



Qatar University Research Magazine

★ Special
Edition

Issue 22, December 2024

Artificial Intelligence Research at Qatar University: Innovative Insights and Applications

Interview with Dr. Mohammed
Abdulaziz Al-Sada
Director of Kindi and QMIC
Centers

AI-Enhanced Leak Detection in
Oil and Gas Pipelines

AI Stroke Diagnosis: Techniques
and Challenges

Who's the Real Genius, You or
the Robot?

Artificial Intelligence as a Mufti



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Editorial

Distinguished Readers,

The world stands on the cusp of the fifth industrial revolution, shaping a transformational shift to cutting-edge digital technologies and artificial intelligence (AI) that mimics human intelligence, where humans merge with machines to process huge amounts of data and obtain fast and accurate results at the lowest costs.

In this issue, we are delighted to present to you some of the most prominent research achievements of Qatar University (QU) in the aforementioned fields, reflecting the University's keenness to keep pace with technological progress and enhance the skills of students, faculty members, researchers and in general, the University Community in various fields of AI applications.

AI research has covered the University's research pillars in the fields of energy and environment, health and biomedical sciences, information and communications technology, and social and human sciences.

The issue also includes, under the ambit of Energy and Environment, the detection of leaks in oil and gas pipelines using innovative solutions and the application of AI-powered digital twin technology.



It also includes the development of an AI-based computer vision model, integrated with a remotely operated vehicle to create an autonomous robot for cleaning ship hulls. It also incorporates the use of AI and Internet of Things (IoT) technologies to monitor the health of soil, water, and plants as a strategic step in supporting national efforts to achieve environmental sustainability in the State of Qatar.

In the Health and Biomedical Sciences section, the magazine's research articles focused on AI research to combat colorectal cancer, diagnose stroke, provide innovative solutions in infertility treatment, and improve the success of IVF.

In addition, in the ICT field, research shows that while AI can produce predictive analytics, the dual use of technology and human expertise is what an effective audit department needs to operate successfully and provide independent assurance on regulatory risk management, governance, and internal controls and regulations. Another research begs the question: who is the real genius, you or the robot?

The Social and Human Sciences segment comprises several studies, including the prospects for recognizing AI legal personality, and applications of AI in special education towards empowering and enhancing the capabilities of students with disabilities. Another research paper focused on AI in the field of legal *fatwas*, and how AI can enhance Qatar's diplomatic efforts in resolving conflicts. The issue also included interviews conducted with researchers and students who have excelled in the field of artificial intelligence.

It should be noted that no matter how great the capabilities of AI are, humans are indispensable in setting legislative controls for positive use, accountability, and auditing the outputs of this intelligence, in addition to considering ethical and human aspects, which nothing is better at understanding than humans.

I invite you to read and enjoy the diverse topics of this issue and hope it will be beneficial for all of you.

Prof. Aiman Erbad,
Vice President for Research and
Graduate Studies, Qatar University



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Interview with:
Dr. Mohammed Abdulaziz Al-Sada
Director, Kindi Center for Computing
Research and the Qatar Mobility
Innovations Center (QMIC)

Artificial intelligence has seen remarkable development in recent years, being utilized across various fields and offering innovative ideas that emulate human intelligence in performing tasks. To understand the buzz surrounding AI, we meet with Dr. Mohammed Abdulaziz Al-Sada, Director of the Kindi Center for Computing Research and the Qatar Mobility Innovations Center (QMIC).



Dr. Mohammed, how would you introduce yourself to the readers of Qatar University's Research Magazine before discussing artificial intelligence?

I am Mohamed Al-Sada, Director of the Kindi Center for Computing Research and the Qatar Mobility Innovations Center (QMIC) at Qatar University. I earned my Bachelor's degree in Computer Science from Qatar University, followed by a Master's and PhD in Computer and Communication Engineering from the Leading Graduate Program in Embodied Informatics at Waseda University in Tokyo, Japan.

Over the past 15 years, I have worked in research and development within prominent institutions, including Qatar Energy and Sony Science Labs. My research focuses on several fields related to human-centered design for augmented and virtual reality systems, wearable robotics, and humanoid robots for daily and industrial applications. My research has been featured in both international and regional media, such as Yahoo! News and MoguraVR in Japan, as well as JeemTV in Qatar.

What is Artificial Intelligence?

Artificial Intelligence (AI) is an advanced technology that enables machines to think, learn, and make decisions in ways that mimic human capabilities. This allows systems to understand problems, learn from past experiences, and effectively respond to unexpected and new contexts. For example, virtual assistants like Siri and Google Assistant help users by recognizing patterns in their questions and voices and improving the quality of responses over time. Additionally, AI algorithms are used in media platforms, like Netflix and YouTube, to suggest content tailored to users' interests based on their viewing history. These examples highlight AI's vital role in enhancing our daily lives and making processes smarter and more precise across various sectors. In transportation, self-driving cars like Tesla demonstrate AI's ability to interact with diverse road environments, including avoiding accidents caused by unexpected obstacles. In industry, AI-powered robots can conduct various tasks, such as inspection or assembly, in full or partial autonomy, thereby minimizing manufacturing errors, reducing waste and improving efficiency.

Are there specific entities within the University specializing in artificial intelligence?

Yes, the University has specific entities dedicated to research and development of artificial intelligence

and its applications:

The Kindi Center for Computing Research: The center focuses on AI and cybersecurity research, working to develop AI applications across various fields. It promotes innovation through specialized research projects and training programs, while also collaborating with governmental and industrial entities to develop cutting-edge solutions.

The Qatar Mobility Innovations Center (QMIC): The center specializes in applied AI solutions to support various sectors, such as transportation and intelligent mobility. It emphasizes the development of practical smart technologies to meet the needs of industries and communities, making it a leader in promoting AI usage for addressing real-world challenges.

These centers collaborate with each other and the community to foster a research and application-driven environment that supports innovation in AI, both within and beyond the University.

In what fields is AI most widely applied, and how reliable is it?

AI is evolving rapidly, expanding its applications across diverse fields, making it a driving force of the Fifth Industrial Revolution which mainly relies on embodied systems, especially autonomous robotic systems. Such systems have already been used in the last 40 years, and their role is becoming more crucial in the industry world-wide due to the rapid advancements in AI. Furthermore, autonomous robotic systems have already become an integral part of our daily lives, like delivery-robots, self-driving vehicles and humanoid robots.

AI also powers numerous tools and applications, such as social media platforms, search engines, maps, and voice assistants. Additionally, AI plays a critical role in the financial sector, enabling automated trading and fraud detection.

However, the reliability of AI depends significantly on the quality of the data it is trained on, the complexity of the problems it aims to solve, and the transparency of the models used.

What is the role of AI in research and education?

AI plays a pivotal role in scientific research by enabling the analysis of vast amounts of data with unprecedented speed and precision. This capability helps researchers uncover patterns and insights that may remain hidden using traditional methods. AI also supports the development of predictive

models to solve complex problems across various scientific domains, including medicine, engineering, and environmental sciences. Moreover, it automates data analysis and reporting processes, allowing researchers to focus more on innovation and development. With its advanced capabilities, AI has become an essential tool for enhancing efficiency and driving sustainable progress in research.

In education, AI reveals new opportunities to enhance learning and training experiences. It can personalize educational content to meet individual student needs, provide accurate automated assessments, and offer 24/7 virtual assistance. AI can also be utilized in virtual and augmented reality simulations to create immersive educational experiences. Additionally, AI analyzes educational data to identify students' strengths and weaknesses, enabling the development of effective teaching strategies. By integrating AI, the education sector is better equipped to adapt to diverse learning styles and foster more effective and engaging learning environments.

What is your opinion on the integration or conflict between humans and machines?

The interaction between humans and machines is one of the central challenges in contemporary technological evolution. However, this relationship should be understood as a synergy and partnership rather than a conflict. Human creativity and problem-solving abilities can synergize with the advanced computational and mechanical capabilities of machines. While AI has automated certain tasks by mimicking human thinking, learning, and problem-solving, it has also created new job opportunities and innovative fields that did not exist before. Similar to previous technological revolutions, there will be a period of adaptation by the workforce and society.

Thus, the relationship between humans and machines should not be defined as a competition, but as a partnership where the strengths of both can be combined to enhance human life, which is the essential objective of all created technologies. However, it is essential to approach the applications of AI with an impartial perspective that considers both the potential benefits and risks.

Are there any research projects at Qatar University that have delivered innovative and reliable results using artificial intelligence?

Yes, Qatar University has made remarkable

progress in AI applications through its research endeavors in the KINDI Computing Research Center and Qatar Mobility Innovation Center (QMIC). For example, QMIC has numerous substantial systems utilizing AI, such as Falcon-I, which was used for intelligent traffic control during the World Cup 2022 in Doha, Qatar. Falcon-I was fully developed in Qatar University, and proved to be a substantial and reliable asset that is continuously being utilized for various national and international events in Qatar.

Furthermore, our research team at the Kindi Center, in collaboration with Waseda University in Japan, has developed a system that fuses human and artificial intelligence for teleoperating a robot, which was tested with different robot types, including wearable and humanoid robots. By leveraging both human intelligence and artificial intelligence, the system enables new potentials to reap the benefits of human cognitive and intuition capabilities with the precision and efficiency of robots.

How do you view the future of artificial intelligence? Does it represent a greater opportunity or a threat to societies?

AI is a driving force behind the profound transformations reshaping the global landscape across economic, social, and technological fields. While AI presents substantial challenges, it also unlocks promising horizons for contemporary societies. Specialized studies and research underscore its vast potential to revolutionize critical sectors such as robotics and automation, healthcare, education, and scientific research. However, this rapid development raises legitimate concerns about its potential impacts on human autonomy, privacy, and economic equity.

Given these facts, the promising capabilities of AI to enhance human quality of life must be carefully balanced with the accompanying ethical and societal challenges. Such challenges include issues such as safeguarding personal data, addressing potential deepening of social and economic divides, and ensuring fairness in its applications. Addressing these complex issues necessitates an integrated governance framework, comprehensive legislative policies, and a firm commitment to aligning AI applications with the ethical and cultural values of human societies.

Ultimately, the future of this AI hinges on the international community's ability to craft an impartial strategic vision that ensures AI serves humanity effectively and responsibly.

Artificial Intelligence
in a Special Interview



Qatar University students have made significant strides in the field of Artificial Intelligence (AI), as the university provides an advanced educational environment characterized by high professional standards that contribute to producing exceptional graduates aligned with the demands of the job market and scientific and professional development. Here, we meet Jeham Helal Al-Kuwari, a student in the Computer Engineering and Science program at the College of Engineering at Qatar University, to shed light on his experience in this field.



Interview with: Jeham Helal Al-Kuwari

Department of Computer
Engineering and Science, College of
Engineering - Qatar University

Jeham, how do you introduce yourself to the readers of Qatar University Research Magazine?

I am Jeham Helal Al-Kuwari, a student in the Department of Computer Engineering and Science at the College of Engineering, Qatar University. My passion for technology started at a young age when I enjoyed understanding how the electronic devices around me worked. As I progressed in my studies, I discovered that AI is not just a future technology, but a transformative force capable of improving people's lives and solving complex problems in innovative ways.

I found in this field a platform to achieve my ambitions and apply my skills in developing smart solutions that serve society and enhance the quality of life. I aspire to contribute to making modern technologies more inclusive and sustainable, and to be part of the transformation taking place in the upcoming industrial revolution. For me, AI is not just an academic discipline, but a passion that drives me to explore new horizons and work on projects that make a tangible positive impact.

As an engineering student, what attracts you to the applications of artificial intelligence? And has it become a part of the university student's journey?

What attracts me to AI applications is their remarkable ability to solve complex problems in innovative and creative ways that go beyond traditional solutions. I am fascinated by the ability of intelligent systems to learn from data and analyze it with high precision, which opens up vast possibilities in various fields—from improving healthcare in medicine, to enhancing productivity in agriculture, to exploring space and dealing with uninhabited environments.

For university students, AI has become an essential and influential element in our academic and professional development, as it has become an integral part of curricula and research projects that contribute to developing our skills. We learn how to design algorithms, build smart models, and analyze data in advanced ways, which makes us more prepared to face the challenges of the future. AI not only provides tools for solving problems, but also opens up avenues for creativity and innovation in all aspects of life.

We know that your graduation project is related to artificial intelligence. Could you tell us more about it?

My project aims to develop a drone that uses AI to improve responses to natural disasters and major accidents. The drone relies on a computer vision system and deep learning techniques to analyze images and data captured during search and rescue operations.

The drone works by identifying the locations of victims trapped under rubble using advanced radar sensors that rely on wireless wave reflection and high-definition images. The AI model analyzes the data to determine whether a human presence is detected, and the result, along with the location, then it is sent in real time to rescue teams via 5G networks, which accelerates the decision-making process.

The goal of the project is to reduce response time and improve the efficiency of rescue operations, contributing to saving lives and reducing human risks during disasters. The drone offers an innovative solution that combines speed and accuracy to serve rescue teams and affected communities.

Do you expect the debris detection drone to gain popularity in industrial use?

Yes, I expect the drone to gain significant popularity in disaster management due to its ability to quickly and accurately identify the locations of victims trapped under rubble. This technology is a revolution in emergency response, as it helps reduce human risks and accelerates rescue operations, making it an indispensable tool.

With the use of AI techniques and advanced sensors, the drone provides high accuracy in collecting and analyzing data, which improves the efficiency of rescue teams and their decision-making in the field. With support from governments and humanitarian organizations, this drone could become an integral part of emergency management plans both locally and internationally.

The global desire to improve efficiency and reduce response time, coupled with the need for innovative solutions that minimize human risks, makes this technology an attractive and future-oriented option. The drone is not just a technical tool; it is a practical model for automating vital operations and could contribute to changing how we handle natural disasters and major accidents in the near future.

