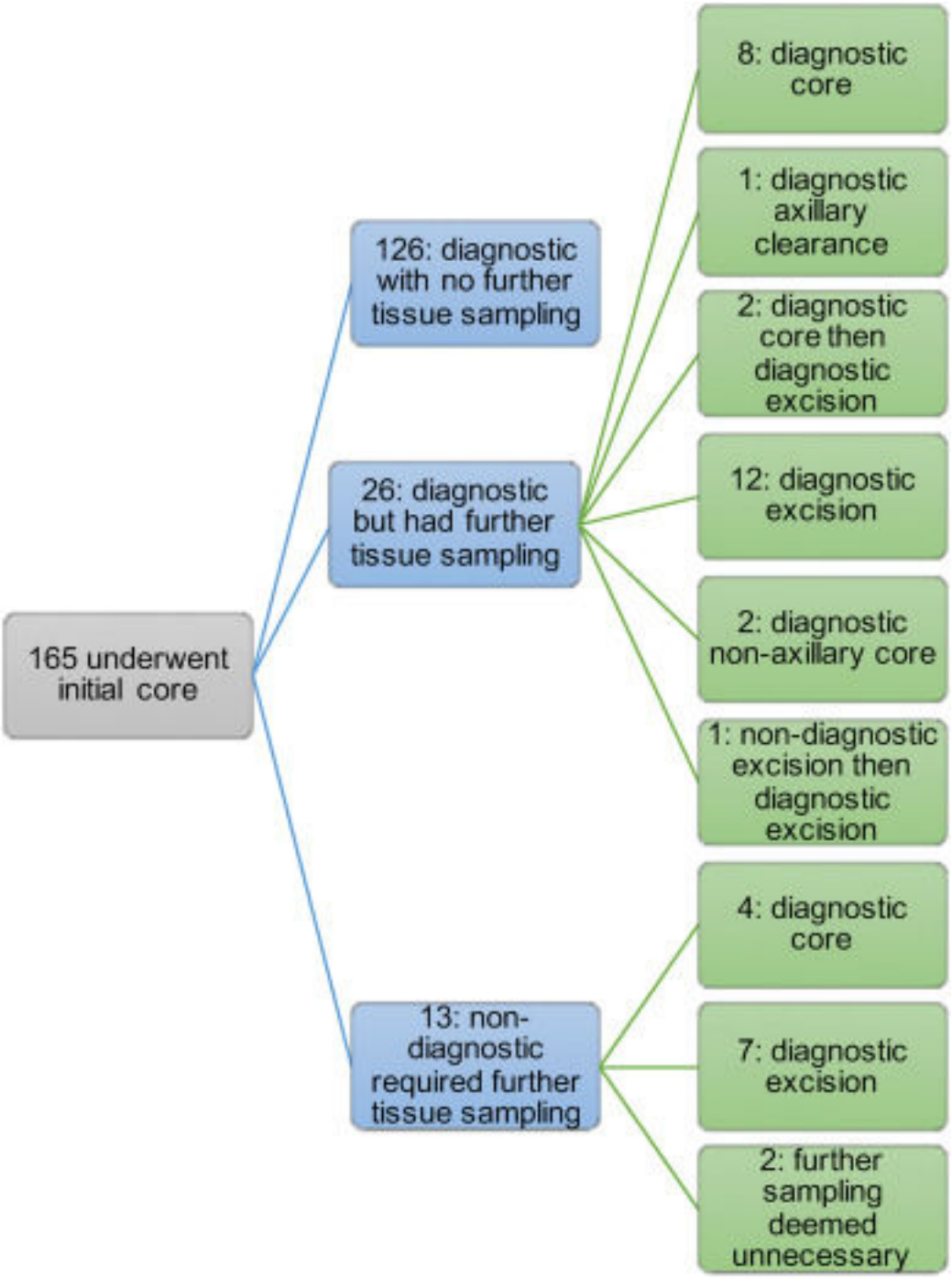

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Fig. 1. Summary of investigations performed in this series of 165 patients.

Results

Table 1 contains a summary of the results of the 165 initial core biopsies. In 152 patients (92.1%), the first core biopsy contained enough tissue for the pathologist to give a definite diagnosis. There were a huge variety of diagnoses made on core biopsy showing the wide range of conditions that can affect axillary lymph nodes and ability of core biopsy to make very specific diagnoses. The final diagnoses on the first core were: 50 benign conditions; 74 haematological malignancies and 28 metastatic cancers. In 13 patients (7.9%), the initial core biopsy did not provide sufficient tissue for the core to be considered diagnostic.

Table 1. Results of first core biopsy.

Result	No.
Normal node/reactive node	49
Non-Hodgkin Lymphoma	58
Leukaemia Other than Chronic Lymphocytic Leukaemia	2
Small Lymphocytic Lymphoma/Chronic Lymphocytic Leukaemia	8
Metastatic Melanoma	18
Metastatic Breast Carcinoma	3
Metastatic Lung Carcinoma	2
Metastatic Adenocarcinoma with Gastric Primary	1
Metastatic Merkel Cell Carcinoma	1
Metastatic Ovarian Adenocarcinoma	1
Metastatic Squamous Cell Carcinoma	1
Multiple Myeloma, Plasmacytoma with Amyloidosis	1
Plasmacytoma Consistent with Relapsed Myeloma	1
Angioimmunoblastic T Cell Lymphoma with EBV Related B Cell Lymphoma	1
Tuberculosis	1
Small B Cell Lymphoma	1
ALK Anaplastic Large Cell Lymphoma	1
Hodgkin Lymphoma Nodular Sclerosing type	1
High Grade Undifferentiated Malignant Tumour (right axilla)	1
[N]Possible Hodgkin Lymphoma but considered insufficient material for definite diagnosis	1
[N]∗No convincing evidence of Relapse Hodgkin Lymphoma - more tissue requested	1
[N]∗∗Features of T Cell Lymphoma but further tissue requested for confirmation	1
[N]Insufficient lymph node tissue for diagnosis	5
[N]No evidence of malignancy but core was considered insufficient	5

Result	No.
Total	165

[N] = non-diagnostic ∗ = false negative result ∗∗ = false positive result.

In this series of 165 patients, 106 patients had malignancy. The prevalence of cancer in this series was 64%. The probability of a particular positive test result being a true positive for a first core biopsy that contained sufficient tissue was 1.00 (95%CI 0.94–1.00). For a negative result the probability that it was a true negative (NPV) was 1.00 (95%CI 0.88–1.00). Fig. 2 summarises the final diagnoses of the total group and the further investigations patients had to reach a diagnosis. In patients with haematological malignancies, in 75 of the 78 patients (96%), the first core correctly predicted that malignancy was present. This includes one patient where the axillary node was correctly diagnosed as being benign but where a subcutaneous lesion from the chest wall was biopsied and extra-nodal malignancy was established. In the 28 patients with metastatic breast cancer, the first core was correct in 100% of the time. In 57 patients that did not have malignancy, the first core established this in 86%. The rate of diagnosis was significantly higher for metastatic lesions than for benign conditions $p = 0.048$. There was no significant difference between the rate of diagnosis for either benign or metastatic lesions compared to haematological malignancies.

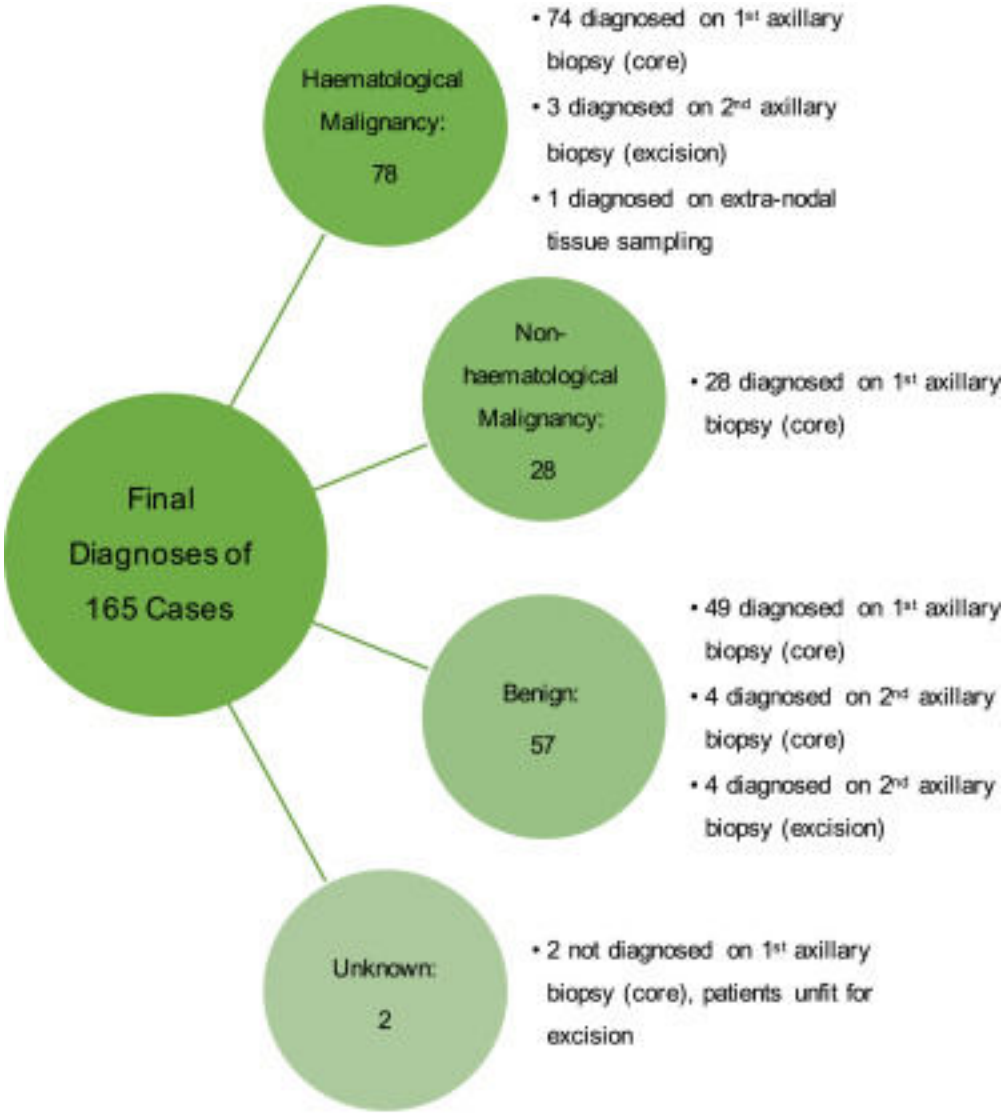

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Fig. 2. Summary of the final diagnoses of 165 patients in this study.

A number of patients particularly early in the series had axillary nodes that were radiologically suspicious of malignancy where the first core was benign and the multidisciplinary team advised another core biopsy. As time passed this practice stopped. All 14 patients (Fig. 1) that had a repeat axillary core biopsy were diagnostic. Twenty-two patients had one or more axillary nodes excised. One of these patients had to undergo excision twice, as the first excision was also considered non-diagnostic. There were no complications of core biopsies in this series. Specifically, there were no significant episodes of bleeding although some degree of bruising was common.

Table 2 compares the diagnosis of the first and second samples for each patient who had a second sample taken. As noted above, out of all patients with a core biopsy containing

sufficient tissue and reported as showing no evidence of malignancy; none had malignancy identified on a second core or node excision.

Table 2. Patients undergoing a first core biopsy followed by further tissue sampling.

Results from first core biopsy	Further tissue sampling method (Results provided if different from first core)	No.
No Evidence of Malignancy	Core	6
	Excision	7
	Core then Excision	2
Tuberculosis	Core	1
Lymphoma	Core	1
	Excision	3
	Excision then Excision	1
	Neck Core	1
High Grade Undifferentiated Malignant Tumour	Therapeutic Right Axillary Clearance (Histiocytic Sarcoma)	1
Chronic Lymphocytic Leukaemia (CD5 Weakly Expressed)	Excision (Mature B Cell Non-Hodgkin Lymphoma with Features of Chronic Lymphocytic Leukaemia and Small Lymphocytic Lymphoma)	1
CD20 Negative Follicular Lymphoma with Probable High Grade Transformation	Excision (Diffuse Large B Cell Lymphoma)	1
No Evidence of Malignancy	Left Posterior Chest Core (Extra-Nodal Marginal Zone Lymphoma) – different site biopsied	1
[N]Insufficient Lymph Node Tissue Sampled	Core (No Evidence of Malignancy)	3
	Core (Tuberculosis)	1
	Excision (No Evidence of Malignancy)	3
	Excision (Hodgkin Lymphoma (Nodular Sclerosing))	1
	Excision (Low Grade B Cell Lymphoma)	1
	Excision not performed as patient unfit	2
[N]∗No convincing evidence of Relapse Hodgkin Lymphoma	Excision (Nodular Lymphocyte Predominant Hodgkin Lymphoma)	1
[N]∗∗Features of T Cell Lymphoma, further tissue for confirmation	Excision (No Evidence of Malignancy)	1

[N] = non-diagnostic; ∗ = false negative result; ∗∗ = false positive result.

A = Node returned to normal.

B = Patient would not sufficiently well to tolerate treatment if malignancy were detected.

There were 78 patients with haematological malignancies. In 67 patients (85.9%), there was sufficient material in the first core biopsy to allow the pathologist to make an actionable diagnosis and not ask for more tissue sampling prior to treatment. Table 3 gives details of the sampling performed in the remaining 11 patients to establish an actionable diagnosis. In seven of the 74 patients, the first core was diagnostic, but it was felt further sampling was needed. This did not alter the general lymphoma classification given on the first core, but did allow sub classification necessary to treat these patients. These individual patients are listed in Table 2. In three patients with lymphoma, the diagnosis was missed on the first core, because the amount of tissue submitted was considered insufficient. All three patients had their cores performed in the first 3 years of this study.

Table 3. Summary of lymphoma cases.

	N (% of total)
Diagnosed with first core, no follow up tissue sampling required	66 (84.6%)
Diagnosed with first core, confirmed in follow up core	1 (1.3)
Diagnosed with first core, confirmed in follow up excision	6 (7.7)
Diagnosed with first core, confirmed in follow up neck core	1[H] (1.3)
Not diagnosed with first core – insufficient tissue, diagnosed in follow up core	0 (0)
Not diagnosed with first core – insufficient tissue, diagnosed in follow up excision	3 (3.8)
Axillary core correctly diagnosed no malignancy, extra-nodal marginal zone lymphoma diagnosed by follow up posterior chest core	1 (1.3)
Total N	78

[H] = Hodgkin Lymphoma.

Between one and 11 years have passed since the cores from this series of patients were performed. In no patient has follow up determined that the diagnosis given on the original core was wrong. Specifically, none of the patients with benign cores have been shown to have malignancy in the axilla and none of those with lymphoma is thought to have had their initial disease incorrectly classified.

Discussion

This retrospective study analysed a series of 165 patients who presented with enlarged axillary lymph nodes with no signs of breast cancer who underwent core biopsy. The accuracy rate for obtaining a diagnosis of benign or malignant disease on the first core biopsy was 92%

(152/165). This is comparable with series of core biopsies from nodes at other sites. Core biopsy in lymph nodes in the head and neck region has accuracy rates of 81–94% [12]-[14]. Many series have combined results from nodes at different sites and have included patients having axillary node core biopsies; their rates of accuracy have varied between 74% and 96% [17], [15], [18]. Most patients with axillary lymphadenopathy have an underlying breast problem. Patients with simultaneous breast problems were deliberately excluded from this study and the current series was limited to patients with axillary lymph node enlargement without any breast abnormality. Excluding breast related lesions makes the results of this study even more impressive, as many of the series of lymph nodes from other sites include patients with local cancers that metastasise to regional lymph nodes. There was a high prevalence of malignancy in this series at 64%, with 78 patients having lymphoma (46% of all patients) and 28 (17%) having metastatic carcinoma. The rate of obtaining an actionable diagnosis on the first core was highest in patients with a prior history of malignancy and just significantly lower in patients with benign disease. There are some obvious reasons for this. In a patient with a prior malignancy with a known immunoprofile, a small area of cancer in a node can allow the pathologist to make a definitive diagnosis of a metastasis to an axillary node. Excluding malignancy in contrast requires more tissue and given that on average the malignant nodes were larger than those with benign conditions, it is perhaps surprising that we report rates of an actionable diagnosis in over 85% in patients with either haematological malignancy or benign lymphadenopathy. One patient in this series required two whole node excisions to get a definitive diagnosis so even removing axillary nodes at open surgery is not 100% reliable.