In your opinion, what are the main advantages and disadvantages of artificial intelligence?

AI is characterized by its ability to improve efficiency and productivity across various fields. It provides innovative solutions and reduces human errors, making processes more accurate. AI contributes to the development of advanced services such as medical diagnostics and smart education.

However, it faces challenges such as job loss due to automation and privacy concerns. AI can also exhibit biases if not trained properly. Additionally, complete reliance on AI could lead to significant problems in the event of technical failures.

What do you think about the University's efforts in supporting artificial intelligence and its role in encouraging students to achieve excellence and creativity?

Qatar University is making outstanding efforts in supporting AI, starting from updated curricula that align with the latest technologies, to research projects that encourage students to be creative and innovative. The labs equipped with the latest technological tools, in addition to collaborations with leading global institutions, offer students unique opportunities to develop their skills and keep up with the rapid advancements in this field.

The University also ensures the hosting of high-level AI competitions and conferences, giving students the chance to present their ideas to global experts. Furthermore, the University provides workshops and practical training programs that help prepare students to be ready for the job market and future requirements, with a focus on innovation and creativity.

Tell us about your future plans and what you aspire to achieve in this field?

In the future, I aspire to work in the field of AI, applying the skills I've gained at the University to projects or tasks that serve the community and enhance efficiency in vital areas. My goal is to improve the use of smart technologies in our daily lives, such as developing tools to facilitate disaster response or enhance the quality of services in education, healthcare, and transportation.

I also aim to continue developing myself through lifelong learning and working in areas that deepen my knowledge of AI and its advanced techniques. I focus on creating innovative and simple solutions that address real needs and make technologies more accessible and usable for everyone. My ultimate goal is to leave a tangible impact by using these technologies to contribute to technological progress and society, helping to create a better and more sustainable future.



Interview with: Artificial Intelligence Association

Students at Qatar University participate in various associations to build networks of interaction among students and alumni, helping them develop their scientific and professional skills across multiple disciplines. In this issue, we are delighted to introduce the Artificial Intelligence Association, which was established in September 2021, and its role in enhancing scientific knowledge. Here, we meet Kaoutar Barakat, a graduate student in the Doctor of Pharmacy program at Qatar University and the association's chair.



Student Kaoutar Barakat, the association's chair.

How did the idea of establishing the AI Association begin, and why?

The idea emerged in response to the rapid developments in the field of artificial intelligence (AI) and its impact on various aspects of life, says Kaoutar. The primary goal was to create a pioneering platform, the first of its kind in the Middle East, bringing together students interested in AI. It provides them with opportunities to learn, collaborate, and apply their knowledge practically. Through the association, practical understanding of AI is enhanced and linked to real-world challenges facing Qatari and global communities, Kaoutar adds. The founders Mr. Moslem Al-Qawasmi, Founder of AIQU and Mr. Yaman Kutmawi, Co-Founder, believed in the importance of students taking an active role in driving technological innovation and recognizing the Qatar Vision 2030.

How are you guided and mentored in this association?

The association receives academic and professional guidance from professors and experts in the field of AI at Qatar University. Faculty members provide mentorship on technical topics, scientific research, and methods for applying AI to solve real-world problems, says Kaoutar. We take this opportunity to extend our sincere gratitude and appreciation to Dr. Abdulaziz Al-Ali, Assistant Professor of Computer Engineering, College of Engineering, for his efforts in guiding and mentoring the association during the past period, and to Dr. Wadha Labda, Head of Technology Innovation and Engineering Education Unit, College of Engineering, for her ongoing efforts as the current advisor to the association, which undoubtedly contributed to its progress and success, she says.

Additionally, the association receives support and guidance regarding event organization and all related activities from the Students Clubs and Organizations Department at Qatar University, under the Student Activities Department. We would like to thank Mr. Yasser Al Qawasmi, Head of Students Clubs and Organizations Department, for his continuous efforts and dedication in supporting and guiding the association toward achieving success, as well as Mr. Anas Abu Yousef, the association's student program advisor, for his ongoing support.

The association is also keen on benefiting from the expertise of sponsoring organizations and local and international institutions through partnerships and joint workshops. These collaborations help guide students toward using AI responsibly and creatively.

What are the key annual events and activities supervised by the association?

The association organizes many significant events throughout the year, most notably AI Week, the largest annual event, which has been held for the past three years. AI Week includes a series of training workshops, scientific seminars, and lectures held by local and international experts. It also features AI challenge competitions where students can present their innovative ideas and projects. A concurrent exhibition showcases innovative solutions and applications from startups, companies, and sponsors in AI fields, says Kaoutar.

Another notable event is the AI Innovation Program, the official training program for the Qatar IoT & AI Challenge. Over several weeks, students are trained in AI and IoT technologies to create their projects, culminating in a qualifying competition where top participants advance to the finals held during GITEX Dubai, one of the region's largest tech exhibitions. Additionally, the association organizes hackathons, educational workshops targeting schools and youth, and participates in international competitions like the Arab IoT & AI Challenge at GITEX Global, offering students opportunities to explore global advancements and build professional networks. It also hosts discussion sessions on the future of AI in Qatar and its applications in various sectors, Kaoutar adds.

When you graduate from Qatar University, what benefits do you gain from joining such associations?

Joining the Artificial Intelligence Association offers numerous advantages, such as developing practical and technical skills in one of today's most vital technological fields. The association provides an inspiring environment for teamwork and participation in real-world projects, helping students gain practical experience that enhances their employability. Additionally, membership opens doors to expand professional networks within and beyond Qatar, a valuable asset for students aiming to work or pursue

higher education in AI. It also boosts self-confidence, innovation, and critical thinking skills, she says.

Does the association's activity focus solely on campus, or does it extend beyond the university?

The association's activities extend well beyond the campus. It organises events and participates locally, such as in Qatar's tech conferences, and internationally, such as GITEX Dubai, where graduates of the AI Innovation Program showcase their projects and interact with global AI experts. The association also engages with the local community through awareness and training workshops in collaboration with schools and community organizations. This wide outreach strengthens the association's position as a leading AI platform in Qatar and globally, conveys Kaoutar.

Tell us about the support the association receives from the University and other entities.

The association benefits from diverse support from Qatar University, including financial and logistical resources for organizing events, as well as an educational environment that fosters skill development for its members. It also leverages partnerships with tech companies and local as well as international organizations, which actively support these initiatives. For example, Vodafone Qatar, a partner in the association's success, has sponsored events like AI Week and the AI Innovation Program, along with offering technical training programs that enable students to use the latest AI tools and technologies, Kaoutar said.

In your opinion, what role does AI play in achieving Qatar's Vision 2030?

AI plays a crucial role in supporting Qatar's Vision 2030, which aims to build a knowledge-based, diversified economy. AI applications can enhance the efficiency of vital sectors such as education, health, and the economy, while fostering innovation in infrastructure and transportation. Kaoutar

concluded by saying that, AI also promotes environmental sustainability by developing smart solutions for managing natural resources and renewable energy. Furthermore, it supports the digital transformation of institutions, making them more globally competitive.





Qatar Delves into the Earth:
**AI Unveils the Secrets
of Soil, Water, and
Plants for Environmental
Sustainability**

Dr. Noora Al-Qahtani

Research Assistant Professor in Materials Science and Engineering, Center for
Advanced Materials - Qatar University



Introduction

Qatar faces significant environmental and agricultural challenges due to its harsh climatic conditions, including high temperatures and scarce rainfall. These factors contribute to water scarcity, soil salinity, and hinder sustainable agricultural production—challenges that are critical to the nation's food security. In response, Qatar has embraced a forward-thinking vision for sustainable development, launching a multidisciplinary and collaborative research project involving academia and government.

This initiative is led by a team from Qatar University under the supervision of Dr. Noora Al-Qahtani. The team comprises graduates and undergraduate students from the Colleges of Arts and Sciences and Engineering, along with high school students participating in training programs. The project is in collaboration with the Ministry of Municipality's Agricultural Affairs Department and Agricultural Research Administration.

The project employs Artificial Intelligence (AI) and the Internet of Things (IoT) to monitor soil, water, and plant health through a network of sensors that collect real-time data on soil moisture, pH, nutrients, water quality parameters, and plant characteristics. This data is processed to provide actionable insights enabling farmers and experts working in the agriculture sector to make informed decisions about irrigation, fertilization, and resource management. This approach boosts crop productivity, minimizes resource consumption, and promotes sustainable agricultural practices aligned with Qatar National Vision 2030.

Data Collection and AI Analysis

Figure 1 shows the entire system, showcasing how the system starts by collecting data from soil, water, and plant sensors, including key parameters such as soil moisture, pH, temperature, and nutrient levels, as well as water quality parameters like turbidity, dissolved oxygen (DO), and salinity. Data is transmitted via an ESP32 microcontroller using the MQTT (Message Queuing Telemetry Transport) protocol through Azure IoT Hub, either via Wi-Fi or LoRa (Long Range) for areas with limited connectivity. Upon reaching the cloud, the

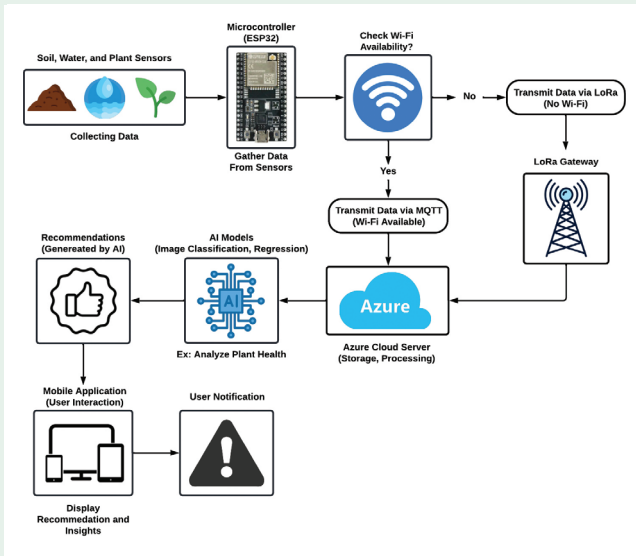


Figure 1: System Architecture and Workflow.

data becomes stored in an Azure SQL database for structured data and analyzed using Azure Time Series Insights for temporal trends. Advanced AI techniques are applied:

- **Regression Models** predict irrigation needs based on weather and environmental changes.
- **Convolutional Neural Networks (CNN)** analyze plant images to detect diseases or nutrient deficiencies using Azure Custom Vision.
- **Integration with Geographic Information Systems (GIS)** ensures location-specific recommendations, enhancing resource efficiency and sustainable agricultural performance.

Real - Time Alerts and Recommendations

A key feature of the system is its ability to provide instant notifications/alerts and recommendations. Automated actions, such as triggering irrigation when soil moisture drops below thresholds, are activated based on real-time data analysis. Notifications about nutrient management are sent directly to users. Users can access these insights via an interactive interface displaying data through graphs and dashboards. Figure 2 illustrates the initial design of the mobile app, showcasing features including real-time soil, water, and plant health indicators, as well as user instructions for optimal usage. Recommendations are supported by cloud-based storage, enabling access via mobile devices for comprehensive long-term monitoring. These

features empower farmers and experts to make informed decisions, optimize resource use, and reduce manual interventions.

Significance for Qatar

This project represents a strategic step in supporting national efforts toward environmental sustainability in Qatar. With soil and water quality serving as the foundation for agricultural development and resource sustainability, the project provides precise and comprehensive data on the characteristics of these vital resources. This enables stakeholders to guide policies and investments toward enhancing food security and improving water-use efficiency, in alignment with Qatar's National Vision 2030. Additionally, the project modernizes the agricultural sector by equipping it with advanced technology and fosters collaboration between academic institutions and government entities, helping to identify Qatar's environmental needs and align them with the latest scientific advancements. Coordination has already taken place with the Ministry of Municipality and Environment to ensure the project's results are aligned with national plans.

Empowering students

The project also includes active student participation, offering hands-on training in the latest artificial intelligence and environmental technologies. Involving both undergraduate and high school students, participants gain field experience through data collection and sample analysis using advanced tools. This experience encourages students to engage in scientific research and develop effective problem-solving skills, enhancing

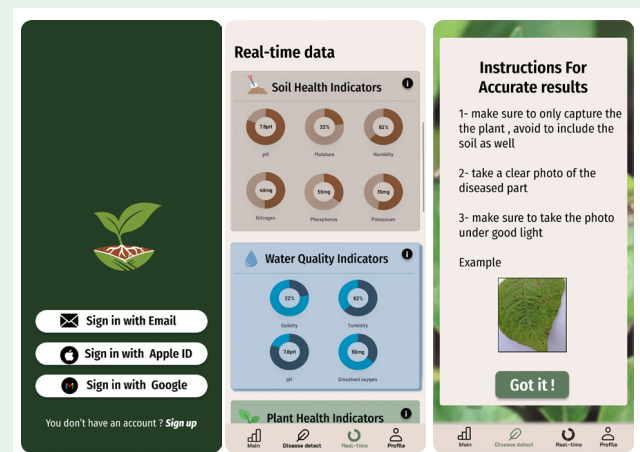


Figure 2: Initial Program Design.

their abilities to tackle environmental challenges with modern technological solutions. Through this involvement, students interact with experts and decision-makers, which hones their leadership and research skills and deepens their understanding of Qatar's environmental challenges and ways to actively address them.

Challenges and Solutions

The project faces challenges such as managing and accurately analyzing large datasets. Addressing these challenges involves advanced AI tools and intensive training for students and researchers. Partnerships with international institutions specializing in environmental data analysis and internal training programs have been established to overcome these obstacles.