Breast radiologists, radiographers and breast surgeons performed these biopsies. This group of clinicians are used to performing core biopsies from axillary nodes and this may explain the high rate of accuracy for core biopsy in this series. Our results suggest that patients with axillary lymphadenopathy should be referred to regional breast units or directly to breast radiologists rather than to general surgeons. It should be stressed that all patients biopsied had a detailed history taken and had a thorough clinical examination of the breasts and regional nodes as well as any nodes considered abnormal on prior imaging. Furthermore, details of the working clinical diagnosis, and any history of malignancy were provided to the pathologist. There were no significant complications in this series demonstrating that core biopsy of axillary nodes is both safe and accurate. The safety of axillary core biopsy is supported by other studies [1]-[3]. Early in the series where patients had imaging features of malignancy and the core biopsy was benign, patients had their cores repeated. None of the repeat cores demonstrated malignancy if the first core was reported as benign and contained sufficient tissue for the pathologist to give a definitive diagnosis. One reason core biopsy was repeated was because over a decade ago, a

limited numbers of cores were taken from axillary nodes to try and limit any complications. The aim now is to obtain at least four on target biopsies with adequate material on inspection. In larger nodes we perform more biopsies and send two or three cores fresh for culture, if tuberculosis is suspected. Because of taking more cores, our rate of inadequate sampling has reduced over time. Our study clearly shows that if the first core contains sufficient tissue to allow a diagnosis, then the core need not be repeated even in the presence of a discrepancy between the imaging and pathology diagnosis. Multidisciplinary teams (MDT) play an important role in making such decisions and deciding if the sample obtained provides an actionable diagnosis. All patients in Edinburgh with axillary lymphadenopathy are discussed at both the breast MDT and the relevant specialist MDT if malignancy is identified. Over the decade of this study the MDTs have adapted core biopsy and now request core biopsies as their first investigation of choice in axillary and other sites of lymphadenopathy.

The National Institute for Health and Care Excellence (NICE) states that excision biopsy should be considered as a first line procedure as part of the diagnostic work up in a patient with a suspected non-Hodgkin lymphoma [6]. These recommendations are mirrored by the National Comprehensive Cancer Network in the US for all suspected Hodgkin and non-Hodgkin lymphoma [7]-[11]. This study shows that in malignancy core biopsy can provide sufficient information to allow classification and treatment in almost 86% of patients. This study mirrors a large meta-analysis of 42 publications looking at the diagnostic accuracy of needle biopsy in lymphoma that reported that core produced enough material to diagnose the lymphoma type in between 66% and 74% of patients. Core biopsies do require extensive workup including immunohistochemistry, and sometimes PCR and FISH, some of which are not performed on excision biopsies. This can affect the time to get a final diagnosis. There have been concerns that heterogeneity seen in some lymphomas could be missed on core biopsy. For instance, a low-grade follicular lymphoma would be classified and treated very differently if there was a very small focal diffuse area of grade 3 morphology and theoretically this could be missed by core biopsy. This was not seen in our series and with prolonged follow up none of the core biopsy diagnosis has proven to be wrong. Flow cytometry can allow a diagnosis of a lymphoproliferative disorder on a whole lymph node excision within a few days allowing further lymphoma work up and is not currently performed on core biopsies. However, core can be performed at the one stop clinic and lymph node excision requires adding the patient to a future operative surgery list. In Edinburgh, diagnosis has been shorter with core than that when patients had lymph node excision as their initial diagnostic procedure. The percentage of definitive diagnoses in patients with lymphoma in the current series (85.9%) is better than others have reported with core biopsy. This likely to reflect more extensive sampling, the

expertise of those performing axillary core biopsy and the increasing experience of our pathologists who have now become used to reporting such samples. If there is insufficient tissue in the core, then the options are to repeat the core or excise the node. We usually repeat the core. If the first or subsequent core establishes that the node contains malignancy, but full classification of the malignancy on the material provided is not possible or the pathologist requests tissue for flow cytometry then the whole node should be excised.

This study has relatively few limitations. The sample size is large and all patients had analysable data. All patients had at least one year follow up and some had over a decade of follow up and in no patient was the core biopsy result shown to have been incorrect. Experienced radiologists or breast surgeons performed the cores and there were few patients in which the node was not sampled adequately. Breast clinics with experienced breast radiologists are widely distributed. The quality of histology reporting and the availability of immunohistochemistry PCR and FISH is clearly needed when reporting such samples but regional centres that specialise in the diagnosis and treatment of lymphoma now exist. Breast pathologists reported the initial cores, but where lymphoma was suspected then the biopsies were forwarded to specialist lymphoma pathologists. All but four patients in this study had a 14 gauge core biopsy so the results from this study relate to the needle type in common usage. There is a huge advantage for the patient, as core biopsy is performed on the same day that they are seen in the clinic under local anaesthesia. Any extra time needed to perform immunohistochemistry of the cores is more than counterbalanced by the advantages of core biopsy for the patient and the clinician. This study has shown that core biopsy should now be considered the investigation of choice for patients presenting with significant axillary lymphadenopathy where a histological diagnosis is needed.

Declaration of competing interest

No author has any conflict of interest to declare.

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Neurocognitive Profile Study of Parkinsonian Patients by Automatic Analysis of Rey's Complex Figure-A

Taher Moussa Ahmadou

***Abstract*—** In order to know better the screening bias of neurocognitive disorders in the specific tests and unfamiliar to the population, we formulate the hypothesis that Parkin┐ son's disease, the duration of evolution and the level of education have an impact on the perceptual structuring of the Rey-A Complex Figure (RCF-A). In the present study, two groups were compared: parkinsonian patients (n=60) and control subjects (n=60) with a numeric and order-of-work type using a computerized recording of the digital plot of the RCF-A, analyzed by the software ELIAN (Expert Line Information Analyzer) which renders on the screen the dynamics of the patient's path. The results show a significant disparity between the two groups, concerning both the scores and the (technical) types of achievements of the figure (RCF-A). There is a statistically significant difference between the Parkinson's patient group and that of the control, indicating a clear loss of accuracy in the Figure. Our study shows that Parkinson's disease affects neurocognitive functions in patients who suffer from perceptual and mnemic processes.

***Keywords*—** neurocognitive,Parkinson,FCR-A,brain.

Taher Moussa Ahmadou is with the Ibn Tofail University, Morocco (e-mail: tahermabg@gmail.com).

Epidemiological Correlates of Adherence to Anti-Hypertensive Treatment in a Primary Health Care Setting of Ludhiana, Punjab

[1]Sangeeta Girdhar, [2]Amanat Grewal, [3]Nahush Bansal

Email Id: [2]amanat10grewal@gmail.com

Abstract

There is increasing burden of hypertension in India. The morbidity and mortality arising from complications is mainly due to non-adherence to medication, unhealthy dietary habits and lack of physical activity. Non-adherence is a well-recognised factor contributing to inadequate control of high blood pressure. Adherence to pharmacotherapy for hypertension varies from 43% to 88%. Non-adherence is influenced by various socio-demographic factors. Understanding these factors is useful in managing non adherence. Therefore, the study was planned to determine adherence among hypertensives and factors associated with non-adherence to treatment. A cross sectional study was conducted at Urban Health Training Centre of Dayanand Medical College and Hospital Ludhiana. Patients attending the OPD over a period of 3 months were included in the study. Prior ethical approval was obtained and informed consent was taken from subjects. A predesigned semi-structured questionnaire was applied which included socio-demographic profile, treatment seeking behaviour, adherence to the antihypertensive medication, lifestyle factors (intake of alcohol, smoking, consumption of junk food, high salt intake) contributing to the development of the disease. Reasons for non-adherence to the therapy were also explored. Data were entered into excel and SPSS 26 version was used for analysis. For the study, a total of 186 individuals were interviewed and out of these, 113 were females (60.8%) and were 73 males (39.2%). Mean age of participants was 60.9±10.7 years. Adherence to anti-hypertensive treatment was found in 68.3% of the participants. It was observed that adherence was more in literate individuals as compared to illiterate (p value- 0.78). Adherence was lower among smokers (33.3%) and alcohol consumers (53.8%) as compared to non-users (69.4% and 70.6% respectively). The predominant reasons for skipping medications were discontinuing medication when feeling well, forgetfulness and unawareness. It was concluded that there is need to generate awareness regarding importance of adherence to therapy among the patients. Intensive health education and counselling of the patients is the need of hour.

Keywords: hypertension, anti-hypertensive, adherence, counselling

Introduction

Hypertension is a major non communicable disease affecting 1.13 billion population across the globe [1]. It is also one of the leading causes of premature death worldwide [2]. Hypertension is an important risk factor for chronic disease burden in India and a preventable contributor to death and disability [3], [4]. Nearly 10.8% of all deaths are attributed to hypertension in India [5]. The complications arising from uncontrolled or poorly controlled hypertension damages heart (congestive heart failure, coronary artery disease), brain (stroke), kidneys (chronic kidney disease) and blood vessels (peripheral vascular disease). These complications account for 0.94 crore deaths annually highlighting the importance of management of high blood pressure [6]. Multipronged strategies should be opted for better management of hypertension which includes pharmacological therapy, lifestyle modifications i.e., strict diet with salt restriction, cessation of smoking /tobacco and alcohol intake and regular physical activity. Apart from the treating doctor, the patient himself has to take responsibility of managing the disease.

Chronic disease like hypertension requires regular management and monitoring, which becomes a difficult on the part of the patient to maintain. Non-adherence to drug therapy and

the related routine is a big roadblock and a major cause of uncontrolled hypertension. Various socio-economic factors along with level of motivation affects adherence of patients [7]. As per the World Health Organization, medication adherence is defined as "the extent to which a person's behaviour – taking medication, following a diet, and/or executing lifestyle changes, corresponds with agreed recommendations from a health care provider". Adherence to drug therapy for hypertension vary between 43% to 88%. The variation can be attributed to different study settings and different methodology used in the studies [8].

Treatment seeking behaviour, socio-demographic profile, and dietary and personal habits of the patient may be affecting adherence among patients. In order to address the issue of non-adherence, it is important to identify the barriers and target the interventions accordingly. Therefore, the major objective of this study is to determine the adherence to treatment for hypertension among patients in urban area of Ludhiana, Punjab. Further, the factors responsible for non-adherence to medication regimen were also explored.

Materials and methods

Study setting

A cross sectional study was conducted at Urban Health training Centre Shimlapuri, Dayanand Medical College and Hospital Ludhiana, Punjab over a 3-month period from July to September 2019.

Inclusion criteria

All the adult patients above the age of 18 years willing to participate, clinically diagnosed with hypertension with or without any coexisting medical condition and on treatment for at least 1 month were included in the study.

Exclusion Criteria

Patients with dementia, depression and having difficulty in understanding or responding to the questions were excluded from the study.

Ethical consideration and consent

Ethical approval was obtained from Institutional Ethics Committee. Patients were briefed about the purpose of the study and informed consent was taken.

Study tool

A predesigned semi-structured questionnaire was used for socio-demographic profile of the patients which included their age, gender, marital status, years of education and working status.

Various aspects related to treatment seeking behaviour were explored. Duration of treatment (calculated from date of diagnosis of hypertension), treatment taken from doctor/chemist/RMP and the type of treatment (Allopathic/Ayurvedic/Homeopathic/Desi) was asked. Patients were

also enquired about monotherapy or polytherapy and presence of any complications due to hypertension.

The lifestyle factors among the patients were assessed such as extra intake of salt, consumption of junk food and its frequency in a week, smoking (number of cigarettes or bidi in a day), alcohol consumption (>2 standard drinks for males and >1 standard drink for females). Daily physical exercise > 5 days in a week was also assessed.

To assess the adherence to drug therapy for hypertension, patients were asked about the intake of prescribed medicine for average number of days in a week. Literature reveals that drug therapy taken for 80% of the days in a week was acceptable [8]. Therefore, patients who took medications for ≤5 days in a week were considered to be non-adherent. The factors responsible for non-adherence were explored and subjects were asked to specify them such as financial issues, discontinuation on feeling well, unawareness, forgetfulness, distant health facility, non-availability of drugs, fear of side effects or any other.

Anthropometric measurement of the patients was done. Body mass index (BMI) was calculated by applying standard formula (weight/height^2). Height was measured using a non-stretchable tape. Subjects were asked to stand against the wall, feet parallel while heels, buttocks, shoulder and back of the head touching the wall. The participants were asked to remove shoes. A flat surface like a book was held on the top of the head and by lowering the tape, height was recorded from head to toe in centimetres. A standard manual weighing scale was used to measure weight of the subjects. It was standardised by putting a known weight over it. The weighing machine was placed on a flat even surface and subject was instructed to stand without shoes and minimum clothes at the centre of platform without touching anything and weight was recorded in kilograms. Asian-Pacific criteria for BMI classification was used for categorisation of the subjects [9].

Statistical Analysis

Data were entered in Excel and analysed by using SPSS version 26. The quantitative variables were described as mean ± SD whereas frequencies and percentages were used to define qualitative variables. The categorical variables were compared using Chi-square. The level of significance was set at $p < 0.05$.

Results

A total of 204 patients who visited Urban Health Centre, Shimlapuri during the study period with diagnosis of hypertension were considered for the study. Among them, 18 patients were excluded as four had concurrent dementia, six expressed difficulty in responding to the questions and eight did not give consent for the study. Of the eventual 186 patients included in the study, there were 73 males (39.2%) and 113 females (60.8%). The mean age of the subjects was 60.9 ± 10.7 years. Only 42 patients (22.6%) were working whereas 144 (77.4%) were not working. A total of 128 subjects (68.8%) were living with spouse.

Among 186 patients, 127 (68.3%) were adherent to the drug regimen and 59 (31.7%) were found to be non-adherent. Association between socio demographic variables and adherence to treatment is as observed in Table 1. Gender wise analysis revealed that 50 males (68.5% of all males) and 77 females (68.1% of all females) were adherent to the medication and this difference was not statistically significant. Adherence to treatment was seen among 68.8%

literate and 66.7% illiterate subjects. Marital status had no significant impact on adherence demonstrating the adherence values of 67.2% and 70.7% among patients living with spouse and not living with spouse, respectively. Similarly, working status had no significant bearing (p=0.313) on the adherence levels in the study population.

Table 1 Association between Socio-demographic Factors and adherence to Anti-hypertensive treatment

Variables	**Adherent to Treatment (%)**	**Total (N=186)**	**P value**
Age			
≤ 40	6 (66.7)	9	0.544
41-60	47 (65.3)	72	
>60	74 (70.5)	105	
Gender			
Male	50 (68.5)	73	0.960
Female	77 (68.1)	113	
Education			
Illiterate	32 (66.7%)	48	0.078
Literate	95 (68.8%)	138	
Working status			
Working	26 (61.9%)	42	0.313
Non-working	101 (70.1%)	144	
Marital status			
Living with spouse	86 (67.2%)	128	0.634
Not living with spouse	41 (70.7%)	58	
Smoking			
Yes	2 (33.3%)	6	0.082
No	125 (69.4%)	180	
Alcohol intake			
Yes	14 (53.8%)	26	0.112
No	113 (70.6%)	160	

**p-value of <0.05 is significant*

Among the respondents, 101 (54.3%) were on monotherapy and 85 (45.7%) were on polytherapy.

Assessment of the lifestyle modifications showed that only 67 subjects (36.0%) were engaged in the regular physical exercise and 119 (64.0%) were not doing it. Dietary analysis revealed that 70 subjects (37.6%) reported daily intake of extra salt while nearly three fourth of the subjects (116 patients; 62.4%) had salt intake within the recommended limit. Only 41 subjects (22.0%) had frequent consumption of the junk food whereas 145 subjects (78.0%) did not report this. Current study also showed that 26 subjects (14.0%) consumed alcohol frequently and six subjects (0.03%) were frequent smokers.

Most of the lifestyle modifications like engaging in physical exercise, limited salt intake and avoidance of junk food consumption were not significantly ($p>0.10$) different between the adherent and the non-adherent groups indicating that drug regimen and lifestyle changes are adopted independently of each other by the hypertensive patients. Adherence levels were lower in the alcohol consumers (53.8%) than who did not consume alcohol (70.6%). Similarly, smoking also has a considerable ($p=0.082$) impact on adherence in hypertensive patients with adherence levels in smokers and non-smokers being 33.4% and 69.0%, respectively.

Table 2 Reasons for non-adherence to Anti-Hypertensive Treatment

	Reasons	N (%)
1	Forgetting to take the medicine	20 (33.9)
2	Lack of awareness	5 (8.4)
3	Discontinuation of medication when feeling well	53 (89.8)
4	Side effects of drugs	7 (11.8)
5	Financial problem	14 (23.7)

**Multiple responses*

The predominant reasons among the hypertensive patients for skipping their medication were discontinuation of medication when feeling well (89.8%), forgetting to take the medicine (33.9%), financial problem (23.7%), drug side effects (11.8%) and the lack of awareness (8.4%).