Expected Outcomes

The project is anticipated to deliver innovative results, enhancing Qatar's capacity to address environmental challenges. Interactive maps of soil distribution and water quality will aid in agricultural planning, pollution mitigation, and sustainability.

These outputs will directly contribute to efficient policymaking, supporting a green economy and bolstering water and food security.

Agricultural Sector Benefits

Agriculture stands to benefit significantly from this project. Precise soil and water analyses will enable farmers to optimize resource use, reduce reliance on chemical fertilizers and pesticides, and sustainably increase productivity. Additionally, water quality data will inform better resource management strategies, ensuring sustainable utilization of these critical inputs. This research initiative, led by Qatar University in collaboration with the Ministry of Municipality, sets a benchmark for employing AI in soil and water analysis to achieve sustainable development. Through academic and field collaboration, it bridges scientific innovation with Qatar's strategic needs, offering groundbreaking environmental solutions. With the expected outcomes, this project will have a long-term impact on key sectors like agriculture and water resource management, supporting Qatar's vision of comprehensive environmental and economic sustainability.



During the research team visit to Hayat Water Factory to observe the process of adding materials to the water.

Artificial Intelligence to Enhance the Efficiency and Reliability of AI-BAMS In Smart Sustainable Buildings

Dr. Fodil Fadli

Associate Professor of Architecture and Urban Design, College of Engineering - Qatar
University



Dr. Fodil Fadli



Our world is facing a tremendous challenge of Climate Change initially labelled as “Global Warming” which recently shifted to the alarming “Global Boiling.” This has brought in a lot of negative impact to our natural and built environment. We, as humans, cause major damages to our planet and environment due to our lifestyle and the exaggerated consumption rates of energy, water, and other resources. Since, we consume large amounts of energy and water, we produce large amounts of CO₂, in turn, which damages the environment.

Over the last few decades, we have witnessed a major global rise in urban populations accounting to almost 75% of the world population. Energy consumption in buildings has become a critical issue, currently accounting for approximately 35% of the total global energy use.

In order to mitigate those negative impacts and deliver resilient solutions to promote smart sustainable buildings and cities which would provide environment-friendly processes and tools through the legacy of the SPORTE.3Q research project led by Dr. Fodil Fadli [LPI] and his Qatar University-based research team and the Cardiff University collaborating research team. The SPORTE.3Q Research project provided multitude of relevant and impactful research outputs such as the highly-cited journal paper: “AI-big data Analytics for Building Automation and Management Systems: A Survey, Actual Challenges and Future Perspectives.”

The aforementioned unique study highlighted the importance of designing, developing and implementing powerful AI-based Building Automated Management Systems [AI-BAMS]. AI-BAMS development is highly important but also very challenging due to frequent fluctuations in energy demand over the daily, weekly, monthly seasonal and yearly usage.

The digitization of building modelling platforms and tools such as Generative Twins [Composition of Generative Artificial Intelligence with powerful Digital Twins Models] aims to enable real-time Building Automated Management Systems inclusive of Energy Management Modules (EM2), forecasting and prediction tools such as the SPORTE.3Q Computational Urban Sustainability Platform [CUSP] model as shown in Figure 1. Initially developed by Cardiff University collaborating team members, it has been enhanced and adjusted to the Qatar context

through the SPORTE.3Q project. The upgrade and adaptation opted for the use of Generative Digital Twin technology alongside IoT devices and advanced data-driven algorithms. This offers substantial upgrades in Building Automation and Energy Modeling, Management and Optimization, Servicing, Maintenance, and Energy-Efficient Smart Sustainable Building Design together with an unprecedented users-machines/buildings real-time interaction [Figure 2].

AI-BAMS have the potential to provide all the necessary tools and functionalities for analyzing, operating, and managing buildings, whether they are simple mono-functional or complex multi-functional structures. However, in practice, these systems primarily focus on controlling, managing and operating heating, ventilation, and air conditioning (HVAC) systems. Consequently, several critical tasks remain the responsibility of the operator, such as evaluating building performance, detecting unusual energy consumption, identifying efficiency improvements, and ensuring user security and privacy. In order to address these gaps, the integration of Artificial Intelligence (AI), Machine Learning (ML) and Big Data Analytics (BDA) has emerged as a promising solution. These advanced technologies offer tailored, innovative approaches that are well-suited for modern and futuristic building automated management systems. Moreover, AI-enabled tools can assist operators in:

1. Analyzing Meta Data sets generated by interconnected equipment, tools and platforms.
2. Making informed, timely, intelligent decisions to enhance building performance.
3. Enabling real-time users-machines/buildings interaction.

This breakthrough innovation developed over the study [legacy of SPORTE.3Q project] provides a thorough systematic development of the application of AI and Big Data Analytics in BAMS. It explores diverse AI-driven tasks, including load forecasting, energy needs and consumption, water management, indoor environmental quality monitoring, and occupancy detection.

The first part of the study elaborates on a detailed taxonomy to examine existing frameworks and

platforms. A comprehensive analysis was conducted on various aspects, such as learning processes, building environments, computing platforms, application scenarios and users-machines/buildings interaction. An in-depth exploration follows, highlighting current challenges and future perspectives in the field. The outcomes of the study focused on real-world applications of AI and Big Data Analytics in BAMSs. It presented three types of buildings and facilities as pilot studies (including the A07 Multi-Purpose Sports Hall building in Qatar University), showcasing their utility in:

- Detecting energy anomalies in diverse buildings typologies such as domestic, educational and offices.
- Optimizing energy and water use and performance in sports facilities.
- Predicting energy, water and occupational load and forecasting potential health risks to the users.

To conclude, this innovative study explores and lists futuristic perspectives and delivers unique guidance to improve and upgrade the efficiency and reliability of AI-BAMSs for Smart Sustainable Buildings. To sum-up, SPORTE.3Q team developed an innovative AI-based framework that reached well its aims to reduce energy consumption by approx. 40% and water usage by approx. 20%, leading to substantial CO₂ reductions and cost savings based on the developed modeling and simulation. This pioneering research project [SPORTE.3Q] and derived studies enabled a vision that supports and encourages Qatar's renewable energy potential by helping increase its revenue and decreasing gradually its reliance on natural resources, that are currently reaching up to 60% of Qatar's national economic income. The plus-value is mainly generated through expanded endeavors such as a variety of environmental (reduced GHG emissions), social (improved health, community connections) and contextual (improved comfort) benefits. These goals and targets align well with the Qatar National Vision 2030 strategy and goals.

The AI-enabled BAMS framework consists of different components for real-time measurement, analysis and prediction that provide an end-to-end management solution, from water and energy production to end-user demand/consumption management in sports facilities and stadia, and potentially expandable

to other buildings typologies, urban districts and cities. Innovative computational tools and artificial intelligence techniques leveraging simulation, neural and genetic algorithms reasoning have been utilized to optimize operation scenarios as a major legacy of the tournament's stadiums, facilities and precincts. SPORTE.3Q innovated by designing, developing and applying a pioneering AI-based platform to enable futuristic Smart Sustainable Buildings in the follow-up proposed and recently awarded research project SPORTE.4AI.

The SPORTE.3Q project team comprises of multidisciplinary experts from College of Engineering in Qatar University and Cardiff University, UK. From Qatar University, the team includes Dr. Fodil Fadli (Lead Principal Investigator), Associate Professor of Architecture and Urban Design, Prof. Nader Meskin, Professor of Electrical Engineering, Dr. Ahmad M. Ahmad, Assistant Professor of Architecture and Urban

Planning, Dr. Yassine Himeur, Research Associate (former), Eng. Mariam Elnour, Research Assistant; and Architect. Hamdi Ahmed Mohammedsherif, Research Assistant. Representing Cardiff University, the team includes Prof. Yacine Rezgui (Professor), Dr. Ioan Petri (Associate Professor), and Eng. Andrei Hodorog (Research Assistant), from the School of Engineering and BRE Trust Centre on Sustainable Engineering. This collaboration integrates expertise in sustainable architecture and urban design, sustainable engineering, electrical engineering, computer science and artificial intelligence to advance the project's objectives.

Acknowledgement: This publication was made possible by NPRP Grant No. NPRP12S-0222-190128 from the Qatar National Research Fund (a member of Qatar Foundation).

For more about the project:

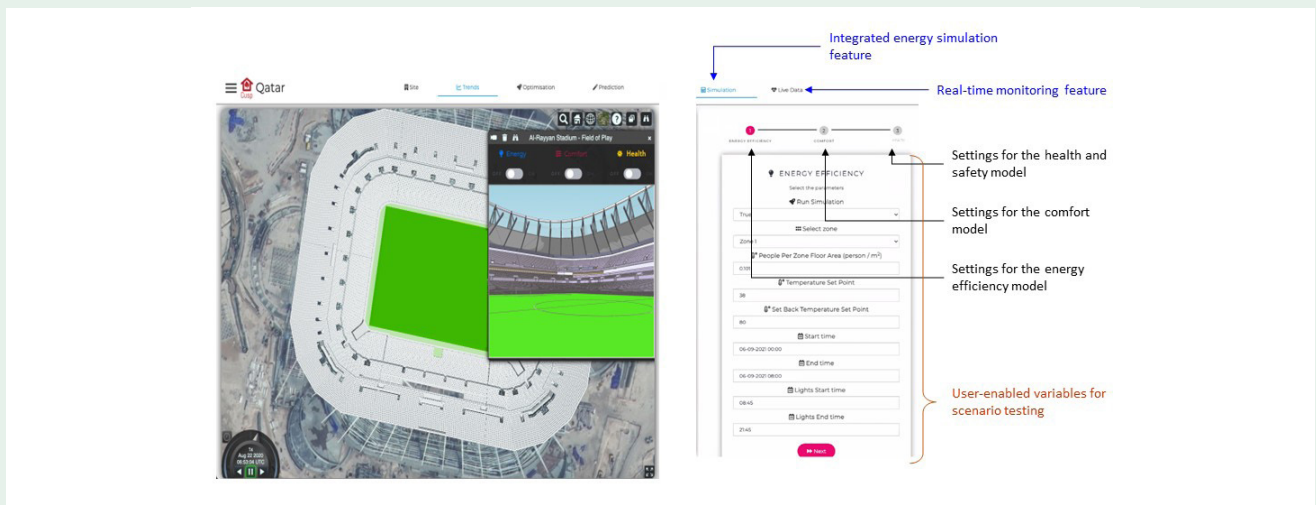


Figure 1: The CUSP model on the web server [SPORTE.3Q project website].

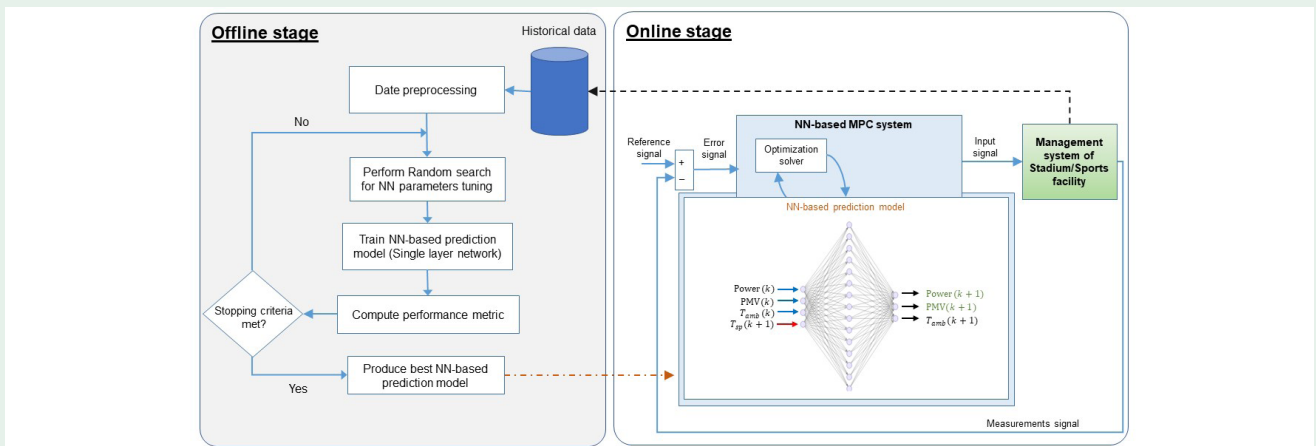


Figure 2: The CUSP model with three integrated models for efficiency, comfort, and health & safety.

AI-Enhanced Leak Detection in Oil and Gas Pipelines with Digital Twin Technology

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Wahib Ahmed Al-Ammari, Research Assistant, College of Engineering - Qatar University

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From the left: Wahib Al-Ammari, and Prof. Ahmad Sleiti.

In the oil and gas industry, pipeline leaks are not only considered a significant environmental hazard but also serve as a threat to operational integrity and business viability. Detecting these leaks early and accurately can save resources and prevent disasters. While traditional methods of leak detection are effective, the complexity and vast scale of offshore pipeline networks call for more innovative solutions. One such cutting-edge solution is the implementation of artificial intelligence (AI)-driven digital twin technology.

What is a Digital Twin?

A digital twin is a virtual representation of a physical asset. In the case of pipeline leak detection, the digital twin mirrors the entire pipeline network, allowing for real-time monitoring, predictive maintenance, and advanced data analysis. This virtual model is continuously updated with live data from sensors installed on the actual pipelines. By integrating sensor data, machine learning algorithms, advanced visualization, and AI techniques, the digital twin can simulate the behavior of the pipeline under various conditions, including leak scenarios.

The digital twin approach goes beyond just mimicking the pipeline's physical structure. It incorporates real-time data streams, environmental conditions, and historical performance, thereby, allowing for an accurate representation of the pipeline's operational state. This technology is particularly useful for offshore pipelines, which are harder to access and monitor due to their remote and harsh environments.

The Role of Visual Twins in Leak Detection

One of the most significant innovations in digital twin technology is the concept of the visual twin, which combines the digital twin model with high-fidelity visualization powered by gaming engines. These visualizations allow operators to interact with the digital twin in a dynamic and engaging way. For instance, in the context of pipeline leak detection, a visual twin presents a realistic, real-time visual representation of the subsea pipeline (See Figure 1), making it easier for operators to identify potential leaks and understand the conditions around them.

The visualization is powered by live data streams from sensors monitoring pressure, temperature, flow rate, and other key indicators. Afterwards, this data is mapped onto the visual twin, providing a 3D interactive environment where operators can explore the pipeline in real-time. This enhanced situational awareness reduces operator fatigue and cognitive load, making it easier to pinpoint the exact location of leaks and predict their potential impact.

How Digital Twin Enhances Leak Detection

One of the main challenges in pipeline leak detection is managing the vast amounts of data generated

by sensors. Offshore pipelines, in particular, have complex layouts and operate under varying seabed conditions and water depths. This makes it difficult to create accurate mathematical models of fluid flow and pipeline behavior. Traditional methods, such as Extended Real-Time Transient Model (E-RTTM) and acoustic emission detection, are often used, but they fall short when applied to longer pipelines or multiple leak scenarios.

Digital twin technology addresses these issues by incorporating machine learning algorithms, such as Support Vector Regression (SVR) and Artificial Neural Networks (ANN). These algorithms are trained on historical data to identify patterns that indicate leaks. The system can simulate various leak scenarios, including different leak sizes and locations along the pipeline, and predict the likely outcomes. In one recent project, an ANN model achieved an impressive coefficient of determination ($R^2 = 0.9973$) for single leak detection, showcasing the accuracy and reliability of this approach.

In addition, digital twins can detect multiple leaks simultaneously—a significant improvement over traditional methods, which often struggle with multi-leak detection. The ability to analyze data from different sources in real time, combined with advanced visualization techniques, allows operators to quickly identify and respond to leaks.

Applications in Offshore Pipelines

Offshore pipelines present unique challenges for leak detection due to their remote locations, complex environments, and high maintenance cost. However, the implementation of AI-powered digital twin technology offers a promising solution. By using real-time sensor data and integrating it into the digital twin, operators can monitor the health of the pipeline continuously. In the event of a leak, the system provides real-time alerts, allowing for immediate action.

The system's accuracy in predicting leak locations is enhanced by validated simulations, which generate

extensive datasets covering various leak scenarios. These simulations allow for the creation of a database of potential leak patterns, which the machine learning algorithms can use to improve detection accuracy. By visualizing the pipeline environment in 3D, operators can easily assess the severity of the leak and decide on the best course of action.

The Future of Leak Detection

As the oil and gas industry continues to evolve, the need for advanced leak detection systems becomes even more critical. AI-Enhanced digital twin technology, combined with machine learning and high-fidelity visualization, offer a robust solution to the challenges posed by offshore pipeline leaks. The ability to continuously monitor pipelines, detect leaks in real-time, and predict future failures is a game-changer for the industry.

Looking ahead, further advancements in digital twin technology will likely include more complex models that can simulate a wider range of leak scenarios. As more data is collected, machine learning algorithms will become even more accurate, making it possible to predict leaks before they occur. Additionally, the integration of AI into the system will allow for fully automated leak detection and response, further reducing the risk of environmental damage and operational downtime.

Conclusion

The deployment of AI-powered digital twin technology for leak detection in oil and gas pipelines represents a significant step forward in the industry. By combining real-time sensor data, machine learning algorithms, and interactive visualizations, digital twins provide unparalleled accuracy in detecting and managing pipeline leaks. This innovative solution not only improves operational efficiency but also helps safeguard the environment through ensuring that leaks are detected and addressed as quickly as possible. As this technology continues to evolve, it will undoubtedly set new standards for pipeline monitoring and leak detection in the upcoming years.

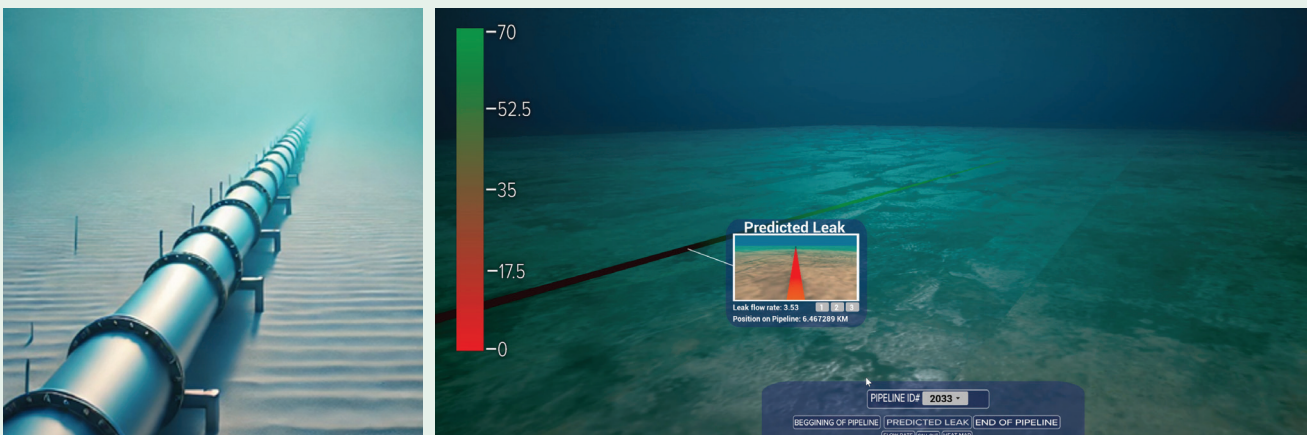


Figure 1: Pipeline on the sea floor (left), Digital/visual presentation of the pipe with predicted leak location (right).

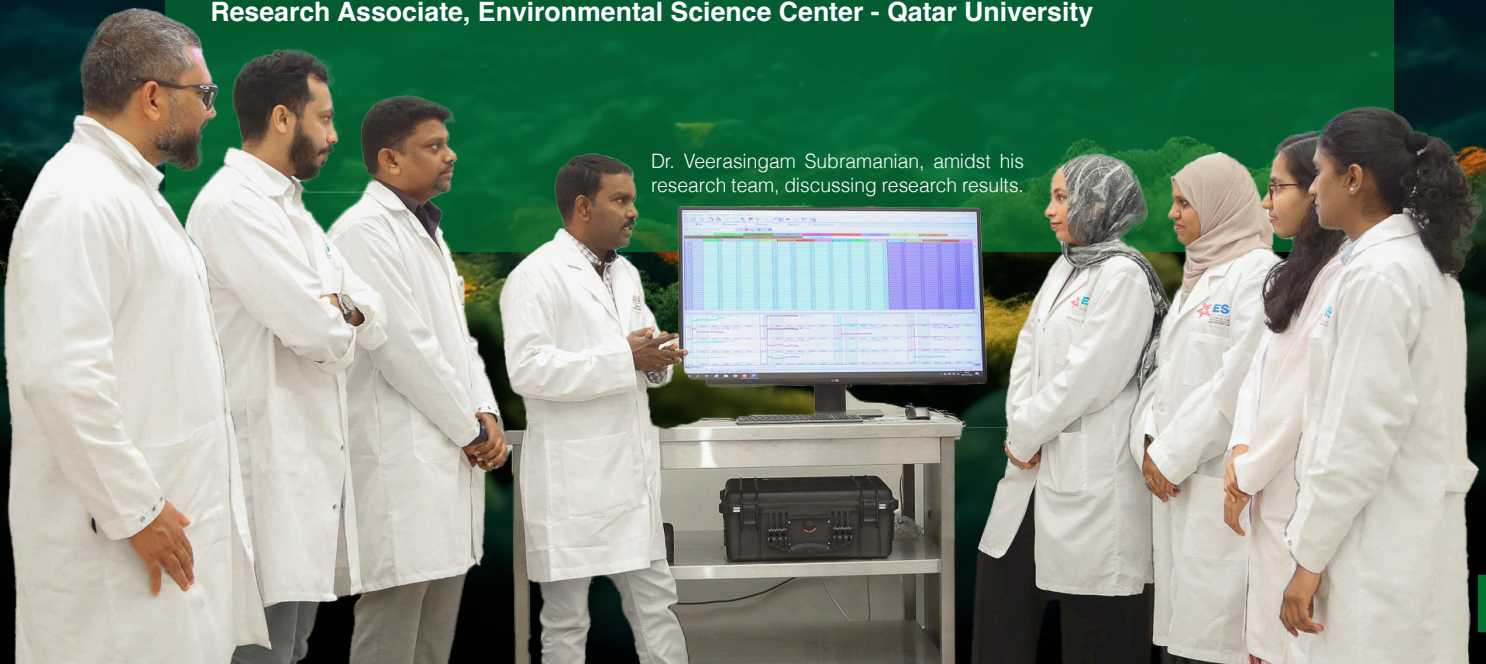
Harnessing Artificial Intelligence to Protect
the Arabian Gulf:

Tackling Biofouling, Litter, and Microplastics

Dr. Veerasingam Subramanian

Research Associate, Environmental Science Center - Qatar University

Dr. Veerasingam Subramanian, amidst his
research team, discussing research results.



The Arabian Gulf is one of the world's most ecologically and economically rich marine regions, providing habitat for diverse marine species and supporting commercial fisheries, tourism, and international shipping routes. However, this region faces several natural and anthropogenic pressures, such as biofouling, marine litter, and microplastics, threatening marine health, biodiversity, and human well-being. Traditional monitoring and management approaches are costly, labor-intensive, and limited in scale, highlighting the demand for more innovative and efficient solutions.

Artificial intelligence (AI) offers revolutionary possibilities for enhancing environmental management, particularly through advanced data analytics, real-time monitoring, and predictive models. AI technologies such as machine learning (ML), deep learning (DL), and computer vision (CV) have proven effective in various fields, such as marine conservation. To address these challenges, researchers at the Environmental Science Center (ESC) are applying advanced AI techniques with funding from Qatar University.

Tackling Biofouling with AI

Biofouling, the accumulation of sessile organisms on submerged surfaces such as ship hulls, marine structures, harbor/port facilities, and aquaculture installations, is a notable issue in the Arabian Gulf due to its warm and nutrient-rich waters. Biofouling increases fuel consumption and greenhouse gas emissions in ships, and damages marine infrastructure. Additionally, it contributes to the spread of invasive species, disrupting local ecosystems. Our team examined the level of biofouling on the hull and propellers of the QU research vessel Janan (Figure 1a). During dry-docking, extensive fouling organisms were removed using mechanical cleaning and antifouling coating techniques, both costly and time-consuming. Therefore, we conducted a biofouling monitoring survey using a remotely operated vehicle (ROV) to generate a preliminary biofouling dataset for the research vessel Janan (Figure 1b-d). An AI-based computer vision model integrated with the ROV is in development to create an autonomous hull-cleaning robot that uses reinforcement learning to adapt and improve its cleaning efficiency in the Arabian Gulf's marine environment.

Combating Marine Litter with AI

Marine litter, such as plastics, discarded fishing gear, and other debris, poses a major threat to marine life and ecosystems in the Arabian Gulf. It causes physical harm, entanglement, ingestion,

and habitat destruction, ultimately resulting in reduced biodiversity and ecological health. Recently, we found that marine litter facilitates the transfer of non-native species across the Arabian Gulf by allowing organisms to 'hitchhike' to new environments (Figure 1e). Our team conducted a marine litter survey using smartphone video recordings along the mainland and islands of exclusive economic zone (EEZ) of Qatar (Figure 1f). These videos were analyzed using the AI-based real-time object detection model 'YOLO' (You Only Look Once) to identify and classify marine litter (Figure 1g, h). Expanding this AI-based model across all Gulf countries would enable real-time monitoring, swift response actions, and better collaboration among neighboring countries.

Addressing Microplastics through AI

Microplastics, tiny plastic particles ranging from 0.1 μm to 5 mm, have become a major global environmental concern, especially in semi-enclosed seas like the Arabian Gulf, where they pose a significant threat to ecosystems and human health. Microplastics originate from various sources, including the breakdown of larger plastic items, wastewater discharges, and industrial activities. Microplastics have been reported in air/atmospheric dust, water, soil/sediment, biota, and table salt in countries along the Arabian Gulf. Our team conducted outreach activities to raise awareness about microplastic pollution and train high school students through a Qatar Research Development and Innovation Council (QRDI) funded research project (HSREP04-1018-220008). Activities included hands-on workshops, laboratory demonstrations, and mentorship programs to introduce students to scientific research and environmental conservation. We studied microplastics in four different commercial fish species purchased from supermarkets in the State of Qatar (Figure 1 i-l), automatically counting their presence using an AI-based object detection model (YOLO). Various AI algorithms, to improve microplastic detection accuracy in environmental matrices like water, sediment, fish, salt, and atmospheric dust.

Atmospheric deposition is a key pathway for microplastics to enter the ocean, contributing to the increasing concentration of plastic particles in the marine environments. These particles can affect ocean biogeochemical processes, such as carbon cycling. To address this issue in the EEZ of Qatar, we recently initiated a study to examine the influence of dust activities on the indoor and outdoor microplastics and radionuclides in Qatar using geochemical, spectroscopic and AI techniques, under the QRDI funded project (CCEC01-1029-230098).