Discussion

Adherence to medication for chronic diseases is one of the issues being faced in the current scenario as it is on the rise in India. Therefore, this study was done in UHTC of Dayanand Medical College, Ludhiana to assess the prevailing problem of non-adherence among patients attending the OPD. The present study reveals that females represented 60.8% of the population, which was in concordance to the findings of Bhandari et al. (2015) who studied adherence to antihypertensive treatment and its determinants in urban Kolkata and mentioned that 68.1% of their study population comprised of females [10].

More than one third (68.3%) of the study population was found to be adherent to drug therapy for hypertension. The adherence to antihypertensives has been variable in different studies. Findings of present study are in line with Asgedom et al. (2018) who assessed antihypertensive medication adherence and associated factors among adult hypertensive patients in southwest Ethiopia and revealed 61.8% adherence in the study while Khanan et al. (2014) conducted similar study in Bangladesh and reported 73.8% adherence [11], [12]. Similar to the present study, Tabassum and Rao (2017) found 61.7% of their study population in Hyderabad was adherent to antihypertensives [13]. Mishra et al. (2017) in North India and Venkatachalam et al. (2015) in Tamil Nadu found adherence only in one-fourth of the study population [14], [15]. In another study in North India by Ahmed S (2015), adherence to treatment was found to be 57.2% [16]. High adherence was found by Mallya et al. (2018) in Karnataka where 96.0% of the study subjects were found to adherent to the medication [17]. Such a wide range of variation can be attributed to the different study settings, different adherence assessment tools being used and different cut off values taken for assessing adherence.

It was seen that adherence was higher among subjects aged 60 years and above. Similar findings were presented by Mallya et al. (2018) in their study where adherence was higher among older people [17]. The present study reveals higher adherence among males than females which is in concordance to Tabassum and Rao (2017) who found adherence was higher among males [13]. The difference in adherence among the participants living with spouse and without spouse was found to be non-significant which was similar to Kumarswamy RC (2015) who studied adherence among patients in South India and found no association of adherence with marital status of the participants [18]. The present study also revealed non-significant association of adherence to literacy and occupation of participants which was in agreement to findings to Mallya et al. (2018) who also did not find any impact of education and occupation on adherence to the medication [17].

Considering the lifestyle modifications adopted by study subjects, physical exercise, salt intake and consumption of junk foods had no relation with adherence to drug therapy. However, Ahmed S (2015) studied these factors and the findings were in contrast to the present study as difference in adherence among the participants with and without lifestyle modifications was found to be statistically significant [16].

More than half of the subjects who consumed alcohol were found to be adherent to the medications which was lower than adherence among participants who did not consume alcohol. Ahmed S (2015) reported less than half (43.6%) of the alcohol consumers had good adherence which was lower to those who did not consume alcohol [16].

More than two-thirds of the non-smokers (69.4%) were found to be adherent to antihypertensives in the study as compared to smokers where only 33.3% were adherent.

Venkatachalam et al. (2015) reported significant association between adherence and smoking among study participants as 72.0% of the non-smokers were adherent and 83.5% of the smokers were non adherent [15].

The major reason for non-adherence among subjects was discontinuation of medication when symptoms subsided followed by forgetfulness, financial constraints, fear of side effects of medicines and lack of awareness. Misra et al. (2017) studied adherence to antihypertensives in Haryana and found the most common reason for non-adherence was symptom free period followed by forgetfulness [14]. Similarly, Tabassum and Rao (2017) also mentioned forgetfulness and financial problems as causes of non-adherence among the study population [13]. Pandian et al. (2020) in her study on compliance to treatment among rural populations enlisted various reasons of non-compliance such as lack of knowledge followed by fear of side effects and cost of treatment [19]. A study conducted in Navi Mumbai by Kotian et al. (2019) revealed financial constraints as the major reason of non-adherence among the study population [20].

Conclusion

Nearly two third of patients were adherent to anti-hypertensive treatment. Behavioural and informational interventions can be done for improving adherence. There is need to address the barriers for non-adherence to drug therapy. Regular counselling of the patients should be done by the treating physician regarding the benefits of the therapy and ill-effects due to non-adherence along with regular follow-ups. The patient should be made aware of the possible side effects of the drugs, but be informed of how the benefits outweigh the side effects which is instrumental in patient satisfaction and can ensure higher levels of adherence. Health education is recommended to the patients as well as their family members/care givers to strictly follow the medication routine as prescribed. There is need to focus more on primary level of prevention for non-communicable diseases.

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Social Participation and Associated Life Satisfaction among Older Adults in India: Moderating Role of Marital Status and Living Arrangements

Varsha Pandurang Nagargoje, K. S. James

***Abstract*—** Background: Social participation is considered as one of the central components of successful and healthy aging. This study aimed to examine the moderating role of marital status and living arrangement in the relationship between social participation and life satisfaction and other potential factors associated with life satisfaction of Indian older adults. Method: For analyses, the nationally representative study sample of 31,464 adults aged ≥60 years old was extracted from the Longitudinal Ageing Study in India (LASI) wave 1, 2017-18. Descriptive statistics and bivariate analysis have been performed to determine the proportion of life satisfaction. The first set of multivariable linear regression analyses examined Diener's Satisfaction with Life Scale and its association with various predictor variables, including social participation, marital status, living arrangements, socio-demographic, economic, and health-related variables. Further, the second and third sets of regression investigated the moderating role of marital status and living arrangements respectively in the association of social participation and level of life satisfaction among Indian older adults. Results: Overall, the proportion of life satisfaction among older men was relatively higher than women counterparts in most background characteristics. Regression results stressed the importance of older adults' involvement in social participation [$\beta = 0.39$, $p < 0.05$], being in marital union [$\beta = 0.68$, $p < 0.001$] and co-residential living arrangements either only with spouse [$\beta = 1.73$, $p < 0.001$] or with other family members [$\beta = 2.18$, $p < 0.001$] for the improvement of life satisfaction. Results also showed that some factors were significant for life satisfaction: in particular, increased age, having a higher level of educational status, MPCE quintile, and caste category. Higher risk of life dissatisfaction found among Indian older adults who were exposed to vulnerabilities like consuming tobacco, poor self-rated health, having difficulty in performing ADL and IADL were of major concern. The interaction effect of social participation with marital status or with living arrangements explained that currently married older individuals, and those older adults who were either co-residing with their spouse only or with other family members irrespective of their involvement in social participation remained an important modifiable factor for life satisfaction. Conclusion: It would be crucial for policymakers and practitioners to advocate social policy programs and service delivery oriented towards meaningful social connections, especially for those Indian older adults who were staying alone or currently not in the marital union to enhance their overall life satisfaction.

***Keywords*—** Indian, older adults, social participation, life satisfaction, marital status, living arrangement.

Varsha Nagargoje is with the International Institute for Population Sciences, Mumbai, India (e-mail: nag.varsha2009@gmail.com).

Interwoven Pathobiology of Stroke and Diabetes in Vitamin D Deficiency

Ravinder Singh

***Abstract*—** Vitamin D deficiency has reached epidemic proportions in India and recent epidemiologic studies have suggested that the pandemic of vitamin D deficiency is affecting almost 50% of the population worldwide of all age groups and ethnicities population. Over the past few decades, a strong link between hypovitaminosis of vitamin D concentrations in the body with development of cardiovascular disease through its association with risk factors, such as diabetes and stroke has been established. Stroke is defined as damage to the brain from interruption of its blood supply. Vitamin D deficiency via relative hyperparathyroidism causes activation of the RAAS system, disrupts lipid metabolism, and affects astrocytes in the brain causing endothelial dysfunction thus promoting stroke. Moreover, type-1 diabetes occurs as a result of beta-cell destruction in the pancreas for various reasons such as glucotoxicity, lipotoxicity, and inflammation whereas type-2 diabetes is a result of insulin resistance caused by inflammatory state associated with elevated cytokinase levels which through oxidative stress cause endothelial cell dysfunction. It is frequently developing after the age of 40, therefore, it is known as "Adult - Onset Diabetes". It is supposed that diabetes will affect almost 109 million people worldwide by 2035. However, the prevalence of both diabetes and stroke is higher in men than in women in all age groups, but females often develop more serious complications and are at greater mortality risk. It could be suggested that vitamin D deficiency is the possible reason behind these complications and therefore, it is quite evident that vitamin D supplementation fairly reduces the chances of getting diabetes.

***Keywords*—** Stroke,diabetes,vitamin D,metabolic disorders.

Ravinder Singh is with the Chitkara University, India (e-mail: ravi.jaura@gmail.com).

Neuroprotective Effects of Allium Cepa Extract Against Ischemia Reperfusion Induced Cognitive Dysfunction and Brain Damage in Mice

Jaspal Rana

***Abstract*—** Oxidative stress has been identified as an underlying cause of ischemia-reperfusion (IR) related cognitive dysfunction and brain damage. Therefore, antioxidant based therapies to treat IR injury are being investigated. Allium cepa L. (onion) is used as culinary medicine and is documented to have marked antioxidant effects. Hence, the present study was designed to evaluate the effect of A. cepa outer scale extract (ACE) against IR induced cognition and biochemical deficit in mice. ACE was prepared by maceration with 70% methanol and fractionated into ethylacetate and aqueous fractions. Bilateral common carotid artery occlusion for 10 min followed by 24 h reperfusion was used to induce cerebral IR injury. Following IR injury, ACE (100 and 200 mg/kg) was administered orally to animals for 7 days once daily. Behavioral outcomes (memory and sensorimotor functions) were evaluated using Morris water maze and neurological severity score. Cerebral infarct size, brain thiobarbituric acid reactive species, reduced glutathione, and superoxide dismutase activity was also determined. Treatment with ACE significantly ameliorated IR mediated deterioration of memory and sensorimotor functions and rise in brain oxidative stress in animals. The results of the present investigation revealed that ACE improved functional outcomes after cerebral IR injury which may be attributed to its antioxidant properties.

***Keywords*—** ischemia-reperfusion, neuroprotective, stroke, antioxidant.

Jaspal Rana is with the Alkem Laboratories, Baddi, Himachal Pradesh, India (e-mail: Jaspal58rana@gmail.com).

Modern Cardiac Surgical Outcomes in Nonagenarians: A Multicentre Retrospective Observational Study

Laurence Weinberg, Dominic Walpole, Dong-Kyu Lee, Michael D'Silva, Jian W. Chan, Lachlan F. Miles, Bradley Carp, Adam Wells, Tuck S. Ngun, Siven Seevanayagam, George Matalanis, Ziauddin Ansari, Rinaldo Bellomo, Michael Yii

***Abstract*—** Background: There have been multiple recent advancements in the selection, optimisation and management of cardiac surgical patients. However, there is limited data regarding the outcomes of nonagenarians undergoing cardiac surgery, despite this vulnerable cohort increasingly receiving these interventions. This study describes the patient characteristics, management and outcomes of a group of nonagenarians undergoing cardiac surgery in the context of contemporary peri-operative care. Methods: A retrospective observational study was conducted of patients 90 to 99 years of age (i.e. nonagenarians) who had undergone cardiac surgery requiring a classic median sternotomy (i.e. open-heart surgery). All operative indications were included. Patients who underwent minimally invasive surgery, transcatheter aortic valve implantation and thoracic aorta surgery were excluded. Data were collected from four hospitals in Victoria, Australia, over an 8-year period (January 2012 – December 2019). The primary objective was to assess six-month mortality in nonagenarians undergoing open-heart surgery and to evaluate the incidence and severity of postoperative complications using the Clavien-Dindo classification system. The secondary objective was to provide a detailed description of the characteristics and peri-operative management of this group. Results: A total of 12,358 adult patients underwent cardiac surgery at the study centres during the observation period, of whom 18 nonagenarians (0.15%) fulfilled the inclusion criteria. The median (IQR) [min-max] age was 91 years (90.0:91.8) [90-94] and 14 patients (78%) were men. Cardiovascular comorbidities, polypharmacy and frailty were common. The median (IQR) predicted in-hospital mortality by EuroSCORE II was 6.1% (4.1-14.5). All patients were optimised preoperatively by a multidisciplinary team of surgeons, cardiologists, geriatricians and anaesthetists. All index surgeries were performed on cardiopulmonary bypass. Isolated coronary artery bypass grafting (CABG) and CABG with aortic valve replacement were the most common surgeries being performed in four and five patients respectively. Half the study group underwent surgery involving two or more major procedures (e.g. CABG and valve replacement). Surgery was undertaken emergently in 44% of patients. All patients except one experienced at least one postoperative complication. The most common complications were acute kidney injury (72%), new atrial fibrillation (44%) and delirium (39%). The highest Clavien-Dindo complication grade was IIIb occurring once each in three patients. Clavien-Dindo Grade IIIa complications occurred in only one patient. The median (IQR) postoperative length of stay was 11.6 days (9.8:17.6). One patient was discharged home and all others to an inpatient rehabilitation facility. Three patients had an unplanned readmission within 30 days of discharge. All patients had follow-up to at least six months after surgery and mortality over this period was zero. The median (IQR) duration of follow up was 11.3 months (6.0:26.4) and there were no cases of mortality observed within the available follow up records. Conclusion: In this group of nonagenarians undergoing cardiac surgery, postoperative six-month mortality was zero. Complications were common, but generally of low severity. These findings support carefully selected nonagenarian patients being offered cardiac surgery in the context of contemporary, multidisciplinary peri-operative care. Further, studies are needed to assess longer term mortality, and functional and quality of life outcomes in this vulnerable surgical cohort.

***Keywords*—** Cardiac surgery, mortality, nonagenarians, postoperative complications

L. Weinberg, D. Walpole, M. D'Silva, J.W. Chan, L.F. Miles, B. Carp, T.S. Ngun are with the Department of Anesthesia, Austin Health, Victoria, Australia.

S. Seevanayagam, G. Matalanis are with the Department of Cardiac Surgery, Austin Health, Victoria, Australia.

A. Wells, M. Yii are with the Department of Cardiac Surgery, Epworth Eastern Hospital, Victoria, Australia.

Z. Ansari is with the Department of Intensive Care, Epworth Eastern Hospital, Victoria, Australia.

R. Bellomo is with the Department of Intensive Care, Austin Health, Victoria, Australia.

D. Lee is with the Department of Anesthesiology and Pain Medicine, Dongguk University, Ilsan Hospital, Goyang, South Korea.

A Case Report of Aberrant Vascular Anatomy of the Deep Inferior Epigastric Artery Flap

Karissa A. Graham, Andrew Campbell-Lloyd

***Abstract*—** The deep inferior epigastric artery perforator flap (DIEP) is used to reconstruct large volumes of tissue. The DIEP flap is based on the deep inferior epigastric artery (DIEA) and vein. Accurate knowledge of the anatomy of these vessels allows for efficient dissection of the flap, minimal damage to surrounding tissue, and a well vascularized flap.

A 54 year old lady was assessed for bilateral delayed autologous reconstruction with DIEP free flaps. The right DIEA was consistent with the described anatomy. The left DIEA had a vessel branching shortly after leaving the external iliac artery and before entering the muscle. This independent branch entered the muscle and had a long intramuscular course to the largest perforator. The main DIEA vessel demonstrated a type II branching pattern, but had perforators that were too small to have a viable DIEP flap. There were no communicating arterial branches between the independent vessel and DIEA, however, there was one venous communication between them. A muscle sparing transverse rectus abdominis muscle flap was raised using the main periumbilical perforator from the independent vessel.

Our case report demonstrated an unreported anatomical variant of the DIEA. A few anatomical variants have been described in the literature, including a unilateral absent DIEA and peritoneal-cutaneous perforators that had no connection to the DIEA. Doing a pre-operative CTA helps to identify these rare anatomical variations, which leads to safer, more efficient and effective operating.

***Keywords*—**Aberrant anatomy, CT angiography, DIEP flap, free flap.

K. A. Graham is with the Mater Public Hospital, Brisbane, Queensland, Australia (phone: +617 3163 8111; e-mail: Karissa.Graham@health.qld.gov.au).

A. Campbell-Lloyd was with the Mater Public Hospital, Brisbane, Queensland, Australia (phone: +617 3163 8111; e-mail: Andrew.Campbell-Lloyd@health.qld.gov.au).