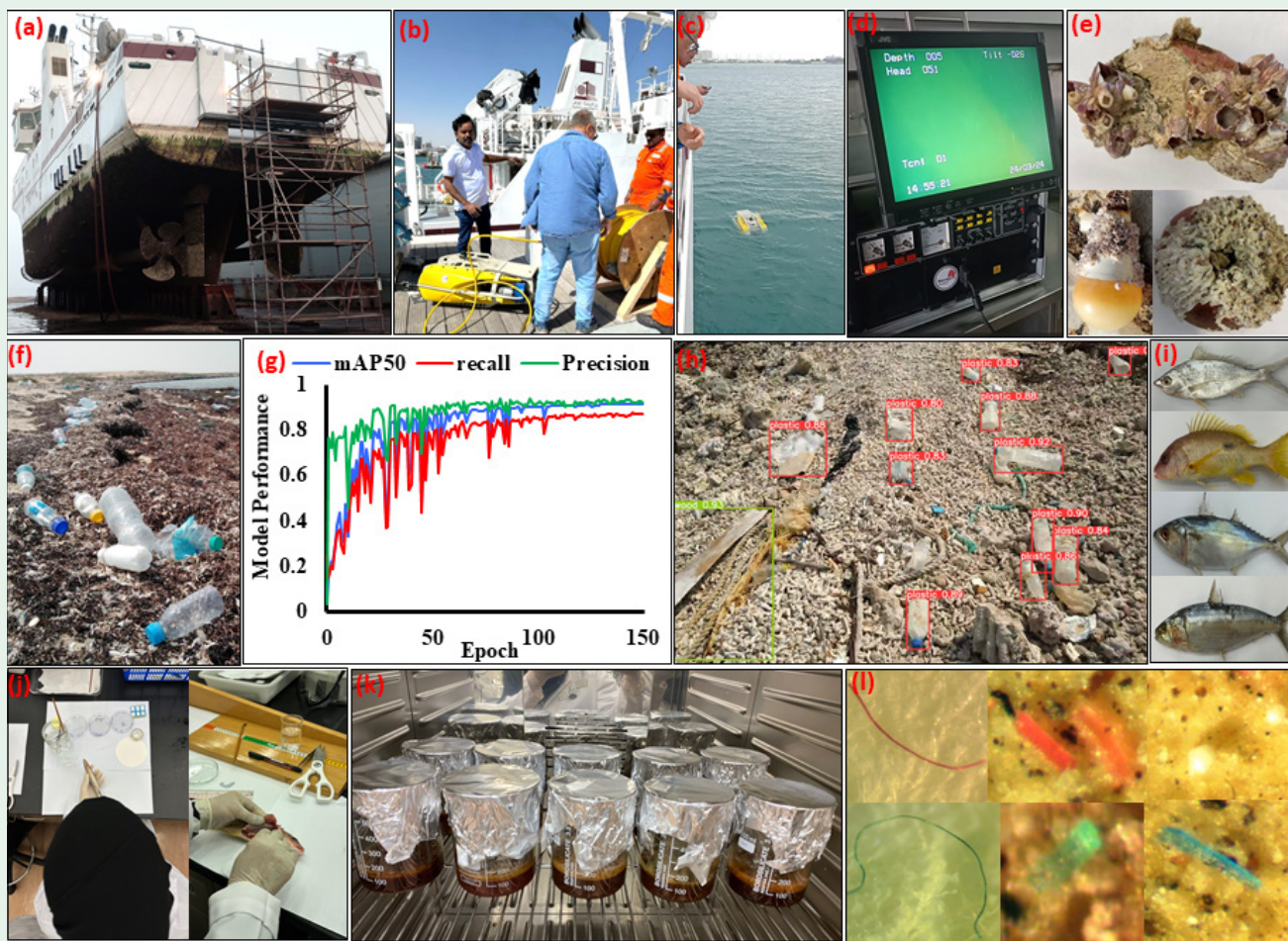


Figure 1: Application of artificial intelligence to tackle biofouling, marine litter and microplastics: (a) Biofouling on research vessel Janan; (b-d) ROV survey of hull and propellers; (e) Hitchhiking organisms on marine litter; (f) Marine litter deposition along the Qatar coast; (g, h) AI-based object detection for marine litter; (i-l) Detection of microplastics in fish species

Microplastics have been detected in sea salt worldwide, highlighting their presence in the ocean and their potential entry into the human food chain. While the use of AI to detect microplastics in food products raises concerns about human exposure, it also presents solutions by enabling large-scale, automated detection and classification of microplastic particles. We have purchased various types of commercial table salts from supermarkets in Qatar under the UREP30-024-1-003 project and examined microplastic levels using spectroscopic and AI techniques. An object detection model was applied to count microplastics extracted from table salts and examined under a stereomicroscope. FTIR spectra of these microplastics were analyzed using various ML models to enhance the accuracy polymer type detection.

Future Potential of AI in Marine Management

AI has the potential to revolutionize the management of marine threats in the Arabian Gulf, offering innovative solutions for tackling biofouling,

marine litter, and microplastics. Integrating AI technologies such as CV, DL, and ML with traditional environmental monitoring techniques enhances detection, quantification, and analysis capabilities. Future developments may include predictive models for biofouling growth and the spread of invasive species, real-time monitoring with AI-powered drones and underwater robots, automated waste sorting and recycling systems, and AI-driven policy recommendations. Although challenges in data collection and model training persist, the future of AI in marine conservation is promising, with the potential to substantially improve the health and sustainability of the marine environment in the Arabian Gulf.

This project is supported by Qatar University (QU) internal grant (QUT2RP-ESC-24/25-343: LPI: Dr. Veerasingam Subramanian, Pls: Prof. Fadhil Sadooni, Prof. Ponnunmony Vethamony, Prof. Jassim Al-Khayat, and Dr. Sankaran Rajendran), and Qatar National Research Fund (QNRF) grants (UREP29-007-1-006 and UREP30-024-1-003).



AI Stroke Diagnosis: **Techniques and Challenges**

Dr. Mohamed Mabrok

Associate Professor of Applied Mathematics, College of Arts and Science -
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Stroke, a devastating cerebrovascular disease, continues to be a leading cause of death and disability worldwide, affecting over 100 million people. Common types of Stroke, (see Figure 1) are ischemic Stroke; caused by a clot or blocked vessel, accounting for 87% of strokes, and hemorrhagic Stroke, caused by a rupture in a blood vessel, leading to blood flooding into the brain. This type has higher mortality and worse outcomes.

As the global population ages and lifestyles evolve, the incidence of strokes is on the rise, placing increasing burden on healthcare systems. In this context, the emergence of artificial intelligence (AI) as a powerful tool in medical diagnosis offers a beacon of hope. By leveraging advanced algorithms to analyze medical images such as MRIs and CT scans, AI has the potential to revolutionize stroke diagnosis, promising faster and more accurate identification of affected brain areas.

The development of artificial intelligence models for stroke diagnosis is heavily based on extensive datasets of brain scans from stroke patients. These datasets should comprise thousands of high-resolution images from diverse patient populations. Subsequently, forming the foundation upon which AI researchers build increasingly sophisticated models. These AI models employ a variety of innovative techniques to analyze brain images effectively. Some take advantage of the natural symmetry of the brain, such as comparing the two hemispheres to detect anomalies. Others utilize multi-scale analysis, including examining images at various levels of detail to identify both small and large stroke-affected areas. Additionally, there is a growing

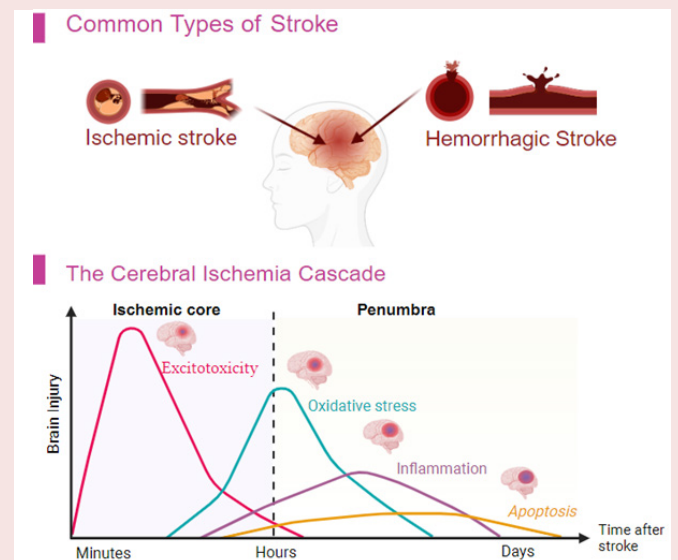


Figure 1: An overview of the epidemiology of ischemic and hemorrhagic stroke.

trend towards 3D analysis, moving beyond the limitations of 2D slice-by-slice examination to capture the full spatial context of the brain.

Despite these promising advances, the field of AI-assisted stroke diagnosis faces several significant challenges. For example, data bias remains a pressing concern. Given that current datasets may not fully represent the diversity of stroke types or patient demographics, potentially leading to skewed results. In addition, the issue of generalization also looms large. To elaborate, models trained on one dataset often struggling to perform well on images from different hospitals or imaging systems. Furthermore, the “black box” nature of many AI models raises questions about transparency and interpretability, making it difficult for healthcare professionals to understand and trust the AI’s decision-making process.

Looking to the future, the research team is exploring various avenues to address challenges and further enhance the capabilities of AI in stroke diagnosis. The researchers at Qatar University are collaborating

with Hyogo University in Japan and HMC in Qatar to develop more advanced models that can handle different types of brain scans and incorporate stroke-specific knowledge. In addition, they are developing anatomy-based approaches that leverage the understanding of brain structure to improve accuracy, particularly for detecting small strokes. They are also working closely on the integration of multi-modal analysis, combining image data with patient symptoms and medical history, to provide more comprehensive and accurate diagnoses, see Figure. 2 for illustration.

As AI technology continues to evolve, it’s crucial to emphasize that these systems are designed to augment, not replace, human expertise. The ideal future of stroke care envisions a synergistic partnership between AI and healthcare professionals, while AI quickly identifies potential areas of stroke and medical experts apply their knowledge and experience to make final diagnoses and treatment decisions. This collaboration has the potential to significantly improve patient outcomes, particularly in areas with limited access to specialist care.

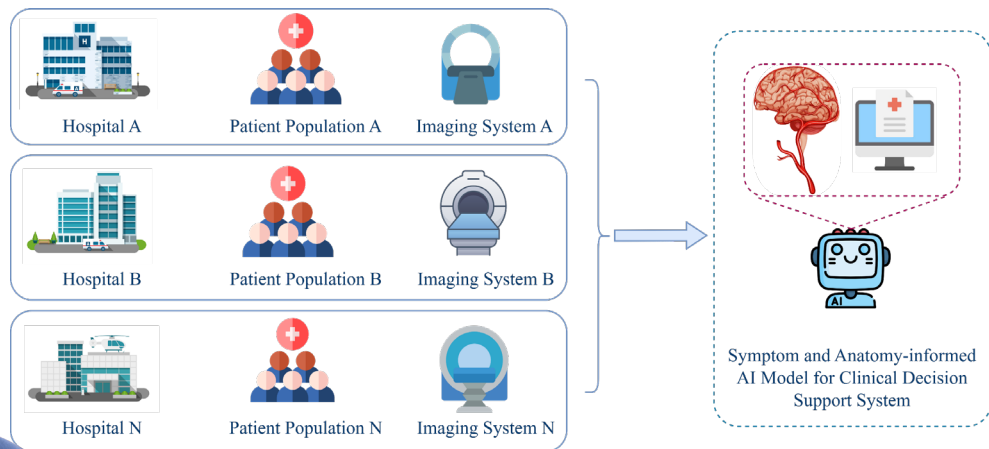


Figure 2: A system for clinical decision support powered by AI, focusing on medical imaging data from different hospitals.

The integration of AI into stroke diagnosis represents a significant leap forward in healthcare, offering hope for earlier detection, more accurate diagnosis, and improved stroke treatment. This progress is not just a triumph of algorithms and data processing; it represents a tangible improvement in healthcare that could save countless lives and enhance the quality of life for millions of stroke survivors around the world.

For more about this research:



Dr. Mohamed Mabrok



Cancer Research from Different
Perspective:

Artificial Intelligence to Combat Colorectal Cancer

Prof. Sergio Crovella

Research Professor, Laboratory Animal Research Center - Qatar University

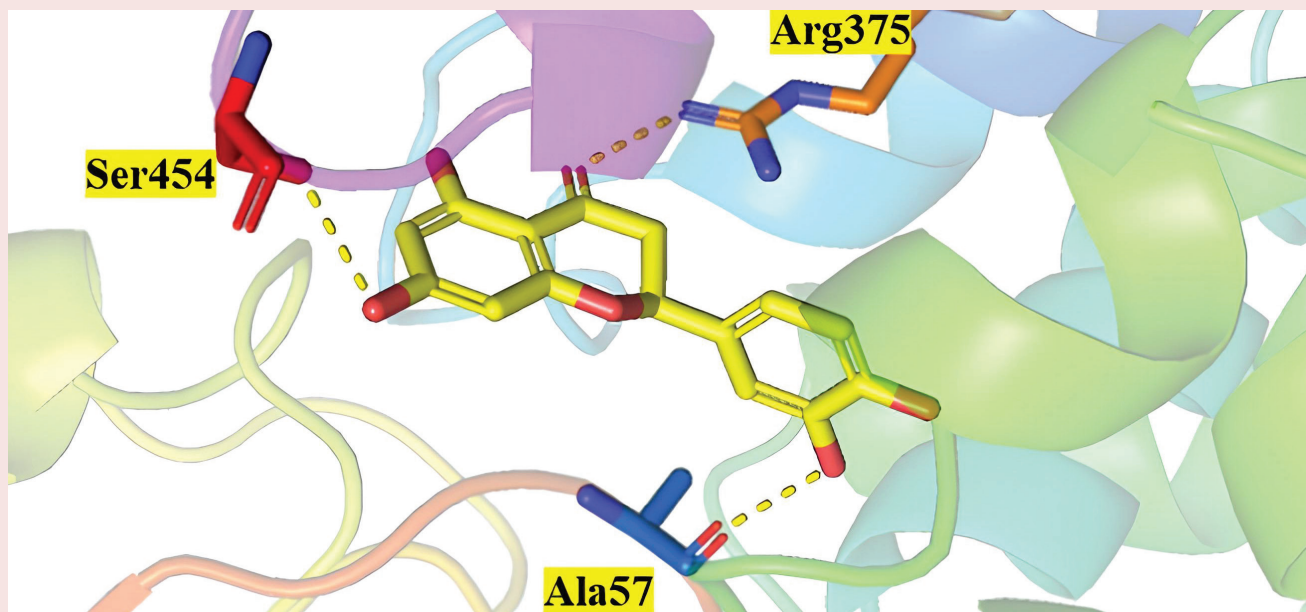


Figure 1: 3D interaction between the target molecule and the in silico designed drug.