Rare Case of Pyoderma Gangrenosum of the Upper Limb

Karissa A. Graham

***Abstract*—** Pyoderma gangrenosum (PG) is a prototypic autoinflammatory neutrophilic dermatosis that is a rare disorder. It presents a diagnostic challenge owing to its variable presentation, clinical overlap with other conditions, it is often associated with other systemic conditions, and there is no definitive histological or laboratory characteristic. The Delphai consensus for PG includes the presence of at least one ulcer on the anterior lower limb. Systemic corticosteroids and immunosuppressive therapies are the mainstay treatment for PG.

We describe a case report of delayed diagnosis of ulcerative pyoderma gangrenosum in a 44 year old male on his forearm. The patient presented with an infected ulcer on his right forearm that had been present for over three years. The patient was a Type 2 Diabetic with no personal or family history of inflammatory bowel disease or other autoimmune disease. The patient was initially investigated for a malignancy, but biopsies returned as chronic inflammatory tissue with neutrophilic infiltrate and no malignancy. The patient was commenced on systemic prednisone for treatment of pyoderma gangrenosum.

The diagnosis of ulcerative PG poses a challenge given the vast differential diagnosis for a cutaneous ulcer (i.e. malignant, vascular, autoimmune, trauma, infective, etc). Diagnostic accuracy is important given that the treatment for PG with steroids does not go without risks and indeed may be contraindicated in other potential causes of the ulcer. Indeed, more common and more sinister causes of ulcers should be investigated first as death from PG is quite rare.

***Keywords*—**Dermatological diagnosis, dermatosis, pyoderma gangrenosum, rare presentation.

K. A. Graham is with the Royal Brisbane & Women's Hospital, Brisbane, Queensland, Australia (phone: +617 3647 8111; e-mail: Karissa.Graham@health.qld.gov.au).

Maternal-Fetal Transmission of SARS CoV-2

Souhail Alouini

***Abstract*—** Objective: There are few data on the maternal-fetal transmission of SARS-CoV-2 and its outcomes. This study aimed to evaluate pregnancy outcomes of pregnant women infected by SARS-CoV-2, to detect SARS-CoV-2 in placenta and different newborns' samples and search antibodies in cord blood. Methods: This was a prospective study of pregnant women diagnosed with SARS-CoV-2 infection from May 2020 to May 2021. At delivery, the placentas were investigated for SARS-CoV-2 using RT-PCR, cord blood. Mothers' blood samples were tested by SARS-CoV-2 serology. PCR of nasopharyngeal, anal and gastric swabs (NPSs) of newborns was performed according to pediatric indications. Results: Among 3626 pregnant women presenting at maternity to deliver, 45 mothers had COVID-19 during their pregnancy or at delivery (32 ± 4.8 years). Most of them were multiparous and in the third trimester. There were 35 (77%) women who remained in ambulatory, while 10 (22%) were hospitalized for severe pneumonia, digestive symptoms, and/or fetal tachycardia. Thirty-eight delivered vaginally, and 7 had a cesarean delivery with normal Apgar scores (9 ± 1.6 at 5 min) and umbilical artery pH (7.22 ± 0.08). Two mothers required ICU admission after cesarean section for fetal and maternal distress. Of the 46 newborns, 6 were premature births (13%) and 5 IUGR (intra-uterine growth restriction,11%). RT-PCR SARS-CoV-2 was positive for 1/30 placental, and 1/33 neonatal anal swabs and negative in all other cases and in gastric swabs. SARS-CoV-2 IgG was positive in 20/41 cord blood samples (49%) and their mothers' samples. IgM was negative in the 23 cord blood samples. Conclusions: Pregnancy outcomes in women diagnosed with COVID-19 during their pregnancy were favorable in most cases. However, some women with severe clinical forms required hospitalization and ICU admission. Preterm births and intrauterine growth retardations were relatively frequent. Vaginal delivery was possible in most cases. SARS-CoV-2 IgG antibodies were positive and elevated in most cord blood samples of newborns. They are possibly of maternal origin, suggesting a probable mechanism of fetal protection against SARS-CoV-2 infection. No SARS-CoV-2 IgM was found in the cord blood samples. Detection of SARS-CoV-2 in placenta is rare.

***Keywords*—** SrAS-CoV-2, IgG G, IgM, maternal-fetal infection of SARS-CoV-2.

Souhail Alouini is with the Orléans University, France (e-mail: alouini.s@orange.fr).

Review of the Efficacy of Complimentary Alternative Medicine Pain Reduction Methods After Injury

John Gaber, Shoko Masuyama

***Abstract*—** Athletics have been an integral part of human development in the modern age. Recovering from injuries has become a nuanced topic. Athletes who wish to train harder and recover faster have many different choices for treating injuries quickly and adequately. This narrative review explores the effectiveness and timeframes of recovery for complementary alternative medicine (CAM) used to treat pain associated with acute injuries. The following CAM methods were selected for the purposes of this study: “cryotherapy”, "acupuncture", "massage", "cupping" and “sotai”. PubMed was used to search the literature using the following terms: "pain”, “athletic injury", “cryotherapy”, "acupuncture", "massage", "cupping" and “SOTAI”. Further data was collected from a pilot study conducted by a collaborating integrative health clinic. We also assessed the effectiveness of acupuncture, cupping, and SOTAI methods on pain, and for the treatment of acute non-specific low back pain (ANLBP). We have compared the magnitude of pain relief using a pain scale assessment method to compare the efficacy of each treatment. The data collected focused on the change in the pain scale assessment method value over the course of treatment. Results reveal that Cryotherapy, Acupuncture, and Massage showed significant improvement in recovery from injury compared to the conventional RICE treatment strategy. Cryotherapy showed significant improvement in pain in the short term while showing no significant improvement in the long - term, beneficial for application between athletic events. Acupuncture and Massage showed a significant improvement in pain relief over the long - term. Using a combination of the therapeutic methods mentioned offers even more benefits to recovery. From our clinical pilot study, in the cupping, acupuncture, and SOTAI therapy groups, the mean of the ANLBP intensity reduced from 8.7±1.2, 8.8±1.2, 9.0±0.8 before the intervention to 3.5±1.4, 4.3±1.4, 3.3±1.3, 24 hr after the intervention, respectively. (Intervention group (IG), n=10) and compared five non-penetrating acupuncture sessions (sham group (SG), n=5), and control groups (n=5). The SPSS statistical software was used to analyze the data using repeated-measures ANOVA. Besides, $p<0.05$ was considered statistically significant. The study suggests that cupping therapy, acupuncture and SOTAI may reduce ANLBP pain significantly. Knowledge of the efficacy of these recovery options is important in the decision-making of athletes who need safe and quick recovery methods in any situation. Therefore, we can also apply these methods to those who are not athletes but sustained an acute or chronic injury elsewhere.

***Keywords*—** acupuncture, cupping, alternative medicine, rehabiliation, acute injury.

John Gaber is with the Kinesiology and Health Science, York University, Canada (e-mail: jgaber@my.york.ca).

Shoko Masuyama is with the Doktorkits - Integrative Holistic Health Clinic, ON, Canada.

Study of Oxidative Processes in Blood Serum in Patients with Arterial Hypertension

Hasmik Zanginyan, Gayane Ghazaryan, Laura Hovsepyan

Laboratory of Experimental biology, Institute of Molecular biology NAS of Armenia

Abstract - Hypertension (HD) is the most common cardiovascular pathology that causes disability and mortality in the working population. Most often, heart failure (HF), which is based on myocardial remodeling, leads to death in hypertension. Recently, endothelial dysfunction (EDF) or a violation of the functional state of the vascular endothelium has been assigned a significant role in the structural changes in the myocardium and the occurrence of heart failure in patients with hypertension. It has now been established that tissues affected by inflammation form increased amounts of superoxide radical and NO, which play a significant role in the development and pathogenesis of various pathologies. They mediate inflammation, modify proteins and damage nucleic acids. The aim of this work was to study the processes of oxidative modification of proteins (OMP), the production of nitric oxide in hypertension.

In the experimental work, the blood of 30 donors and 33 patients with hypertension was used.

For the quantitative determination of OMP products, the based on the reaction of interaction of oxidized amino acid residues of proteins and 2,4-dinitrophenylhydrazine (DNPH) with the formation of 2,4-dinitrophenylhydrazones, the amount of which was determined spectrophotometrically. The optical density of the formed carbonyl derivatives of dinitrophenylhydrazones was recorded at different wavelengths: 356 nm - aliphatic ketone dinitrophenylhydrazones (KDNPH) of neutral character; 370 nm - aliphatic aldehyde dinirophenylhydrazones (ADNPH) of neutral character; 430 nm - aliphatic KDNFG of the main character; 530 nm - basic aliphatic ADNPH. Nitric oxide was determined by photometry using Grace's solution. Adsorption was measured on a Thermo Scientific Evolution 201 SF at a wavelength of 546 nm. Thus, the results of the studies showed that in patients with arterial hypertension, an increased level of nitric oxide in the blood serum is observed, and there is also a tendency to an increase in the intensity of oxidative modification of proteins at a wavelength of 270 nm and 363 nm, which indicates a statistically significant increase in aliphatic aldehyde and ketone dinitrophenylhydrazones. The increase in the intensity of oxidative modification of blood plasma proteins in the studied patients, revealed by us, actually reflects the general direction of free radical processes and, in particular, the oxidation of proteins throughout the body. A decrease in the activity of the antioxidant system also leads to a violation of protein metabolism. The most important consequence of the oxidative modification of proteins is the inactivation of enzymes.

Keywords - Hypertension (HD), oxidative modification of proteins (OMP), nitric oxide (NO), oxidative stress

Understanding the Role of Concussions as a Risk Factor for Multiple Sclerosis

Alvin Han, Reema Shafi, Alishba Afaq, Jennifer Gommerman, Valeria Ramaglia, Shannon E. Dunn

***Abstract*—**Adolescents engaged in contact-sports can suffer from recurrent brain concussions with no loss of consciousness and no need for hospitalization, yet they face the possibility of long-term neurocognitive problems. Recent studies suggest that head concussive injuries during adolescence can also predispose individuals to multiple sclerosis (MS). The underlying mechanisms of how brain concussions predispose to MS is not understood. Here, we hypothesize that: (1) recurrent brain concussions prime microglial cells, the tissue resident myeloid cells of the brain, setting them up for exacerbated responses when exposed to additional challenges later in life; and (2) brain concussions lead to the sensitization of myelin-specific T cells in the peripheral lymphoid organs. Towards addressing these hypotheses, we implemented a mouse model of closed head injury that uses a weight-drop device. First, we calibrated the model in male 12 week-old mice and established that a weight drop from a 3 cm height induced mild neurological symptoms (mean neurological score of 1.6+0.4 at 1 hour post-injury) from which the mice fully recovered by 72 hours post-trauma. Then, we performed immunohistochemistry on the brain of concussed mice at 72 hours post-trauma. Despite mice having recovered from all neurological symptoms, immunostaining for leukocytes (CD45) and IBA-1 revealed no peripheral immune infiltration, but an increase in the intensity of IBA1+ staining compared to uninjured controls, suggesting that resident microglia had acquired a more active phenotype. This microglia activation was most apparent in the white matter tracts in the brain and in the olfactory bulb. Immunostaining for the microglia-specific homeostatic marker TMEM119, showed a reduction in TMEM119+ area in the brain of concussed mice compared to uninjured controls, confirming a loss of this homeostatic signal by microglia after injury. Future studies will test whether single or repetitive concussive injury can worsen or accelerate autoimmunity in male and female mice. Understanding these mechanisms will guide the development of timed and targeted therapies to prevent MS from getting started in people at risk.

***Keywords*—**concussion, microglia, microglial priming, multiple sclerosis

A. Han is a Master's student at the Department of Immunology of the Temerty School of Medicine, University of Toronto, Toronto, Canada (alvinh.han@mail.utoronto.ca).

A. Afaq is an undergraduate student at the University of Toronto and St. Michael's Hospital, Toronto, Canada (alishba.afaq@mail.utoronto.ca).

R. Shafi is a post-doctoral fellow at the Keenan Research Centre for Biomedical Sciences of St. Michael's Hospital (reema.shafi@utoronto.ca).

J. Gommerman is Full Professor at the Department of Immunology of the Temerty School of Medicine, University of Toronto, Toronto, Canada (jen.gommerman@utoronto.ca).

V. Ramaglia is Senior Research Associate at the Department of Immunology of the Temerty School of Medicine, University of Toronto, Toronto, Canada (v.ramaglia@utoronto.ca).

S.E. Dunn is with the Keenan Research Centre for Biomedical Sciences of St. Michael's Hospital and the Department of Immunology at the University of Toronto, Canada (phone: 416-272-6365; email: Shannon.Dunn@unityhealth.to).

Infection Prevention Techniques as a Hallmark of Quality Service Provision in Family Planning Outreach during Covid-19 Pandemic

Elvis Ume

***Abstract*—** Background: Mobile FP Service provision strategically brings Providers closer to high un-met need communities, thereby presenting opportunities to serve and to cause harm. Mariestopes Outreach strategy was aimed at achieving service provision devoid of harm to the clients. Highturnout of clients at sites can task a mobile team beyond their readiness; hence quality can be compromised, resulting in harm to clients. Mariestopes has recorded progress in harm reduction. Methodology The Outreach teammoves with mobile hand washing equipment to sites enforcing staff and clients to use same, including PPEs.Instrument sterilization adheres to MoH standard of 0.5% chlorine solution, including proper hand Hygiene, proper handling of sharp items, environmental cleanliness, Proper waste segregation/ disposal, Aseptic technique, properStorage and traveling with enoughautoclaved insertion kits for each method of family planning per day, avoiding crowds by strictly observing social distancing at all time and educating all clients on how to keep the insertion site free from infestation. Outreach team members undergo thorough clinical competency assessment and a continuous supportive supervisory visit. YearlyInternal quality technical assessment is conducted using a designed checklist as a tool to ascertain their technical skills, clinical governance, infection prevention skills, medical emergency management, storage of consumables, and documentation skill. Result: Out of 16,601 clients served between January to September 2020, 50 infection related incidents were reported, which is 0.30% of the total women served. 24 and 26 of the incidents reported were Minor and moderate incidents; respectively, no critical incident was recorded. All Outreach Service Providers attained competency level 1. Conclusion: Proper and consistent application of MSION clinical quality standard by the outreach team has given room for minute infection related incidents, more satisfied clients, and success stories.

***Keywords*—** Family Planning Service Provision, Clinical Quality, COVID 19 Pandemic, Infection Prevention Techniques.

Elvis Okoro Ume is with the Marie Stopes International Organization, Nigeria (e-mail: elvisokoroume@gmail.com).

Impact of Emergency Medicine Department Crowding on Mortality

Morteza Gharibi, Abdolghader Pakniat, Somayeh Bahrampouri

***Abstract*—** Introduction: Emergency department (E.R.) crowding is a serious widespread problem in hospitals that leads to irregularities, a slower rate of delivery of services to patients, and a long-term stay. In addition, the long-term stay in the E.D. reduces the possibility of providing services with appropriate quality to other patients who are undergoing medical emergencies, which leads to dissatisfaction among patients. This study aimed to determine the relationship between ED-crowding and the mortality rate of the patients referred to the E.D. In a retrospective cohort study, all patients who expired in first 24 hours of admission were enrolled in the study. Crowding index at the moment of admission was calculated using Edwin Score. The data including history and physical examination, time of arrival in the E.D., diagnosis (using ICD 10 code), time of death, cause of death, demographic information was recoded based on triage forms on admission and patients' medical files. Data analysis was performed by using descriptive statistics and chi square test, ANOVA tests using SPSS ver. 19. The time of arrival in E.D. to death in crowded E.D. conditions, with an average of five hours and 25 minutes, was significantly higher than the average admission Time of arrival in E.D. to death in active and crowded E.D. conditions. More physicians and nurses can be employed during crowded times to reduce staff fatigue and improve their performance during these hours.

***Keywords*—** mortality, emergency, department, crowding.

Morteza Qaribi is with the Arak University of Medical Sciences, Iran (e-mail: morteza.qaribi@gmail.com).