Prof. Sergio Crovella is leading a research team at the Laboratory Animal Research Center (LARC) at Qatar University, employing artificial intelligence (AI) in animal research to tackle one of the most challenging types of cancer, colorectal cancer (CRC). Prof. Crovella focuses on developing innovative research that integrates AI to design and discover novel therapeutic molecules, develop accurate rodent models, and create cutting-edge diagnostic tools, all with the ultimate goal of improving both animal well-being and human health.

The research team is at the forefront of AI-driven drug discovery, focusing on the design of new molecules as well as the repurposing of existing drugs that have not yet been utilized for cancer treatment. The team utilizes AI to screen extensive libraries of natural products and synthetic compounds, identifying those with potential efficacy against CRC. This approach targets key molecular pathways involved in CRC progression, such as the Wnt/ β -catenin signaling pathway, EGFR signaling, angiogenesis and others known from biological pathways obtained through OMICs (genomics, transcriptomics, proteomics etc.) analyses.

Once potential drug candidates are identified, the team uses AI to model their interactions with these targets. Through molecular docking and dynamic simulations, AI predicts how well these molecules will bind to and interact with their targets, offering critical insights into their potential effectiveness (Figure 1). This process allows fine-tuning of the

molecular design, optimizing it for enhanced anticancer activity before advancing to further testing.

A crucial aspect of the team's research involves evaluating the biological properties of these AI-designed molecules, including their cytotoxicity, half-life in the bloodstream, and immunogenicity. The LARC research team employs AI to predict these parameters, streamlining the drug development process and minimizing the need for extensive preliminary laboratory testing. LARC's unique research infrastructure allows for accurate testing and assessment conditions for newly synthesized molecules. Cytotoxicity assessments focus on ensuring that the molecules effectively kill cancer cells while sparing healthy cells. AI models analyze the structural features of the molecules to predict their toxicity profiles, allowing the team to make early adjustments that enhance the safety and efficacy of the potential drugs. Half-life in blood is another critical factor in the drug development process. AI tools predict how long a drug will remain active in the bloodstream, which influences dosing schedules and overall therapeutic effectiveness. These predictions are used to design molecules with optimal pharmacokinetic properties, ensuring sustained efficacy with manageable dosing requirements. Immunogenicity predictions are vital for understanding how the immune system might react to the new drug. By analyzing the molecular structure, AI algorithms can forecast potential immune responses, allowing the team to modify the

molecules to minimize adverse reactions, thereby improving the safety profile of the drugs under development.

Following the AI-driven design and evaluation stages, the most promising drug candidates move to in-vitro and in-vivo testing. AI is used not only to design these experiments but also to analyze the resulting data. In-vitro studies involve testing the drugs on cultured cancer cells to assess their efficacy and mechanisms of action. AI optimizes these experiments by predicting the best conditions for testing, such as drug concentration and exposure time.

For in-vivo studies, the team utilizes AI to design and refine rodent models that accurately mimic human CRC. AI predictions help determine the most suitable animal models, including specific mouse or rat strains, dosage levels, and potential side effects. This optimization ensures that the in-vivo studies will provide the most informative data possible, advancing the drug candidates toward clinical trials with greater confidence.

Qatar University's Laboratory Animal Research Center is a world-class scientific facility that develops rodent models of colorectal cancer using AI. These models are essential for preclinical evaluations of new anti-cancer drugs.

Additionally, AI simulations allow to predict how the new drugs will interact with the tumors and surrounding tissues in these models. This predictive power not only enhances the accuracy of preclinical studies but also reduces the time and resources required to bring effective therapies closer to clinical application.

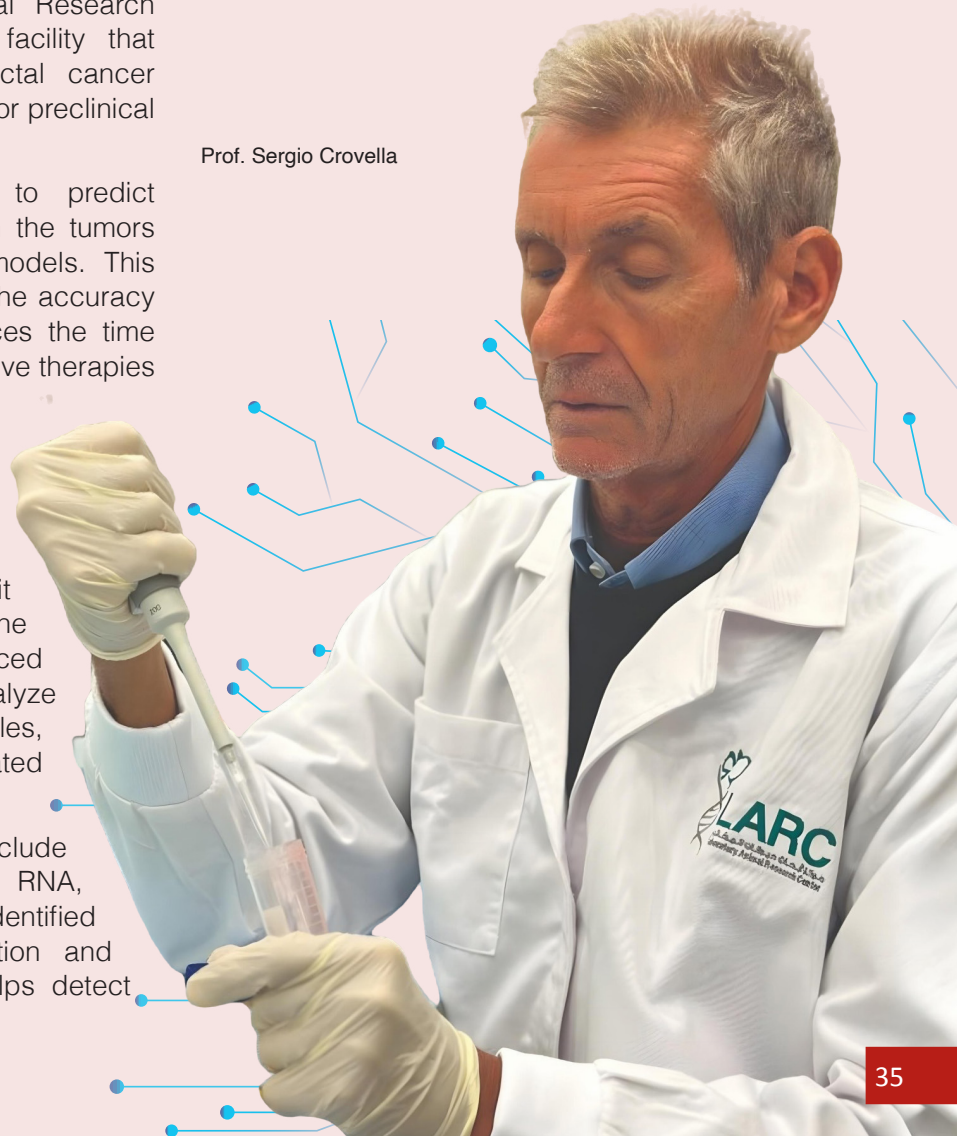
Beyond drug development, the research team is leveraging AI to revolutionize the early diagnosis of CRC. Early detection is critical for improving patient outcomes, as it enables timely intervention before the cancer progresses to more advanced stages. The team is using AI to analyze large datasets of patient blood samples, searching for novel biomarkers associated with CRC.

These biomarkers, which may include circulating tumor DNA (ctDNA), RNA, proteins, and metabolites, are identified through advanced pattern recognition and machine learning techniques. AI helps detect

subtle differences between healthy individuals and CRC patients, leading to the development of blood tests that can diagnose CRC at its earliest stages.

All in all, Dr. Sergio Crovella and his research team at the Laboratory of Animal Research Center (LARC) are at the forefront of integrating artificial intelligence into colorectal cancer research, thereby opening up chances for research collaborations to discover innovative treatments for different types of cancer. Their work encompasses the design and discovery of new and repurposed drugs, the development of accurate rodent models, high quality and reproducible research, and the creation of advanced diagnostic tools, all aimed at combating CRC more effectively. Through the innovative use of AI, LARC research team is accelerating the development of new therapies, improving early detection methods, and ultimately enhancing patient outcomes in the fight against colorectal cancer. As AI technology continues to evolve, its application in CRC research at LARC promises to bring about even more groundbreaking advancements in the years to come.

Prof. Sergio Crovella



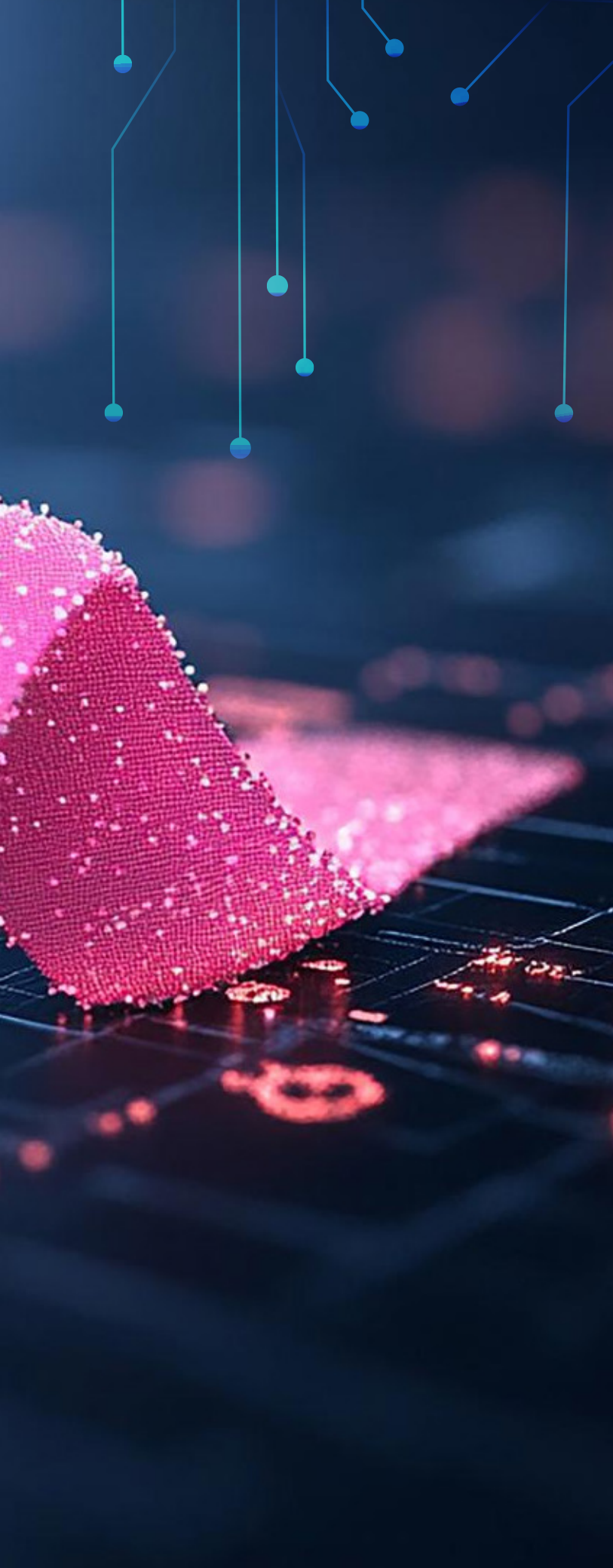
Harnessing AI to Enhance HER2/neu
Breast Cancer Assessment:

A Collaborative Effort at Qatar University

Dr. Semir Vranic, Associate Professor of Pathology, College of Medicine

Dr. Rafif Abdulaziz Mahmood, Assistant Professor of Pathology, College of Medicine

Dr. Muhammad Enamul Chowdhury, Assistant Professor of Electrical Engineering,
College of Engineering
Qatar University



Qatar University's College of Medicine and College of Engineering have partnered to advance the field of breast cancer diagnostics using pioneering artificial intelligence (AI) technologies. Their recent work, published in "Expert Systems with Applications (IF 7.5)," highlights a deep learning-based framework developed to automate HER2/neu assessment in breast cancer. This interdisciplinary collaboration showcases the power of combining medical expertise with AI innovations to tackle one of the key challenges in breast cancer pathology.

The Role of AI in Pathology

AI is rapidly transforming pathology by offering tools that can assist pathologists in diagnosing diseases with greater speed, accuracy, and consistency. In traditional pathology, the evaluation of tissue samples, such as those used in cancer diagnostics, relies heavily on manual analysis, which can be time-consuming and prone to inter-and intra-observer variability. AI models, particularly deep learning, have shown tremendous potential to reduce these variabilities by learning intricate patterns in tissue samples and automating diagnostic tasks.

In areas like cancer diagnostics, AI can assist in identifying malignant cells, classifying tumor grades, and even predicting treatment responses. AI's ability to process vast amounts of data and recognize subtle visual cues in histological images allows pathologists to make more informed decisions, particularly in cases where human judgment may vary. By augmenting human expertise, AI can enhance diagnostic accuracy and efficiency, enabling pathologists to focus on complex cases and improving overall patient care.