Feasibility of Online Health Coaching for Canadian Armed Forces Personnel Receiving Treatment for Depression, Anxiety and PTSD

Noah Wayne, Andrea Tuka, Adrian Norbash, Bryan Garber, Paul Ritvo

***Abstract*—** Program/Intervention Description: The Canadian Armed Forces(CAF) Mental Health Clinicstreat a full spectrum of mental disorder, addictions, and psychosocial issues that include Major Depressive Disorder, Post-Traumatic Stress Disorder, Generalized Anxiety Disorder, and other diagnoses. We evaluated the feasibility of an online health coach interventiondelivering mindfulness based cognitive behavioral therapy (M-CBT) and behaviour changesupport for individuals receiving treatment at CAF Clinics. Participants were provided accounts on NexJ Connected Wellness, a digital health platform, and 16 weeks of phone-based health coaching,emphasizingmild to moderate aerobic exercise, a healthy diet, and M-CBT content. The primary objective was to assess the feasibility of the online deliverywith CAF members. Evaluation Methods: Feasibility was evaluated in terms of recruitment, engagement, and program satisfaction. Weadditionallyevaluatedhealth behavior change, program completion, and mental health symptoms (i.e. PHQ-9, GAD-7, PCL-5) at three time points. Results: Service members were referred from Vancouver, Esquimalt, and Edmonton CAF bases between August 2020 and January 2021. N=106 CAF personnel were referred, and n=77 consented.N=66 participated, and n=44 completed 4-month and follow-up measures. The platform received a mean rating of76.5 on the System Usability Scale, and health coaching was judged the most helpful program feature (95.2% endorsement), while reminders (53.7%), secure messaging (51.2%), and notifications (51.2%) were also identified. Improvements in mental health status during active interventions were observed on the PHQ-9 (-5.4, $p<0.001$), GAD-7 (-4.0, $p<0.001$), and PCL-5 (-4.1, $p<0.05$). Conclusion: Online health coaching was well-received amidst the COVID-19 pandemic and related lockdowns. Uptake and engagement were positively reported. Participants valuedcontacts and reported strong therapeutic alliances with coaches. Healthy diet, regular exercise, and mindfulness practice are important for physical and mental health. Engagements in these behaviors are associated with reduced symptoms. An online health coach program appears feasible for assisting Canadian Armed Forces personnel.

***Keywords*—** coaching, CBT, military, depression, mental health, digital.

Noah Wayne is with the exJ Health, Canada (e-mail: noah.wayne@nexjhealth.com).

Using Near Infrared Spectroscopy to Help Consumer's Food Choices

Zeyneb Guneysu

***Abstract*—** In sustainable food systems, innovations using new technology are needed to facilitate the food preferences of consumers. NIRs technology is a spectroscopic method used in the analysis of organic compounds of foods, determination of imitation and irritation in foods, determination of protein, fat, dry matter, and compositional properties. It is very important to integrate this technology, which is widely used in the food industry, into the field so that consumers can make their product choices more easily and reliably. From this point of view, it is aimed to develop an artificial intelligence model that can decide on behalf of consumers whether the food products they want to buy in online shopping applications and/or local markets, by using NIR technology, are suitable for their own tastes and liking. In this context, White cheese was determined as the study group due to its widespread use. Spectra of the compositional properties of 15 different feta cheese samples selected from local food markets in Turkey were taken using NIRs technology. Then, sensory analysis of all cheeses was made with randomly selected consumers (n=100) and the cheeses were evaluated on the parameters of taste, smell, elasticity, hardness, color, and overall liking. At the same time, fat, dry matter, acidity, protein determinations, texture, and color analysis of cheeses were made. With all the data obtained, a data set was created using the SPSS data analysis system and determined the relation between data. In addition, a significant correlation of NIR spectra and sensory analysis data was performed with data analysis systems (Principle Component Analysis, MatLab). With the chemometric study, white cheeses could be grouped according to their spectral, compositional, and sensory properties. In this way, the consumer, who introduces the taste criteria to the developed artificial intelligence model by tasting once, will be able to understand whether the product fits his taste by reading the QR code on the product, which contains the product characteristics data, during his shopping. This developed forecasting model has the potential to serve for the product development of the food industry in the future and to help consumers make informed choices.

***Keywords*—** near ınfrared spectroscop, sensory analysis, emoji, consumer choices.

Zeyneb Guneysu is with the Hacettepe University, Turkey (e-mail: guneysuzeyneb@gmail.com).

Smart Infant Heath Monitoring Based on IoT

Safwan Sadeq Mahmood Ali

***Abstract*—** Due to the highly hectic and busy lifestyle of parents, it is easy to overlook minute issues in baby care. Infant people's health is the most concern in the family society member nowadays. It is hard to take care of the infant people and work at the same time. However, if there is a maid for taking care of the infant people it will be more costly and will spend a lot of money for that. Sometimes, a medical issue with the infant is noticed a bit late and it may result in negative outcomes. When a baby is taken for medical care, oftentimes distraught parents won't be able to give correct and accurate information. Thus, the proposed system can monitor temperature and motion by using a Bluetooth module, uploading data to things peak via MATLAB, and sending alert messages by GSM module to parents when the infant is crying or shouting. To ensure that the monitoring process is not hindered even if one part of the system fails. Moreover, this system it is inexpensive, and it can be severe for long term of lifespan.

***Keywords*—** GSM module,Thingspeak platform,IoT interface,Mobile application.

Safwan Sadeq Mahmood Ali Safwan Sadeq is with the Universiti Teknologi PETRONAS, Malaysia (e-mail: asafwanalshahri@yahoo.com).

Use of Information and Communication Technologies in Enhancing Health Care Delivery for HIV in Bamenda Health District

Abanda Wilfred Chick

***Abstract*—** Background: According to World Health Organization, the role of Information and Communication Technologies in health sectors of developing nations has been demonstrated to have had a great improvement of fifty percent reduction in mortality and or twenty-five-fifty percent increase in productivity. The objective of this study was to assess the use of information and communication technologies in enhancing health care delivery for Human Immunodeficiency Virus patients in Bamenda Health District. Methods: This was a descriptive-analytical cross-sectional study in which 388 participants were consecutively selectedamongsthealthpersonnelandHIVpatientsfrompublicandprivatehealthinstitutions involved in Human Immunodeficiency Virus management. Data on socio-demographic variables, the use of Information and communication technologies tools, and associated challenges were collected using structured questionnaires. Descriptive statistics with a ninety-five percent confidence interval were used to summarize findings, while Cramer'sVtest, logistic regression, and Chi-square test were used to measure the association between variables, Epiinfoversion7.2, MS Excel and SPSS version 25.0 were utilized for data entry and statistical analysis respectively. Results: Of the participants, one-quarter were health personnel, and three-quarters were HIV patients. For both groups of participants, there was a significant relationship between the use of ICT and demographic information such as level of education, marital status, and age ($p<0.05$. For impediments in using ICT tools, a greater proportion identified the high cost of airtime or bundles, followed by an average proportion that indicated inadequate training on ICT tools. For health personnel majority said inadequate training on ICT tools/applications, and half said unavailability of electricity. Conclusion: not up to half of the proportion of HIV patients effectively make use of ICT tools/applications to receive health care. For health personnel, three quarters who use ICTs, only one quarter effectively use mobile phones and one-third of computers, respectively, to render care to the HIV patients.

***Keywords*—** ICT tools, HIV patients, health personnel, health care delivery.

Abanda Wilfred Chick is with the University of Buea, Cameroon (e-mail: abanwilwil@yahoo.co.uk).

Spatial Interactions between Earthworm Abundance and Tree Growth Characteristics in Western Niger Delta

Eludoyin O.S. and Olisa C.O.
Department of Geography and Environmental Management,
University of Port Harcourt, Port Harcourt, Nigeria
Corresponding Email: olatunde.eludoyin@uniport.edu.ng

Abstract— The study examined the spatial interactions between earthworm abundance (EA) and tree growth characteristics in ecological belts of Western Niger Delta, Nigeria. Eight 20m x 20m quadrat were delimited in the natural vegetation in each of the rainforest (RF), mangrove (M), fresh water swamp (FWS) and guinea savanna (GS) ecological belts to gather data about the tree species (TS) characteristics which included individual number of tree species (IN), diversity (Di), density (De) and richness (Ri). Three quadrats of 1m x 1m were delineated in each of the 20m x 20m quadrats to collect earthworm species the topsoil (0-15cm) and subsoil (15-30cm) and were taken to laboratory for further analysis. Descriptive statistics and inferential statistics were used for data analysis. Findings showed that a total of 19 earthworm species was found with 58.5% individual species recorded in the topsoil and 41.5% recorded in the subsoil. The total population of *Eudrilius eugeniae* was predominantly highest in both topsoil (38.4%) and subsoil (27.1%). The total population of individual species of earthworm was least in GS in the topsoil (11.9%) and subsoil (8.4%). A total of 40 different species of TS was recorded of which 55.5% were recorded in FWS while RF was significantly highest in the species diversity (0.5971). Regression analysis revealed that Ri, IN, DBH, Di, and De of trees explained 65.9% of the variability of EA in the topsoil while 46.9 % of the variability of earthworm abundance was explained by the floristic parameters in the subsoil. Similarly, correlation statistics revealed that in the topsoil, EA is positively and significantly correlated with Ri ($r=0.35$; $p<0.05$), IN ($r=0.523$; $p<0.05$) and De ($r=0.469$; $p<0.05$) while DBH was negatively and significantly correlated with earthworm abundance ($r=-0.437$; $p<0.05$). In the subsoil, only Ri and DBH correlated significantly with EA. The study concluded that EA in the study locations was highly influenced by tree growth species especially Ri, IN, DBH, Di and De. The study recommended that the TS abundance should be improved in the study locations to ensure the survival of earthworms for ecosystem functions.

Keywords— Interactions, Earthworm abundance, Tree growth, Ecological zones, Western Niger Delta

The Effect of Eight Weeks of Thigh Muscle Resistance Training on Lower Extremity Pain، Strength and Kinematical Parameters in Women with Patellofemoral

Abdolrasoul Daneshjoo

Abdolrasoul Daneshjoo is with the Islamic Azad University East Tehran Branch, Iran (e-mail: phdanesh@yahoo.com).

Abstract

Introduction & Objectives: The aim of this study was to evaluate the effect of strengthening the abductor and external rotator of the hip joint muscles on pain, thigh muscle strength and lower limb kinematics in women with patellofemoral complication.

Materials and Methods: Twenty-four patients with patellofemoral pain were randomly divided into experimental and control groups. The experimental group received 3 sessions of strengthening exercises for the abductor muscles and external rotators of the hip joint using Traband for 8 weeks. The control group did not have any training intervention; Pain was assessed by visual acuity scale, hip muscle strength by hand dynamometer and lower limb kinematics using video analysis before and after the intervention. Samples included people with patellar pain who had pain in both or one knee; If the pain was bilateral, the exercises were performed bilaterally on both lower limbs, but measurements were taken only from the lower extremity, which was most in pain. Analysis of variance for repeated measures was used by SPSS software for statistical analysis.

Results: The results of this study showed that after training, In the experimental group, pain decreased and the strength of the abductor muscles and external rotator of the hip joint muscles increased. knee dynamic valgus and pelvic drop was observed in single leg squat only in the experimental group.

Conclusion: Current research results showed that The strengthening of the hip joint can cause the pain of people with dyspnea pain, increases the strength of the muscles and the lower kinatidum of the lower limbs on the frontal motor screen, and this can be the mechanism of the effect of this intervention on the symptoms of pain.

Keywords: Local Fatigue; Pelvic drop; One-legged jump-landing

Introduction

Patellar thigh pain is one of the most common causes of anterior knee pain, especially among young women, which is twice as common in women as men and accounts for about 25% of knee joint problems. [1] This syndrome is a clinical condition characterized by pain in the back or under the patella that is associated with activities that involve weight bearing on the lower limbs, such as walking, running, jumping, climbing stairs, sitting for a long time, and kneeling [2]. Decreased thigh muscle strength has been considered as an important factor associated with patellar pain [3]. Another accepted cause of patellofemoral pain is the abnormal deviation of the patella between the femoral gutters. [4] The cause of this deviation may be a delayed onset of vastus medialis activity relative to the vastus lateral . It is likely to cause a temporary muscle imbalance in the internal-external force, which causes the patella to deviate. [5] Kinematics and kinetics of the knee and hip joints, in different motor planes, can be affected by lack of proper control of the hip muscles. [6] Improper function of these muscles is a common problem in patients with patellar pain [7], which can cause abnormal patellar outward movement. [8] Research has shown that this condition can be associated with kinematic changes in the hip joint in people with patellofemoral pain [9]. Due to recent attention to the abnormal kinematic role of the hip joint in patients with patellar pain, some researchers have decided to investigate the effect of strengthening the thigh muscles on the symptoms of patellar pain in clinical and review studies. [10]

Muscal and colleagues examined the effect of 14 weeks of endurance training and thigh, pelvic and trunk muscles on the symptoms of patellar pain in two affected women. Following the mentioned exercises, the thigh adduction angle and the amount of pelvic prolapse on the opposite side were significantly reduced [11]. It seems that the load on the patellofemoral joint has a multifactorial source and studies also indicate the effective role of strengthening exercises [12].One of the reasons why some treatment protocols fail is the multifactorial nature of this syndrome [13]. It has long been the case that the treatment of this syndrome has been localized and focused on the site of pain, the patellofemoral joint [14]. Therapies have sometimes been unsuccessful in controlling pain [15]. Today, in addition to the muscles around the knee joint, the thigh area is considered the best treatment [12].Recent studies have suggested a possible role for thigh muscle weakness in causing this complication and adding thigh strengthening to regular knee muscle exercises for the treatment of these patients. [16]

In Balden's study, 31 female athletes with patellar pain who exercised recreationally were divided into two groups. After the training intervention, in addition to improving pain, muscle function and strength, trunk displacement in the frontal plane, pelvic prolapse of the opposite side, adduction of the hip and abduction of the knee during one-legged squat in the group of functional stability exercises decreased and pelvic inversion and flexion The thigh was enlarged [17], but other studies have shown that no kinematic changes in the lower limb have been observed following a strengthening program of the hip muscles.

Ferber et al. Investigated the effect of strengthening the hip muscles on the kinematics of the

lower limb frontal plane during running. The course of strengthening exercises performed by the stretcher was about 3 weeks and included the abductor and rectus muscles of the thigh. Participants were athletes who exercised for fun. After three weeks of strengthening training, muscle strength increased, but the valgus angle of the knee did not change compared to before the training intervention. [18] In fact, each study specifically evaluated the effect of a method on treatment, while the latest approach in the treatment of patients with patellofemoral pain consists mostly of orthoses, prostheses, strengthening and stretching exercises [19]. For the first time, Ireland and colleagues examined the strength and kinematics of the femur and reported its effect on the patellofemoral joint. Healthy individuals have been reported. Patients with patellofemoral pain reported that the abductor 26%and external rotator of the hip muscles were weaker than healthy individuals.It is argued that the weakness of the abductor thigh muscles causes internal rotation of the femur, and more muscle involvement results in loss of tensor fascia latate muscle function, resulting in external tension on the patella leading the patella to move outward and causing pain in this area[20]. Earl et al. Considered strengthening the muscles of the hip area as another effective method in improving pain and function in patients with patellofemoral pain [21]. In their study, Fallah et al. Reported that strengthening the muscles Fallah et al. In their study reported strengthening the external extensor and rotator cuff muscles in improving the pain and function of patients with patellofemoral pain syndrome more effectively than the quadriceps muscles [22]. Stabilization of the central trunk is mainly due to the active function of the muscular structures, creating the abdominal muscles from the front, the Gluteus and parietal muscles from the back, and the pelvic floor muscles and around the thighs from below. [Definition of the body's ability to maintain the correct alignment of the lumbar-pelvic-thigh complex, and that the central stability of the trunk is the basis of the stability of the trunk that allows the creation of, transfer, control of force and movement to the lower parts of the motor chain such as the knee joint [23]. The results of research show that so far, a special study has not evaluated the effect of thigh muscle strengthening exercises on strength, pain and kinematics of lower extremities in women with patellofemoral complication. Studies that have examined the effect of strengthening these muscles in protocols have contradictory results. Therefore, in this study, we decided to investigate the effect of strengthening the abductor and external rotator cuff muscles on the amount of pain, thigh muscle strength and lower limb kinematics in women with patellofemoral complication.

Method

The method of the present study was quasi-experimental and applied in terms of purpose. It was performed in two stages of pre-test and post-test. The statistical population of this study was all female volleyball players in the age range of 18 to 28 years in Tehran. Statistical sample of 24 people who were selected by available and purposeful sampling with the help of G-Power software and after screening and homogenization based on body mass index (BMI) were divided into two groups of 12 people: control and experimental.In order to implement the research plan, the subjects first completed the informed consent form to participate in the research. Then, preliminary assessments including (height, weight, actual leg length, etc.) were performed by valid tools and devices in the methods mentioned below.

Volleyball players in the study included people with patella pain. The age range was between 18 and 25 years. This age range was chosen to reduce the risk of developing osteoarthritis in people. Subjects with pain in both or one knee; If the pain was bilateral, the exercises were performed bilaterally on both lower limbs, but measurements were taken only from the lower extremity, which was most painful. If the pain in both knees were equal, data were collected only from the upper lower limb.

abductor and external rotator of the hip joint muscles. To test the isometric strength of the abductor muscles of the hip joint, the subject stood sideways and placed the whole body in one direction. Then, to keep the body steady, bend the lower leg slightly from the knee and keep the test leg straight. The subject's pelvic joint was fixed by the tester and the dynamometer pad was placed above the external epicondyle of the thigh. The subject was asked to move his leg away with maximum force and the maximum force exerted by the device was recorded [24].