Challenges in HER2 Assessment in Breast Cancer

HER2/neu, a protein found on the surface of certain breast cancer cells, plays a crucial role in determining treatment options for patients. HER2-positive breast cancers, which account for 15-20% of cases, are typically more aggressive but respond well to targeted therapies like trastuzumab and pertuzumab. As such, accurate assessment of HER2 status is vital for effective treatment planning.

The standard method for evaluating HER2 is



From the left: Dr. Rafif Abdulaziz Mahmood, Dr. Semir Vranic, and Dr. Muhammad Enamul Chowdhury.

immunohistochemistry (IHC), where pathologists visually assess the intensity and completeness of cell membrane staining. However, this manual method has limitations, including subjective interpretation, variability between pathologists, and challenges in cases with heterogeneous staining. Fluorescence in-situ hybridization (FISH) is often used as a follow-up test for equivocal cases, but it is time-consuming and costly.

Automating the HER2 assessment using AI can address many of these challenges by providing more consistent and objective results. The AI-based framework developed by Qatar University uses deep learning models to analyze digital whole slide images (WSIs) of stained tissue samples. It automatically identifies tumor regions and classifies HER2/neu scores (0, 1+, 2+, and 3+), offering a more reliable alternative to manual scoring. This approach significantly reduces variability and improves the speed and accuracy of HER2 assessments, allowing for faster diagnosis and treatment decisions.

Overcoming Challenges and Future Directions

While AI shows great promise in pathology, several challenges remain with its implementation. One key issue is ensuring the generalizability of AI

models across diverse populations and healthcare settings. AI systems trained on specific datasets may not perform so well on images from different laboratories or patient populations. Additionally, regulatory and ethical considerations around AI adoption in clinical practice, such as ensuring transparency and interpretability of AI decisions, must be addressed.

In the case of HER2/neu assessment, AI has the potential to enhance diagnostic accuracy and reduce inter-observer variability, but further validation is needed to ensure that AI models can handle complex cases, such as those with borderline staining or tumor heterogeneity. Qatar University's collaborative work serves as an important step in this direction, demonstrating how AI can be successfully integrated into clinical workflows to complement human expertise.

As AI technologies continue to evolve, they will likely play an increasingly central role in pathology, aiding in disease detection, diagnosis, and personalized treatment planning. The collaboration between Qatar University's pathologists and engineers/AI experts underscores the immense potential of interdisciplinary approaches in healthcare innovation, driving improvements in patient outcomes and shaping the future of medical diagnostics.

Precision Nutrition in Maternal and
Child Health:

AI-Powered Solutions

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Precision nutrition (PN), also known as personalized nutrition, is an emerging field within lifestyle medicine. It delves into the interplay of genetic and non-genetic factors that influence disease risk and diagnosis. The focus of PN in lifestyle medicine is revolving around disease prevention through identifying genetic risk factors. Factors affecting nutritional health can be either non-modifiable or modifiable. Understanding these factors, whether they can be altered or not, is the center of developing a personalized nutrition plan that considers both non-modifiable and modifiable factors and their interactions. This approach aims to provide a comprehensive profile of patients' health risk, moving towards individualized nutrition care rather than a one-size-fits-all approach.

PN is built upon the foundations of nutrigenetics and nutrigenomics, which connect genetics with environmental factors like lifestyle and diet. These disciplines offer insights into how these factors influence gene expression. While nutrigenetics examine how genetic composition affects responses to nutrients and diets, nutrigenomics focuses on how nutrients impact gene expression. When

combined, they provide a robust understanding of these interactions.

The advantages of PN are substantial, including potential reductions in healthcare costs, extended health and lifespan, and the ability to tailor nutrition plans to a patient's evolving health needs and personal circumstances. Additionally, PN can address personal interests beyond medical necessity, such as enhancing fertility, achieving fitness goals, and improving cognitive performance. Another area of interest is the contribution to developing nutraceuticals and functional foods, thus creating a new dimension of personalized medicine that incorporates genetic variability across different ethnic groups and individuals, thereby advancing precision medicine.

Our research focus is mainly on maternal and neonatal precision nutrition, specifically examining the vital roles of folic acid, thiamine, and vitamin B12. Previous research highlights the need for a comprehensive approach to nutrition for pregnant and lactating women. This approach should include assessments of individual and maternal

Prof. Walid Qoronfleh, and Dr. Sawsan Mohamed.



characteristics, genetics, and microbiota, due to the varying risks and treatment responses associated with different controllable and uncontrollable factors.

It is well-recognized that maternal nutrition significantly affects the risk of metabolic syndromes, nutrient deficiencies, and other health outcomes. PN can enhance prenatal care by promoting optimal health outcomes for both mother and child. Evaluating genetic predispositions and the intrauterine environment helps achieve the best possible outcomes throughout pregnancy and childbirth. Nutrient intake levels, including those of folic acid, thiamine, and vitamin B12, are essential from pre-conception to post-natal and childhood stages. Inadequate nutrition during these crucial periods can lead to developmental issues and increased risks of adverse health outcomes, some of which may be irreversible. Therefore, a PN approach tailored to pregnant women can help reduce the incidence of negative health outcomes through comprehensive assessments, including dietary, genetic, and anthropometric evaluations.

Artificial intelligence (AI) and machine learning (ML) are pivotal analytical tools in nutrition research. Unlike traditional nutritional intervention studies, which often focus on a limited number of nutrients and factors, AI can analyze extensive datasets that encompass a wide range of dietary and non-dietary variables. This capability allows for a more personalized and precise approach to developing nutritional interventions by accounting for each individual's unique factors. AI can also integrate multi-omics profiles to enhance the creation of tailored nutrition strategies. ML, a subset of AI, excels in considering numerous variables in diet patterns and combining them into a comprehensive assessment. This approach, known as "diet synergy," surpasses traditional nutritional assessments by enabling detailed analysis of interactions between diet, metabolism, genetics, personal characteristics, and microbiota.

One example of AI/ML application is the analysis conducted in the Nulliparous Pregnancy Outcomes Study: Monitoring Mothers-to-Be. Using the Super Learner, an ML algorithm combined with targeted maximum likelihood estimation (TMLE) methodology, researchers predicted adverse pregnancy outcomes—such as preterm birth, small-for-gestational-age birth, gestational diabetes, and pre-eclampsia—based on fruit and vegetable



Figure 1: AI and Precision Nutrition. Multiple streams of data (big data) analysis via artificial intelligence and machine learning.

intake before and during early pregnancy. Another example is the use of ML to assess genetic risks for isolated orofacial clefts, also known as non-syndromic cleft lip with or without cleft palate (NSCL/P), a congenital condition influenced by both genetic and environmental factors.

In conclusion, given that the nutritional requirements for folic acid, thiamine, and vitamin B12 vary throughout an individual's life, precision nutrition (PN) can be a valuable tool for assessing these needs and understanding physiological responses to diet during critical phases such as fetal development, pregnancy, lactation, childhood, and adulthood. The need for these nutrients are not static and can change based on various 'omics' influences. The application of advanced technologies, particularly AI, in conjunction with multi-omics, represents a promising new direction in PN (Figure 1). Although there is substantial research on many aspects of nutrition, the integration of AI with multi-omics in PN remains underexplored. Therefore, further research is needed to fully understand and utilize these technologies in healthcare.

Future studies on PN focusing on maternal, fetal, and childhood health outcomes related to folic acid, thiamine, and vitamin B12 should target specific and relevant populations. This approach will help in integrating new findings into the PN model, potentially enhancing its effectiveness and application.

Improving IVF Success:

AI and Semantic Segmentation for Embryo Morphological Assessment

Hadeel Al-Haddad, Research Assistant,

Dr. Muhammad Arsalan, Research Assistant Professor,

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Prof. Ponnuthurai Nagarathnam Suganthan, Research Professor,

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Infertility, defined as the inability to achieve pregnancy after a year of unprotected sexual intercourse, is a growing global health concern. According to the World Health Organization (WHO), approximately 17.5% of the adult population worldwide will experience infertility at some point in their lives. This highlights the significance of addressing infertility and exploring effective solutions. Among the various assisted reproductive technologies (ART), in-vitro fertilization (IVF) stands out as a leading option for addressing infertility. IVF involves the fertilization of eggs with sperm outside the body in a controlled laboratory setting. Embryos are cultured until they reach the blastocyst stage before being transferred back into the uterus. Despite its effectiveness, IVF treatment can be financially burdensome for many couples, especially considering that multiple attempts may be needed to achieve a successful pregnancy.

Another challenge is that the IVF procedures involve the transfer of multiple embryos to increase the chances of pregnancy. However, this practice has led to a higher incidence of multiple pregnancies, which come with increased risks for both mothers and babies. Gestational complications, such as preterm birth and low birth weight, are more common in multiple pregnancies.

Objective

To address the risks associated with multiple pregnancies, recent research suggests a shift



Hadeel Al-Haddad

towards transferring a single viable blastocyst during IVF procedures. This approach minimizes the likelihood of multiple pregnancies while maintaining reasonable success rates. By selecting the most viable blastocyst for transfer, the risk of gestational complications can be significantly reduced.

The aim of this research is to improve embryo selection method by incorporating Artificial Intelligence for morphological analysis. The intelligent scheme will reduce human error and provide faster morphometric insight for different embryo components.

Suggested Solution

AI is increasingly utilized across various sectors,

From the left:
Dr. Muhammad Arsalan,
Dr. Abdulaziz Khalid Al-Ali,
and Prof. Ponnuthurai
Nagaratnam Suganthan.



including the medical field, to offer innovative solutions. Semantic segmentation is a branch of deep learning that deals with images by providing pixel-level labels for each pixel in an image. This approach is particularly suitable for our problem for several reasons:

- Provide an aid to the embryologist to analyse the inner structure and the components of the blastocyst.
- Formation of some components like ZP/ICM represents that the embryos are converted into blastocysts, and it is ready to transfer.
- Semantic segmentation helps to identify each component of the blastocyst (pixel-wise) and provide an individual mask for each class (ICM/TE/ZP/BL). Subsequently, these masks can be used to analyse the morphology of these components.



Figure 1: Blastocyst components.

Methodology

Dataset

For this research, a publicly available dataset containing 235 images of human blastocysts with pixel-level annotations of TE (Trophectoderm), ZP (Zona Pellucida), ICM (Inner Cell Mass), and BL (Blastocoel) was used. As shown in Figure 1, these annotations were provided by an expert embryologist. The dataset was divided into a training set comprising 85% (200 images) and a testing set comprising 15% (35 images). To have sufficient training, image augmentation was used to create 6400 images from 200 training images by general image transformations (flipping, rotations, etc.).

Model Building Training

The Figure 2 presents the example of conventional classification network. The proposed approach involved converting a classification network into a semantic segmentation network through the following steps:

- Removing the fully connected layers to adapt to

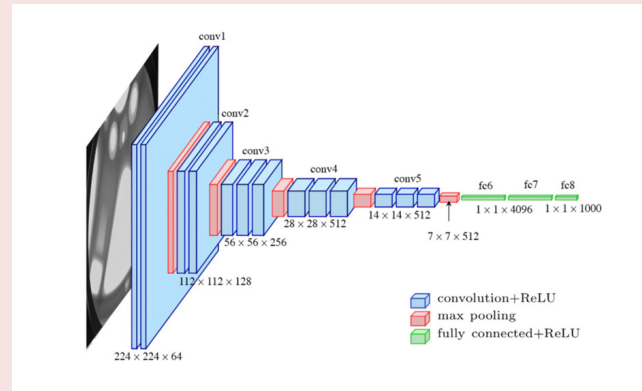


Figure 2: Typical classification model architecture.

the semantic segmentation model nature.

- Adding up-sampling layer and ensuring that the output size matches the original image size.
- Adding pixel classification layer to the network in conjunction with a suitable loss function for semantic segmentation tasks.

After experimenting with various networks and architectures such as VGG16 and Shuffle-Net, the proposed network for this task was DarkNet-53. This choice was based on the following reasons:

- It is commonly used in object detection, which proved its suitability for semantic segmentation tasks like blastocyst component segmentation.
- The use of residual skip connections, which preserve the information through the network and help avoid the vanishing gradient problem.
- There is no use of pooling layers, which can help preserve spatial information and prevent loss of detail during feature extraction.
- Using Leaky ReLU as an activation function, which helps avoid information loss by allowing gradients to propagate even for negative inputs, enhancing **the network's ability to capture subtle features.**

Model Modifications

After testing and experimentation, as shown in Figure3, several modifications have been made to the network architecture:

- The network has been resized to stop at a feature map size of 50x50. This adjustment helps in reducing computational complexity while still preserving essential features.
- Three up-sampling layers have been added to the

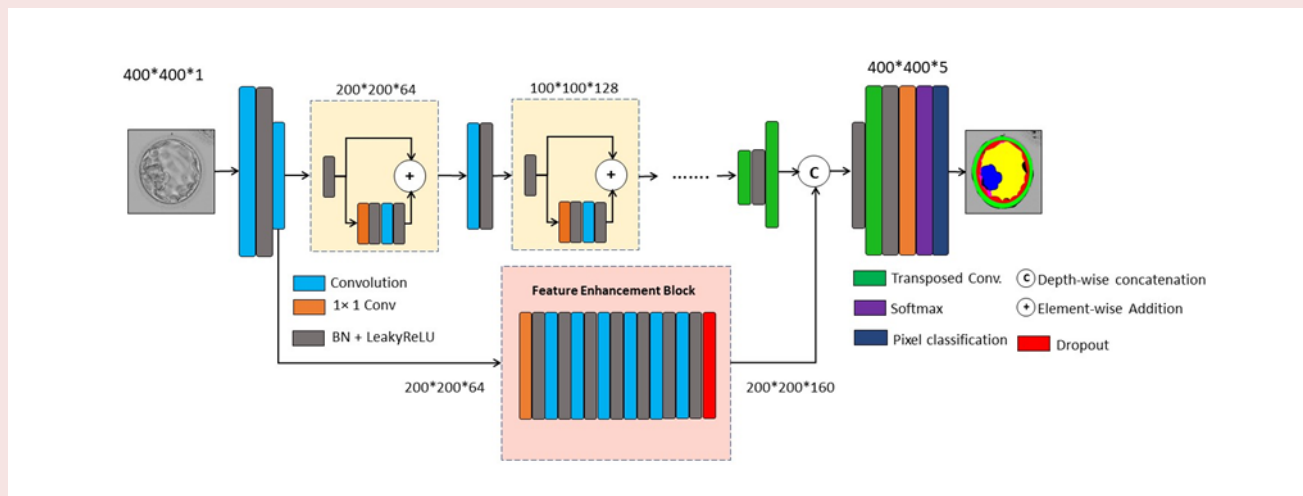


Figure 3: Modified Darknet Architecture.

network to retrieve the original image size.