To test the isometric strength of the external rotator of the hip joint muscles, the subject sat on the edge of the bed with the knee joint at a 90-degree angle of flexion and the calf hanging from the bed. To prevent any use of muscles other than the external rotator cuff muscles, the distal thigh was fixed by the tester. The dynamometer pad was placed slightly above the inner ankle of the foot and the subject tried to rotate the thigh outwards by pushing towards the pad of the device and the maximum force applied by the device was recorded [24].

Figure (1) Isometric strength of abductor thigh muscles

To test the isometric strength of the external rotator of the hip joint muscles, the subject sat on the edge of the bed with the knee joint at a 90-degree angle of flexion and the calf hanging from the bed. To prevent any use of muscles other than the external rotator cuff muscles, the

distal thigh was fixed by the tester. The dynamometer pad was placed slightly above the inner ankle of the foot and the subject tried to rotate the thigh outwards by pushing towards the pad . of the device and the maximum force applied by the device was recorded. [24].

Figure (2) External isometric strength test of the hip rotator cuff

In both muscle strength tests, the subject underwent these steps in three stages with an interval of one minute, and the average of these three stages was recorded as the strength of the subject's hip muscles. Then, in order to normalize the power and make a correct comparison between the two groups, the numbers obtained from the hand-held dynamometer (kg.N) were divided by the body mass (kg) and multiplied by 100.

Two-dimensional motion analysis method was used to determine the kinematics of knee and thigh joints. First, the anatomical points of each person's lower limbs were identified by a physiotherapist. These included thoracic anterior thorns on both sides, internal and external condyles of the femur, large ridges, and internal and external ankles of the target lower limb. Then, the markers on the upper anterior spines on both sides, the midpoints of the joint line of the knee and ankle joints (obtained by connecting the anatomical points and determining their central point by a tape measure), the linear midpoint. Which was drawn from the upper

anterior cruciate ligament to the middle of the patella, was attached to the thigh and the tibia protrusion on the lower limb.

Method of measuring subjects' height

To measure height, subjects stood barefoot with their heels, hips, and head against the wall. In this case, the body weight was evenly distributed on the legs. The head and eyes were parallel to the horizon. Wall meter was used to measure height in centimeters.

Measuring the weight of the subjects

Analog scale (with a sensitivity of 0.1 kg, made in Germany) was used to measure the body weight of the subjects. The subjects were placed on the scales in light clothes and without shoes and their body weight was calculated in kilograms.

How to assess the amount of pain

In this study, visual pain intensity scale (VAS) was used to assess pain. The visual acuity questionnaire is a horizontal bar measuring 100 mm or 10 cm, one end of which is zero and the other end is 10, which is the most severe pain possible. This scale is one of the most authoritative visual pain rating systems. This scale has been widely used in research. Its validity and reliability are excellent and its internal reliability shows ICC = 0.91 [25]

Training protocol

Table (1) How to implement the training protocol with Traband

weeks	First set	repeat	Second set	repeat	Third Set	repeat
1-2	red	20	green	20	purple	20
3-4	red	25	green	25	purple	25
5-6	green	20	purple	20	black	20
257-8	green	25	purple	25	black	25
30 second break between sets, 1-minute break at the end of the set						

The subjects in the experimental group, under the direct supervision of the examiner, performed strengthening exercises of the relevant muscles for 8 weeks and three sessions per week. The control group did not receive any treatment or intervention. Due to the executive restrictions on the use of free weights to increase muscle strength and ensure that the desired muscle groups are strengthened, US-made Traband sports straps were used in 4 colors: red, green, purple and black. Among the caches used in the present study, the cache with red color had the lowest resistance and the cache with black color had the highest resistance. Each training session included 5 minutes of warm-up, 20 minutes of resistance training and 5

minutes of cooling. Exercises in each session consisted of 3sets.

Strengthening exercises of the abductor muscles of the hip joint were performed while standing. First, the elongation was determined by measuring between the abduction axis in the hip and ankle joints. Then the subject stood on the side next to the fixed bar, so that the foot to strengthen the muscles was farther from the bar, one end of the elastic was attached to the subject's ankle and the other end was attached to the bar and fixed. The subject performed the abduction movement of the hip along the range of motion, applying force against the training elbow.

External strengthening exercises of the rotator of the hip joint muscles were performed in a sitting position. First, the elongation was determined by measuring the distance between the axis of movement of the external rotation of the thigh at the hip and knee joints. The subject then sat on the bed, with the foot close to the bar, and hung his feet from the bed, with the feet off the edge of the knee. One end of the clamp was attached to the subject's ankle and the other end to a fixed bar.

Data Analyzing

Descriptive and inferential statistics were used to analyze the data statistically. Descriptive statistics were used to calculate central indicators, dispersion of quantitative scales, charts, and tables. After checking the normality of the data by Shapiro-Wilk test, covariance analysis statistical tests were used. All calculations were performed by SPSS software version 21 at a significant level of $P \leq 0.05$

Findings

The results of the Shapiro-Wilk test on the normality of the data are reported separately in Table (2).

Table (2) Shapiro-Wilk test results regarding the normal distribution of data

indicators	Z	P-value	result
age	1.67	0.331	normal
height	0.90	0.194	normal
weight	0.71	0.622	normal
BMI	1.74	0.571	normal
Strength of the abductor thigh muscles	0.87	0.283	normal
Strength of the external rotator of thigh muscle	0.72	0.233	normal
Knee valgus in step test	0.83	0.733	normal

Knee valgus in squat	1.22	0.156	normal
Pelvic drop in step test	0.79	0.345	normal
Pelvic drop in squat	1.34	0.222	normal
Pelvic drop in squat	1.83	0.178	normal

As can be seen in the table above, the value of the significance level of all indicators in the Shapiro-Wilk test is more than 0.05. Since one of the main assumptions for using the analysis of covariance test is the condition of equality of variance (homogeneity of variance). Therefore, first, the condition of equality of variances was examined by Leven test

Table (3) Leven test results for the condition of homogeneity of variances in the studied factors

variable	F	Degree of (df1) freedom	Degree of freedom (df2)	P-value
Strength of the abductor thigh muscles	20.246	1	13	0.236
Strength of the external rotator of thigh muscles	13.676	1	13	0.111
Knee valgus in step test	39.001	1	13	0.290
Knee valgus in squat	17.245	1	13	0.679
Pelvic drop in step test	48.077	1	13	0.224
Pelvic drop in squat	17.565	1	13	0.360
pain	21.523	1	13	0.463

As shown in the table above, slope homogeneity is not significant for all variables, So the con cept of homogeneity of regression gradients is achieved for the variables and the direction of the hypothesis Used from Covariance analysis.

Table (4) Results of analysis of covariance for the mean scores of pre-test and post-test of the two groups of the abductor thigh muscle

indicator	Source of changes	Total squares	Degree of (df) freedom	Average of squares	F	P-value	Eta coefficient
Pain	**Pre-test**	200.12	1	200.12	6.30	0.001 **	0.210
	group	401.40	1	401.40	4.93	0.001 **	0.568
	error	840.67	17	31.79			
Strength	**Pre-test**	567.11	1	567.11	7.23	0.051*	0.469
	group	560.89	1	560.89	5.34	0.001**	0.236

	error	923.67	34	56.88			
Pelvic drop	**Pre-test**	276.00	1	276.00	4.44	0.032 *	0.320
	group	279.11	1	279.11	2.18	0.000**	0.458
	error	645.66	19	30.75	19		
Knee valgus	**Pre-test**	190.53	1	190.53	7.33	0.001 **	0.850
	group	384.54	1	384.54	4.25	0.011 **	0.203
	error	674.98	24	26.90	24		

The difference in pre-test and post-test scores of two experimental and control groups for the abductor thigh muscle of research significantly and the mean score of the experimental group and at the surface ($p \leq 0.01$), and Etta squares are more than the control group. Therefore, it can be said that eight weeks of resistance training muscles of the thigh muscles on lower limb pain in volleyball players with patellofemoral complication has been positive and significant

Table (5) Results of analysis of covariance for the mean scores of pre-test and post-test of two groups of external rotator of the thigh muscle

indicator	Source of changes	Total squares	Degree of freedom) df(	Average of squares	F	P-value	Eta coefficient
Pain	Pre-test	320.60	1	320.60	6.34	**0.011	0.197
	group	341.72	1	341.72	8.77	**0.011	0.680
	error	760.56	27	36.70			
Strength	Pre-tes	47.00	1	47.00	5.78	0.001**	0.239
	group	278.01	1	278.01	11.33	0.601**	0.201
	error	567.11	49	50.76			
Pelvic drop	Pre-test	210.23	1	210.23	6.34	**0.001	0.510
	group	434.21	1	434.21	7.44	**0.011	0.203
	error	793.41	29	30.54			
Knee valgus	0.320	276.00	1	276.00	4.44	0.032*	0.320
	0.458	279.11	1	279.11	2.18	0.000**	0.458
	error	645.66	19	30.75	19		

The difference in pre-test and post-test scores of two experimental and control groups for the external rotator of the thigh muscle of research significantly and the mean score of the experimental group and at the surface ($p \leq 0.01$), and Etta squares are more than the control

group. Therefore, it can be said that eight weeks of resistance training muscles of the thigh muscles on lower limb pain in volleyball players with patellofemoral complication has been significant.

Table (6) Results of The mean and standard deviation of measured variables scores in groups

variable	group	Pre test	Post test	p-value
pain	experimental	0/65 +-5/96	0/68 +-3/08	0/004
	control	0/35 +-6/87	0/24 +-7/32	0/001
strength	experimental	0/69 +-17/84	0/95 +-23/46	0/782
	control	0/75 +-19/30	0/39 +-22/17	0/001
Knee valgus	experimental	1/18+-169/23	1/16+-170/62	0/003
	control	1/23+-157/65	1/20+-172/04	0/001
Pelvic drop	experimental	0/55 +-5/16	0/60 +-4/45	0/000
	control	0/61 +-5/08	0/47 +-5/31	0/000

The results of data showed that in the pre-test stage, the difference in mean scores of two control and experimental groups in cases of strength variable was not significant ($P < 0.05$). But also in rest of variables of research the difference in mean scores was significant ($P < 0.05$).

Discussion

The aim of this study was to investigate the kinematic changes of the lower extremities following an 8-week strengthening program of the abductor and external rotator of the hip joint muscles. Findings of this study included a significant reduction in pain, a significant increase in the strength of the abductor and external rotator of the hip joint muscles, a reduction in the valgus angle of the knee joint in a single-legged squat, and a reduction in the sagging angle of the opposite pelvis while descending stairs. And externally hip rotator by Traband was in the experimental group. The findings of this study confirmed our hypotheses of reduced pain, increased hip muscle strength, and lower limb kinematic changes. The results of the present study in order to reduce pain following thigh muscle strengthening exercises are consistent with the results of Ganji et al. [26], Khayyam Bashi et al. [27] and Sahin et al. [28]. The results of the present study on increasing the strength of both hip muscle groups are consistent with the results of Ganji et al. [26] Khayambashi et al. [27] and Sahin et al. [28], but with the results of Nakagawa et al. But it does not agree with the results of Nakagawa et al. [29] and the Honarpishe et al. [30]. The reason for the inconsistency of the results is the increase in the strength of the hip muscles of this study with other studies can be due to differences in the implementation of the training protocol and also the longer training period in the present study and the type of training protocol. Another hypothesis of the study that the kinematics of the lower limb improves following the program of strengthening the abductor and external rotator of the hip joint muscles was confirmed by the results of the present study. The analysis of the findings of this study showed the improvement of knee valgus dynamics during single-legged squat in affected women as well as the improvement of pelvic prolapse during descending stairs. Intragroup comparisons showed that all kinematic variables changed significantly over time in the experimental group, but in intergroup comparisons, the results indicated that according to the findings of Bell et al. [31] and Palmar

et al. [32] Valgus knee dynamics improved significantly during single-legged squat in the experimental group compared with the control group. The researchers used combination exercises in their studies, including exercises to strengthen the hip muscles, along with strengthening the ankle muscles, stretching and functional exercises, and motor retraining. The results of the present study showed that in order to cause kinematic changes in the lower extremities and improve the symptoms of patellar pain, it is possible to achieve similar results with more complex exercises with only two simple exercises to strengthen the abductor muscles and external rotator of the hip joint rotations. Improvement of valgus dynamic angle obtained in this study with the results of Farber et al. [18] who showed in their research that after 3 weeks of strengthening exercises of the abductor hip muscles, improvement in lower extremity kinematics including valgus dynamic knee Did not match, did not match. One of the reasons for the inconsistency of the results of the two studies is the duration of the training intervention period. It is noteworthy that the exercises in Farber research were performed at home without supervision for three weeks, while the reinforcing exercises of the present study were performed for 8 weeks, 3 sessions per week and continuously under the supervision of the examiner at the designated location. The rate of pelvic floor prolapse decreased during single-legged squat in the experimental group, with Muscal [11] and Balden [17] suggesting that strengthening hip muscles, functional exercise, and gait retraining are factors associated with improvement. Lower limb kinematics were consistent in patients with patellofemoral pain. In addition to the valgus dynamic variable of the knee, this change was also controlled in the degree of pelvic prolapse. Lower limb length and pelvic width are factors that can affect the kinematics and effectiveness of various strategies on lower limb kinematics in patients with patellar pain [34, 33]. Lower limb length and pelvic width were not considered in the present study. Future research should also consider anthropometric data of the lower extremities as a component. Men and women may also use different kinematic methods to reduce the symptoms of patellar pain. For example, affected men and women may place their knees in different positions as they descend the stairs so that they can moderate the amount of pressure exerted and thus reduce symptoms [33]. Limitations of this study include age, sex, fatigue (subjects were asked not to engage in any strenuous activity for 48 hours prior to exercise), height, weight, and body mass index. Giving and evaluating the same and the same pointed out. It is also suggested that this study be performed in a larger community than the current study on the population of people with patellofemoral complication. Research with the same title on other age groups and other sports. Such research should be conducted on athletes of the male sex and different age groups and other sports.

Conclusion

According to the results of the present study, it can be stated that therapeutic exercise based on strengthening the abductor and external rotator of the hip joint muscles of patients with patellofemoral pain may be able to reduce the dynamic valgus of the knee and the amount of pelvic prolapse on the opposite side. After that, the patients' pain will improve. 8 weeks of abductor and external strengthening exercises external rotator of the hip joint are likely to cause kinematic changes in the lower extremities, and by making these changes, the effect of reducing the

symptoms of patellofemoral pain following the mentioned exercises may be stable. Based on the findings of this study, it may be possible to consider the training method used, which includes strengthening the abductor and external rotator of the hip joint muscles by Traband, as an effective and integrated method in rehabilitation of patients with patellar pain. On the other hand, due to the results of the present study and the lack of sufficient studies on gender differences in how to respond to strengthening exercises, the need for a gender-specific rehabilitation program in patients with patellar pain may be further explored.

Gratitude

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Evaluation of Football Forecasting Models: 2021 Brazilian Championship Case Study

Flavio Fontanella, *FGV/EMAp,* Asla Medeiros e Sá, *FGV/EMAp,* and Moacyr Alvim H. B. da Silva, *FGV/EMAp*

Abstract—In the present work, we analyse the performance of football results forecasting models. In order to do so, we have performed the data collection from eight different forecasting models during the 2021 Brazilian football season. First, we guide the analysis through visual representations of the data, designed to highlight the most prominent features and enhance the interpretation of differences and similarities between the models. We propose using a 2-simplex triangle to investigate visual patterns from the results forecasting models. Next, we compute the expected points for every team playing in the championship and compare them to the final league standings, revealing interesting contrasts from actual to expected performances. Then, we evaluate forecasts' accuracy using the Ranked Probability Score (RPS); models comparison accounts for tiny scale differences that may become consistent in time. Finally, we observe that the Wisdom of Crowds principle can be appropriately applied in the context, driving into a discussion of results forecasts usage in practice. This paper's primary goal is to encourage football forecasts' performance discussion. We hope to accomplish it by presenting appropriate criteria and easy-to-understand visual representations that can point out the relevant factors of the subject.

Keywords—accuracy evaluation, Brazilian championship, football results forecasts, forecasting models, visual analysis.

I. Introduction

FOOTBALL is a popular sport worldwide, with billions of spectators and a multi-billionaire market. As such, forecasting football results has long been a topic of interest [1]. For most applications, assessing the quality of those forecasts should be a major concern, since bad forecasts are likely to generate bad rewards. Despite that, football forecasts evaluation has not been considered a popular topic [2].

Fontanella et al. [3] explores visual data representations to understand better the behaviour of a proposed forecasting model designed to predict football match scores based on past confrontations. In the present work, we expand their analysis to compare several prediction models to assess the quality of football forecasts. We use information visualization techniques to present the models' forecasts and the comparative analysis using data from one complete football season. Our main contributions are:

- The proposal of the *2-simplex* visualization of football results forecasts to enhance model comprehension;
- A comparative evaluation of football result forecasting models through an accuracy metric;
- The investigation of the Wisdom of Crowds effect for the context of football result forecasting.

This paper is structured as follows: in Section II we define football results forecasts and detail a visual representation for forecasts of events with three outcomes. In Section III we present the forecasting models and the data collected for this work and discuss some patterns from the models' forecasts. In Section IV the concept of expected points is approached and followed by a discussion about the performance of teams playing in the championship. Section V comprehends the accuracy evaluation of the forecasts and the models comparison on that issue. In Section VI we investigate the applicability of the Wisdom of Crowds principle in this scenario. Finally, in Section VII we provide comments for consideration and point out future works. All the forecasts and evaluators are presented throughout the text as chart figures designed to enhance our perception of the relevant information.

II. Football Results Forecasting

RESULT for a football match in this context is either a *home win (H)*, a *draw (D)* or a *away win (A)*. A *forecast* for a match result is a triplet of probabilities (p_H, p_D, p_A), constrained to $p_H + p_D + p_A = 1$, where each p is the probability associated with the corresponding result.

A match result forecast (p_H, p_D, p_A) may be visually represented by a point in R^3. The constraint $p_H + p_D + p_A = 1$ implies that such point lies on the triangle with vertices $(1, 0, 0)$, $(0, 1, 0)$, $(0, 0, 1)$, referred to as *2-simplex*. A match result may be associated with the forecast that assigns probability 1 to that result (and 0 to the others), so being identified with a vertex of the 2-simplex. To plot the forecasts into 2-dimensional charts, we apply the linear mapping:

$$\begin{pmatrix} -\frac{\sqrt{2}}{2} & 0 & \frac{\sqrt{2}}{2} \\ -\frac{\sqrt{6}}{6} & \frac{\sqrt{6}}{3} & -\frac{\sqrt{6}}{6} \end{pmatrix} \tag{1}$$

which preserves distances for points on the *2-simplex*, once it consists of an alignment of the plane of interest with the plane $z = 0$ by a rigid motion, followed by a suppression of the z coordinates.

The idea of representing forecasts for three mutually exclusive and exhaustive events as points over the *2-simplex* is described in [4] and traces back to the 1960's at least [5]. Also, football results forecasts have already been seen as points over a triangle [6]. However, we have not found any use of the *2-simplex* plot representation to communicate forecasts and results of football matches or to analyse forecasting models features prior to this work.

The *2-simplex* representation is illustrated in Figure 1, which presents forecasts from different models - to be detailed in Section III - and match result for one single match of the season. It exemplifies how forecasts can be different among models and also how unsure the models can be about certain matches, as none of the points lie close to any vertex.

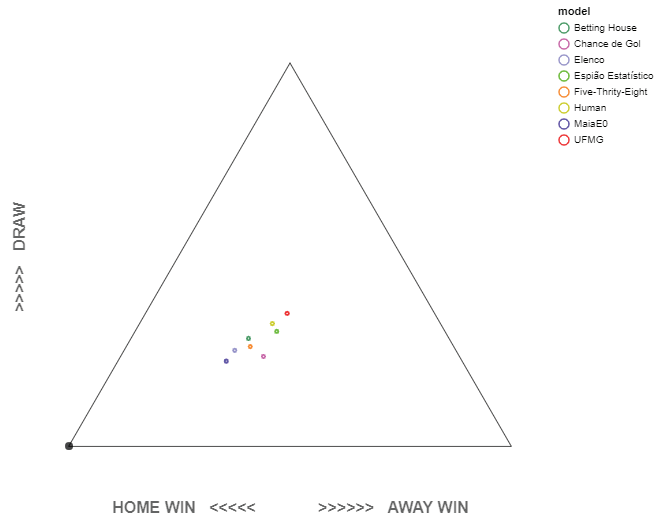

Fig. 1: Forecast projections into the 2-simplex representation. Several forecast strategies and actual result for a single match.

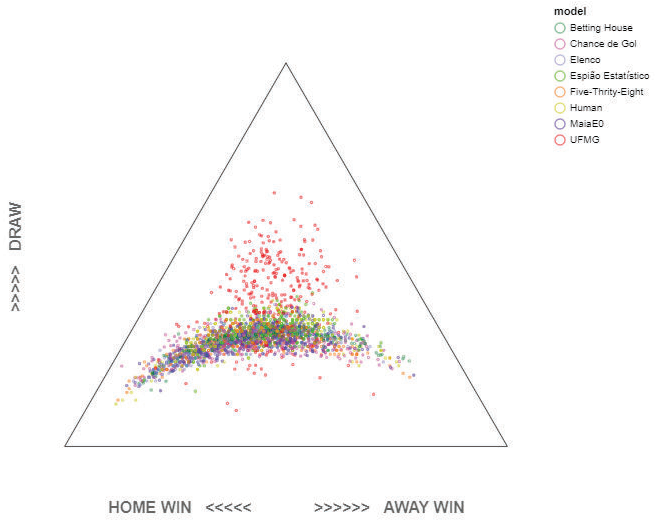

Fig. 2: Forecast projections into the 2-simplex representation. Every forecast for all models and all championship matches.

III. Data and Forecasting Models

FORECASTING models for football results are usually mathematical models that utilize past results data and other relevant information to forecast the results of future matches. Several models have been proposed over the last decades, making use of different techniques, such as independent Poisson distributions [7], [8], Poisson autoregression [9], machine learning [10] and Bayesian statistics [11].

The data used in this work consists of the set of models forecasts, and actual results of every match played in the 2021 Brazilian Championship. Our primary concern to select the set of models to be evaluated was the forecast availability for the matches from the championship season. Two of the chosen models - *Elenco* [12] and *MaiaE0* [13] - were developed within the *Esporte em Números* project framework [14]. Another selected published model is from *Universidade Federal de Minas Gerais (UFMG)* [15]. All other selected models are commercial and release forecasts on their website. That's the case for *Chance de Gol* [16], *Espião Estatístico* [17] and *Five-Thirty-Eight* [18]. We also collected and evaluated, for comparison, forecasts made by a human being who was aware of the purposes of the task.

Additionally, to benchmark the evaluations, we collected opening odds from a well-known betting house, available in the *OddsPortal* website [19]. The odds were converted into implied forecasts, using the following formula:

$$p_H = \frac{\frac{1}{odd_H}}{\frac{1}{odd_H} + \frac{1}{odd_D} + \frac{1}{odd_A}} \quad (2)$$

$$p_D = \frac{\frac{1}{odd_D}}{\frac{1}{odd_H} + \frac{1}{odd_D} + \frac{1}{odd_A}} \quad (3)$$

$$p_A = \frac{\frac{1}{odd_A}}{\frac{1}{odd_H} + \frac{1}{odd_D} + \frac{1}{odd_A}} \quad (4)$$

The forecasts were individually collected from the specialised websites or generated by running the models, fixture-by-fixture, throughout the championship, and we intend to make them available online. As we worked in the data collection for over half a year, some patterns were perceived for the models' forecasts, while others did not come to light until plotted into a chart. While Figure 1 explained the visual representation, Figure 2 shows all models' forecasts for all matches in the championship and Figure 3 splits the views faceting each model forecast.

Observing the pattern formed by the cloud of points, we notice that most points lie close to an arc that starts near the home-win result, ends not so near the away-win result, and passes through the center of the triangle - that represents the naive $(\frac{1}{3}, \frac{1}{3}, \frac{1}{3})$ forecast. Observing the forecasts from each model separately (Figure 3), every model except the UFMG's model seems to follow the arc pattern, each with its subpatterns. For instance, Elenco's arc seems biased towards the home-win result, while Espião Estatístico's seems biased toward the center, given its shorter arc. The Betting House's arc is the narrowest, while Chance de Gol's, MaiaE0's, and Espião Estatístico's are more spread. Surprisingly, the Human's arc does not look much different from the others nor particularly remarkable. It is hard to perceive a pattern in UFMG's cloud, except that it is very different from the others, as many points get closer to the upper vertex of the triangle, which means forecasts place a higher probability to the draw result.

Table I presents mean statistics for the forecasted probabilities by each model. It is possible to confirm some impressions derived from the visual patterns observed in Figure 3 as, for example, Elenco's home-win bias and UFMG's draw bias. The last column displays a measure of (horizontal) centrality for forecasts' points on the *2-simplex*. A point over the triangle height would have $\mid H - A \mid = 0$, while a point over any of the bottom triangle vertices would have $\mid H - A \mid = 1$. Between 0 and 1, the lower this value, the closer to the triangle

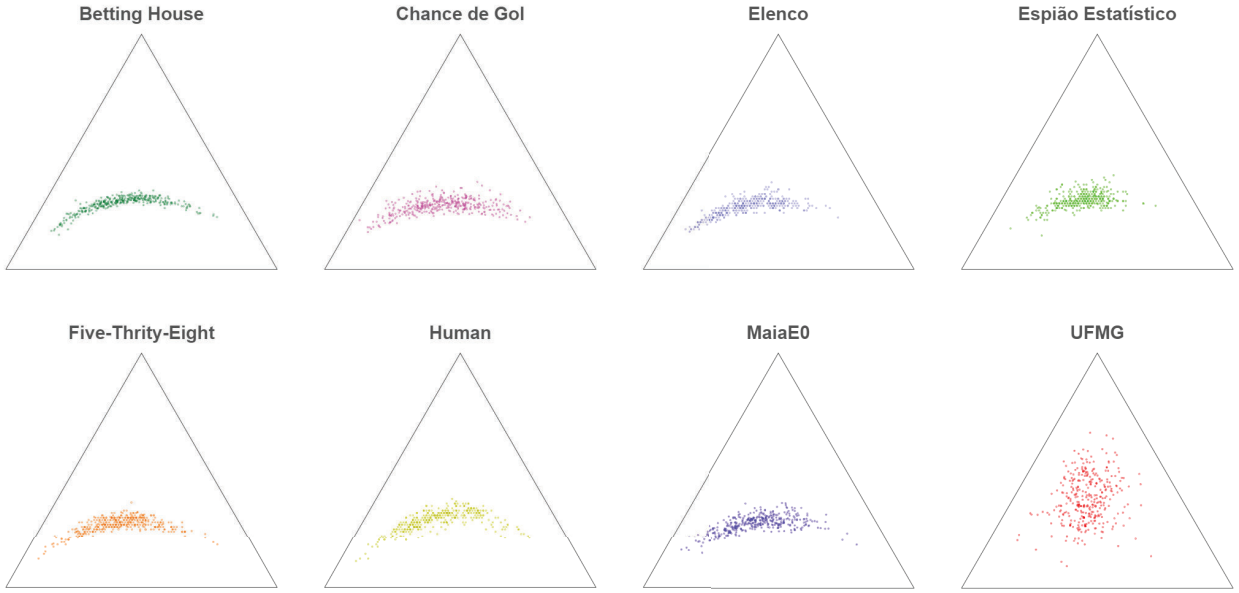

Fig. 3: Forecast projections into the 2-simplex representation. Faceting each model's forecasts for all championship matches.

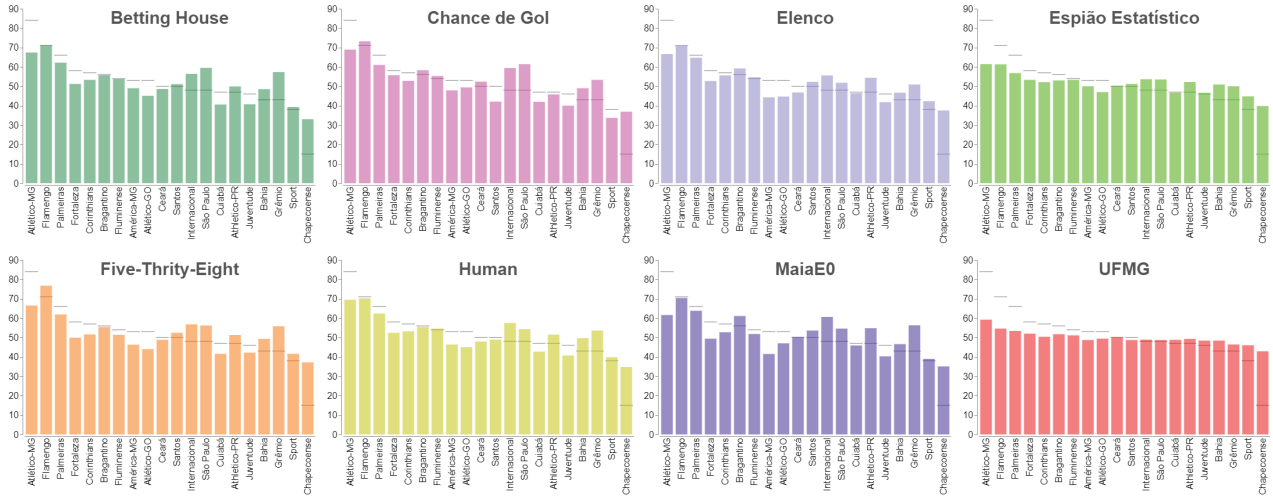

Fig. 4: xPoints standings for each model. The black ticks represent actual points in the final standings.

height the point would be plotted. That should explain Espião Estatístico's shorter arc.

TABLE I: Mean statistics for the models' forecasts

Model	H mean	D mean	A mean	|H-A| mean
Betting House	0.432	0.279	0.289	0.231
Chance de Gol	0.434	0.267	0.298	0.233
Elenco	0.484	0.263	0.253	0.262
Espião Estatístico	0.408	0.294	0.298	0.150
Five-Thirty-Eight	0.445	0.268	0.285	0.225
Human	0.437	0.288	0.275	0.241
MaiaE0	0.443	0.273	0.284	0.224
UFMG	0.349	0.376	0.275	0.125

IV. Forecasts Expected Points

GIVEN any football results forecast, the expected points for the home team (xP_H) and for the away team (xP_A) can be computed as:

$$xP_H = 3p_H + p_D \tag{5}$$

$$xP_A = 3p_A + p_D \tag{6}$$

If matches are considered as *independent events* (which may well be argued against), the total expected points for any team in the championship will be the sum of that team xP computed for every match they play.

In this visual analysis we compared the points earned for the two teams playing the match to the corresponding *expected points (xP)* the forecasts imply. Figure 4 presents as bars the xP inferred by each model's forecasts to each team over the championship. For each bar there is a tick marking the actual

points the team earned in the final championship standings. A tick above the bar means that more points were achieved than the model forecasted. On the contrary, ticks below the upper limit of the bars represent teams performing worse than predicted.

If we compare the last two charts, it's easy to notice that models biased to the center in Figure 3 (UFMG and Espião Estatístico) have smaller bar variation in Figure 4. That's because the xP is shared more evenly between home and away teams in such cases. Another interesting feature is how some team's xP varied among the models. Champion team Atlético-MG highly outperformed every model's prediction while last-place Chapecoense did exactly the opposite. Second-place Flamengo points were well predicted by most models but Five-Thirty-Eight (which expected more), Espião Estatístico and UFMG (that expected much less). Mid-table Ceará and Santos points were also well forecasted by most models, except for Chance de Gol that clearly underpredicted Santos performance. 19th-place Sport was another source of disagreement, as his xP varied from 33.7 (Chance de Gol) to 46 (UFMG). Grêmio's xP were overpredicted by all models, getting as high as 57.3 by the Betting House. Those xP ranks 5th in that model's standings, but the actual 43 points earned Grêmio a relegation. Also noteworthy, 5th-place Corinthians xP was predicted lower than 12th-place Internacional's by all but one model (UFMG), which is likely due to 2020 performances by those teams.

V. Forecasting Models' Accuracy

EVALUATION of a forecast is an assessment of the quality of the forecast. A measure of closeness between the forecast and the actual result of the match can play the role of an *evaluator*. A few other works previously discussed football forecasts evaluation [2], debating evaluators' performance [6] or analysing a case-study [20]. One of the authors has assessed this subject in his MSc thesis [12].

In this work we adopt a proper scoring rule [21] named *Ranked Probability Score (RPS)* [22] as evaluator, defined as follows:

$$RPS(forecast) = \frac{(p_H - e_H)^2 + (p_A - e_A)^2}{2} \qquad (7)$$

where e_H is 1 if the actual match result is a home win and 0 for other results, while e_A is 1 for a away win and 0 otherwise. The RPS for a set of forecasts is obtained by averaging the RPS for each individual forecast and has been considered an appropriate score in football results forecasting context [23].

A Ranked Probability Score of 0 represents perfect fit between the result and the forecast *(e.g. a forecast (0,1,0) for match ended in a draw)* and the higher the score, the worse the accuracy. The upper-limit for the RPS is a score of 1, which happens when the forecast is a perfect indicative of a result other than the actual result.

Figure 5 presents RPS evaluation for all models. The wider ticks on the chart represent every forecast evaluation for each model. Once again comparing to previous figures, it's clear that models biased towards the middle of the 2-simplex (UFMG and Espião Estatístico) get less spread evaluations. It doesn't lead necessarily to lower means or medians, as we can observe in the box-plot marks. In fact, UFMG's forecasts got the highest mean and median values, while Espião Estatístico's got second-higher median. Some forecasts evaluations got closer to 0. They came from Palmeiras 3 x 1 Chapecoense (Human, 2nd fixture) and Flamengo 2 x 0 América-MG (Five-Thirty-Eight, 3rd) matches. Worst evaluations did not get higher than 0.7 and came from Bragantino 1 x 2 Chapecoense (Elenco, 20th), Flamengo 0 x 1 Fluminense (Five-Thirty-Eight, 9th) and Flamengo 0 x 1 Santos (Chance de Gol, 37th) matches.

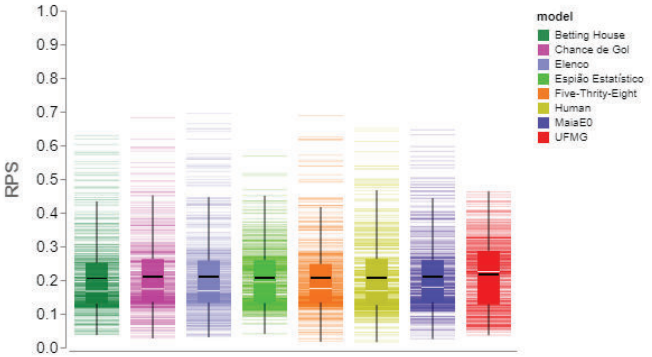

Fig. 5: RPS evaluation for all models. Wide ticks represent evaluations for individual matches. The white tick over the box-plot marks the median and the black tick marks the mean evaluation.

When we consider the box-plot statistics, it's arguable that all models performed relatively close. Trying to rank them by mean RPS will lead to millesimal scale comparison. Averaging the RPS evaluator over all forecasts is indeed the proper scoring rule extended from the RPS [22] and the final score for each model is shown on table II.

TABLE II: Final mean RPS

Model	RPS
Betting House	0.205
Chance de Gol	0.2097
Elenco	0.2096
Espião Estatístico	0.2074
Five-Thirty-Eight	0.2054
Human	0.2069
MaiaE0	0.2103
UFMG	0.2179

We observe how the mean RPS evolved through time as the championship evolved, the information is plotted in Figure 6. It shows models ranking varied greatly through time. The chart also suggests that an important but still unmentioned event may have caused great impact on forecasts performances: the return of the public to the stadiums on October 2nd. From that date on, all models but UFMG improved their mean RPS evaluation, a tendency that could not be seen before inspecting the temporal behaviour of the mean RPS for the models. October 2nd also looks like a turning point in models ranking. By then, for a month and a half, Espião Estatístico

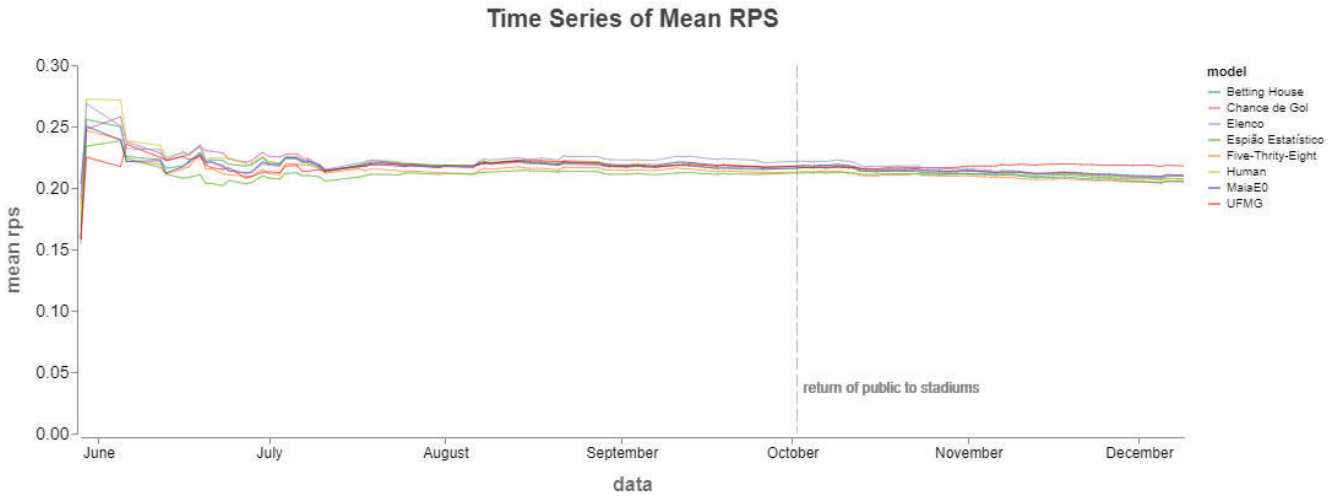

Fig. 6: Time series of mean RPS for each model

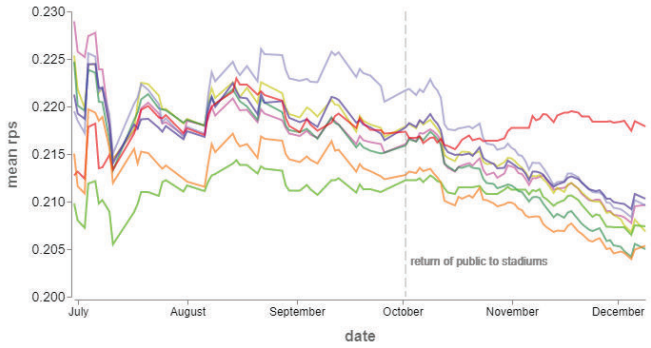

Fig. 7: Time series of mean RPS for each model. RPS axis cut into the interval of interest $[0.200, 0.230]$

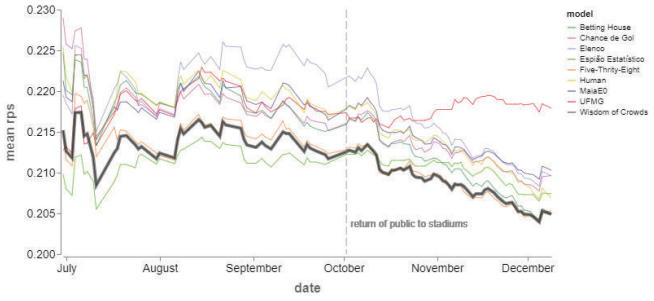

Fig. 9: Time series of mean RPS for each model. Wisdom of Crowds series is highlighted.

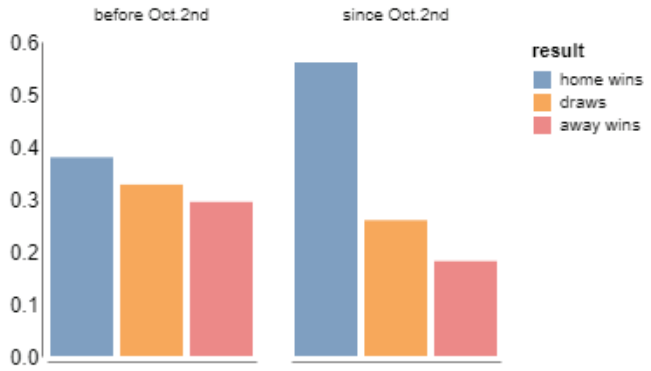

Fig. 8: Results distribution prior and since the return of the public to stadiums

and Five-Thirty-Eight had established a leadership duel, with Elenco far off in last place and all other lines mixed in the middle. From that point on, some models (notably Elenco, Human and the Betting House) went much better, while Espião Estatístico did not and UFMG went worse. The main reason for that is likely to be that the public presence seems to have increased home advantage, thus benefiting models with higher home win bias. Figure 8 shows home-draw-away actual results distribution prior and since October 2nd.

VI. The Wisdom of Crowds Effect

THE *Wisdom of Crowds* (WoC) principle is a conjecture that the average of a mass of independent forecasts tends to be more accurate than the vast majority of the original individual forecasts. It was first presented in the early 20th century by Francis Galton [24] and has gained much popularity since James Surowiecki's book was released in 2004 [25].

To investigate its occurrence in our context, we implemented an additional forecasting model for which each match forecast corresponds to the average of the forecasts from all the other models. This WoC model's forecasts were then evaluated in the same way we did evaluate the original forecasts.

Figure 9 shows once again the evolution of mean RPS for all models' forecasts and adds the WoC model time series. As the conjecture states, the WoC model was among top performers at all times and even finished as best evaluated model, according to the RPS mean criteria, by a tenth of a thousandth over the Betting House.

Also of interest, expected standings (xP standings) implied by the Wisdom of Crowds model is presented in Figure 10. The chart x-axis shows the teams ordered by xP instead

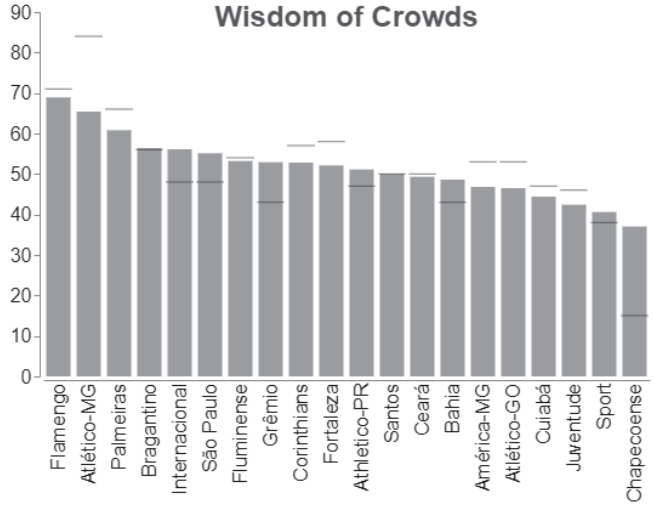

Fig. 10: xPoints standings for the Wisdom of Crowds model. Black ticks mark actual points.

of actual points. Thus, it can be interpreted as the expected ranking of the teams considering all models average forecasts. The *xRanking* shows several differences compared to the actual ranking. Flamengo was expected to be the champion. Internacional (5th), São Paulo (6th) and Grêmio (8th) were all expected to finish seven or more places higher than they actually did. Athletico-PR (11th) and Bahia (14h) were also expected to do better. On the opposite, Fortaleza (10th), América-MG (15th) and Atlético-GO (16th) may be seen as overachievers, as each finished at least six places higher than predicted. Corinthians (9th), Cuiabá (17th) and Juventude (18th) were also underestimated by the models. If we compare the bars to the ticks (xP to actual points) Chapecoense is the greater underachiever, having earned less than half expected points, while Atlético-MG highly outperformed the forecasts with almost 20 points more than expected.

VII. Discussion and Conclusion

COLLECTING the result forecasts, analysing the data, and observing the chart plots gave us much insight on their behaviour and interesting thoughts regarding various aspects of football forecasting models.

As we observe Figures 1 to 3, we may notice that although models differ from each other, all their forecasts concentrate on a small area of the *2-simplex*. If we omit UFMG's model, all the other models' forecasts approximate a perfect arc, so that one result probability nearly determines the other two. We wonder if this arrangement is entirely due to the adopted mathematical modelling or if it could be intrinsic to the nature of the game. For example, a draw result is always one goal away from both other results: home-win and away-win. Whether it could be guessed that a match with two defensive teams is more likely than the average to end in a draw (an assertion that is worth investigation), common sense would say that a $(0.6, 0.2, 0.2)$ forecast is more logical than a $(0.6, 0.05, 0.35)$ for virtually any match. This hypothesis deserves further investigation, and, if confirmed, football results forecasts could be reduced to the forecast of a single variable. That could impact the mathematical basis of forecasting models and how we analyze and evaluate such forecasts.

We used the Ranked Probability Score to evaluate the forecasts. When we analyse models' performances, it may look surprising that the evaluations were so close to one another, but it is not. Once forecasts occur within a small region of the *2-simplex*, their scores should not be very different. Figures 6 and 9 suggest that although score differences are small, the models' ranking may become stable in time, with score variations likely to occur to all models similarly. That seemed to be the case before the return of the public shifted the tendencies. After that moment, though the ranking became unstable, variation behaviour still looks similar among most models. We shall conduct further investigation of this stability issue.

The Wisdom of Crowds effect seems to have taken place on this subject. It suggests that whenever there are a few forecasts available for a football match, we should consider the average forecast, hoping to achieve better accuracy. Of course, this assertion also requires further investigation. However, if confirmed, it may cause a significant impact both in the way football forecasting models are conceived and in how forecasts are disclosed by sports media. In addition, of course, it should also affect the betting market.

Most of this work can be adapted to other sports. The *2-simplex* representation would only be helpful for sports with three different outcomes. On the other hand, expected points can be computed for any sport that ranks participants by points. Accuracy evaluation and the Wisdom of Crowds principle can be applied wherever forecasts are available.

Finally, as future work, we consider extending this analysis to other championships or maybe more extensive sets of matches given the availability of forecasts. In addition, the arc pattern identified for the forecasts, the time stability of models' ranking, and the Wisdom of Crowds effect require and deserve further analysis.

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Flavio Fontanella Master of Science in Mathematical Modelling, School of Applied Mathematics at Getulio Vargas Foundation (FGV/EMAp), 2021. BSc in Mathematics, Rio de Janeiro State University (UERJ), 2004.

Asla Medeiros e Sá Lecturer and Researcher at School of Applied Mathematics at Getulio Vargas Foundation (FGV/EMAp) since 2007. PhD in Sciences with emphasis in Computer Graphics, Institute for Pure and Applied Mathematics (Visgraf at IMPA), 2006. MSc in Applied Mathematics, Federal University of Rio de Janeiro (DMA/IM/UFRJ), 2001. BSc in Mathematics, Federal University of Rio de Janeiro (DMA/IM/UFRJ), 1999.

Moacyr Alvim H. B. da Silva Lecturer and Researcher at School of Applied Mathematics at Getulio Vargas Foundation (FGV/EMAp) since 2004. PhD in Mathematics/Computer Graphics (2004) and MSc in Mathematics (1998), Institute for Pure and Applied Mathematics (IMPA). BSc in Computer Science (1991) and in Mathematics (1996), Rio de Janeiro State University (UERJ).

Importance of Flexibility Training for Older Adults: A Narrative Review

Andrej Kocjan

***Abstract*—** Introduction: Mobility has been shown to play an important role of health and quality of life among older adults. Falls, which are often related to decreased mobility, as well as to neuromuscular deficits, represent the most common injury among older adults. Fall risk has been shown to increase with reduced lower extremity flexibility. The aim of the paper is to assess the importance of flexibility training on joint range of motion and functional performance among elderly population. Methods: We performed literature research on PubMed and evaluated articles published until 2000. The articles found in the search strategy were also added. The population of interest included older adults (≥ 65 years of age). Results: Flexibility training programs still represent an important part of several rehabilitation programs. Static stretching and proprioceptive neuromuscular facilitation are the most frequently used techniques to improve the length of the muscle-tendon complex. Although the effectiveness of type of stretching seems to be related to age and gender, static stretching is a more appropriate technique to enhance shoulder, hip, and ankle range of motion in older adults. Stretching should be performed in multiple sets with holds of more than 60 seconds for a single muscle group. Conclusion: The literature suggests that flexibility training is an effective method to increase joint range of motion in older adults. In the light of increased functional outcome, activities such as strengthening, balance, and aerobic exercises should be incorporated into a training program for older people. Due to relatively little published literature, it is still not possible to prescribe detailed recommendations regarding flexibility training for older adults.

***Keywords*—** elderly, exercise, flexibility, falls.

Andrej Kocjan is with the University of Primorska, Slovenia (e-mail: andrej.kocjan@pef.upr.si).