- Adding Feature Booster Block (FBB), which is designed to retrieve information that may be lost through the down-sampling layers by employing a series of convolutional layers without any pooling layer. This mechanism enhances the network's ability to capture intricate details and improve accuracy.

Evaluation Metrics

The evaluation metric used is the Jaccard Index (JI) with true positive (TP), false negative (FN), and false positive (FP) pixels.

$$\text{Jaccard Index (IoU)} = \frac{TP}{TP+FN+FP}$$

Results and conclusion

Darknet outperforms the mentioned networks, boasting an accuracy of 87.7%. Leveraging Leaky ReLU as the activation function enhances performance by effectively capturing intricate features. Additionally, adding FBB (Feature Poster Block) into the network further enhances results and facilitates the accurate detection of minor classes.

Table 1 shows the accuracy of the proposed AI model's classifications (below) and compares this to other common methods in the field, where numbers closer to 1 are considered more accurate than numbers closer to zero.

The visual results:

The visual results of the proposed method are shown in Figure 4, where red, green, blue, yellow color represent TE, ZP, ICM, BL, respectively.

In conclusion, while our research showed promising insights, it's crucial to conduct further extensive experiments to firmly validate these findings. In the future, collaborations with healthcare institutions in Qatar will provide a great opportunity to acquire a larger and more comprehensive dataset. This step is important to ensure the reliability and effectiveness of our proposed approach.

Table 1: Comparison of the classification accuracy of the proposed artificial intelligence model in the research with previous proposals.

Method	TE	ZP	ICM	BL	BG	Avg
VGG16	0.709	0.810	0.827	0.861	0.951	0.831
VGG16 with skip	0.758	0.827	0.809	0.874	0.954	0.844
ShuffleNet	0.780	0.819	0.856	0.877	0.951	0.857
(ShuffleNet with skip (Two depth encoder	0.779	0.848	0.861	0.884	0.955	0.865
(ShuffleNet with skip (1 residual, 1 skip	0.790	0.841	0.862	0.884	0.951	0.866
ShuffleNet with FBB	0.792	0.836	0.869	0.887	0.951	0.867
DarkNet	0.783	0.845	0.849	0.880	0.955	0.862
Darknet with FBB	0.808	0.855	0.876	0.900	0.960	0.880

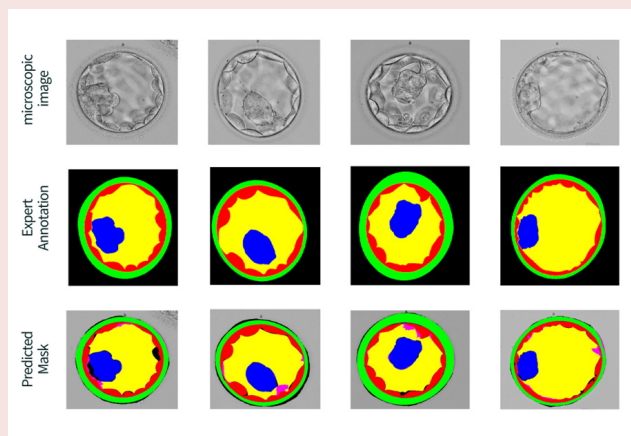


Figure 4: Visual results (comparison between the output of the embryo expert classifications and the output of the artificial intelligence model classifications).

Artificial Intelligence in Healthcare:

Designing and Developing AI Models for Classifying Adventitious Lung Sounds

Dr. Muhammad Salman Khan

Associate Professor, Department of Electrical Engineering, College of Engineering -
Qatar University

Healthcare is one of the most vital pillars of human society, playing a critical role in ensuring physical and mental well-being. The prevention, diagnosis, treatment, and recovery from illness, along with the search for cures, are the fundamentals to maintaining healthy populations. However, diagnosing and detecting abnormal conditions can be complex, often carrying the risk of misdiagnosis and human error. In recent years, medical practice has been revolutionized through the integration of various fields such as computational mathematics, statistics, computer science, bioinformatics, and, most notably, artificial intelligence (AI). AI has the potential to analyze and interpret vast amounts of medical data through sophisticated algorithms, enabling more accurate diagnoses, personalized treatment plans, and overall improvements in healthcare outcomes. By minimizing errors and enhancing decision-making processes, AI is transforming the way healthcare systems operate, ushering in a new era of precision and efficiency in medical practice.

Training research, development, and innovation talent in Qatar is crucial for advancing the nation's healthcare sector and addressing national and international health challenges. By equipping researchers and professionals with cutting-edge skills such as signal processing, machine learning, and deep learning, Qatar can foster the development of sophisticated tools and technologies for disease detection from biomedical and health data. These skills are essential for improving diagnostic accuracy, developing personalized treatments, and enhancing healthcare

efficiency. Additionally, nurturing talent in these areas will enable Qatar to lead in the global arena of medical research and innovation, contributing to the country's vision of becoming a knowledge-based state. This investment in training not only strengthens the local workforce but also supports the broader goal of advancing healthcare outcomes for both Qatar and the international community.

The Department of Electrical Engineering, College of Engineering, Qatar University, strives to train students with fundamental skills that are essential for driving healthcare innovation in Qatar and beyond. This is achieved by providing comprehensive education in fields such as electronics, signal processing, machine learning, and deep learning, preparing students to tackle complex challenges in disease detection and healthcare analytics. The senior design project (SDP) is an important part of the engineering training. The primary goal of the SDP project is to develop students' technical, research, and communication skills through hands-on design, development, teamwork, and presentations. It also emphasizes professional practice and non-technical factors, such as safety, environmental, and social impacts, while encouraging adherence to ethical standards and relevant regulations.

Recently, engineering students undertook a graduation project focused on designing and developing AI models for classifying adventitious lung sounds. The project team comprised students Hamad Alyafei, Mohammed Nour, and Abdulla Al-Obaidan, under

Dr. Muhammad Salman Khan with his students, Hamad Alyafei (left) Mohammed Nour and Abdulla Al-Obaidan (right).





Student training on a manikin with pre-recorded normal and abnormal respiratory sounds.

the supervision of Dr. Muhammad Salman Khan, Associate Professor in the Department of Electrical Engineering at Qatar University.

Lung sounds, which are also called respiratory or breath sounds, are the noises created when air moves through the respiratory system and can be heard through a stethoscope—a process known as auscultation. Auscultation of the lungs is a fundamental diagnostic practice in medicine, used primarily to assess respiratory health and identify abnormalities in the lungs and airways. When performing auscultation, a healthcare provider listens for the quality, intensity, and pattern of these sounds. Normal lung sounds include vesicular breath sounds heard over most of the lung fields, while abnormal sounds, such as wheezes, crackles, or stridor, may indicate respiratory conditions like asthma, pneumonia, or obstructive pulmonary disease.

The students began by conducting a thorough literature review to fully understand the problem, explore the current state of the art, and define the objectives for their SDP project. They were guided on how to access and review research publications in the field, as well as how to conduct market research on existing commercial solutions. The team utilized a publicly available dataset, widely recognized by the research community, which contained both normal and abnormal lung sounds. After downloading the dataset, the students performed preprocessing tasks, including resampling, normalization, and filtering. They were trained in the signal processing techniques required for lung sound analysis and then focused on learning various machine learning and deep learning algorithms. This process involved dataset preparation,

feature extraction, and the training, validation, and testing of different classification models. The students engaged with both the theoretical aspects and the practical, and the hands-on implementation of AI models for lung sound classification.

The SDP group also collaborated with students from the College of Medicine (CMED) at Qatar University (QU), co-mentored by Dr. Maha Desouki, Section Head of Pre-Clinical Education. This partnership was established under the QRDI UREP grant (UREP30-168-2-052) for the project titled “Learning, Identifying, Recording, Analyzing, and Computer-Aided Detection of Abnormal Respiratory Sounds.” Through this initiative, the engineering students had the opportunity to visit the clinical skills lab at CMED, where they received hands-on training using manikins with pre-recorded normal and abnormal lung sounds. Regular meetings were held as part of the project, where medical and engineering students exchanged knowledge and shared experiences, fostering a collaborative environment for multidisciplinary research, development, and innovation.

In conclusion, this interdisciplinary collaboration between engineering and medical students at Qatar University has played a pivotal role in nurturing the next generation of research, development, and innovation talents in healthcare. The project not only enhanced the students’ technical expertise by integrating artificial intelligence with clinical practice but also fostered a multidisciplinary approach essential for addressing complex challenges in the healthcare sector. This collaboration between students and researchers marks a significant step toward improving healthcare outcomes and advancing medical technology.

ME, MY Robot and Artificial Intelligence (AI)

Dr. Faisal Al-Jaber

Assistant Professor of Mechanical Engineering, Department of Mechanical and Industrial Systems Engineering, College of Engineering - Qatar University



Dr. Faisal Al-Jaber, Assistant Professor in the Department of Mechanical and Industrial Systems Engineering at the College of Engineering, is specialized in the design, fabrication, and sensorization of Soft and Bio-inspired Robots. Dr. Al-Jaber's expertise includes the development of soft optical-based sensors that are either pressure-sensitive or pressure-insensitive, enabling **Proprioception (self-internal-state sensing)** for orientation and position, as well as **Exteroception (external-state sensing)** for obstacle avoidance and light intensity detection in inflatable soft robots (Figures 1 and 2).

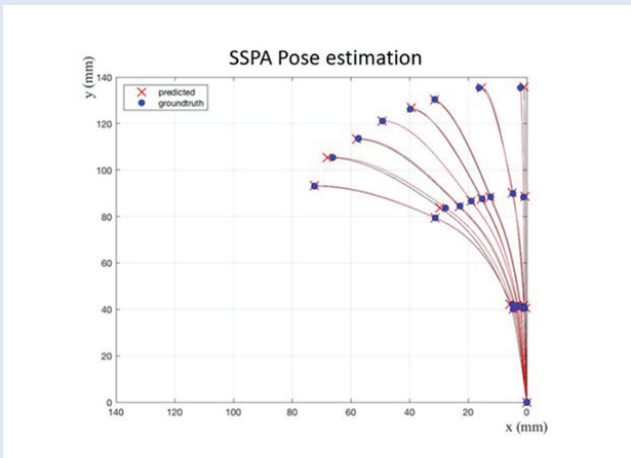


Figure 1: Proprioception sensing which shows the soft robot curvature at different stages of the actuation.

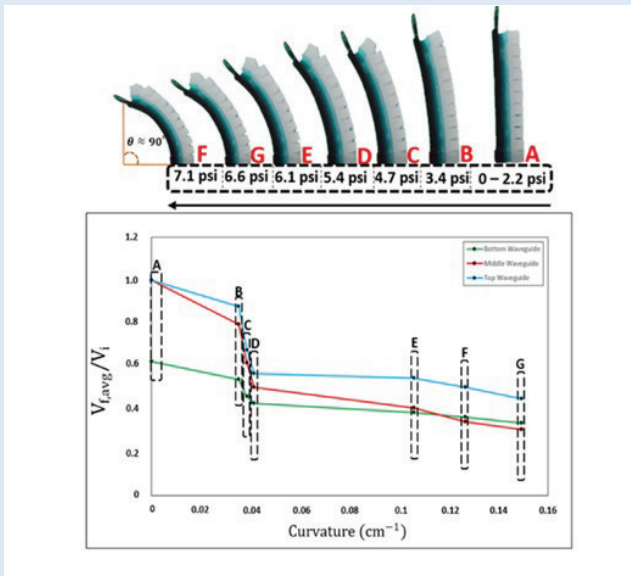


Figure 2: Exteroception voltage vs curvature plot is shown as a result of the pressure input.

To begin, it is essential to define Artificial Intelligence (AI) and its role in the advancing field of Robotics. AI, in simple terms, is the science or the attempt

to mimic the human intelligence in the process of decision-making. This involves training machines to identify or classify specific features related to a given task, enabling them to make informed decisions and perform intelligent actions.

There are some AI methods of implementation in robotics, mainly to enable the robotic systems to execute complex tasks. These methods are as follows:

- 1. Machine Learning:** AI enables robotic systems to learn from a predetermined set of data to use as a reference and improve their performance over time. This method includes learning from previous experiences to implement improved decisions and adjust to find new situations.
- 2. Computer Vision:** AI allows robots to construe and decode visual information from surrounding environment. This method is essential for core tasks involves objects recognition and classification, navigation, and interaction with humans or other machines.
- 3. Natural Language Processing (NLP):** AI helps robots understand and respond to human language, making interactions more intuitive. This method is used in customer service robots and personal assistants.
- 4. Autonomous Navigation:** AI enables robots to circumnavigate complex environments and obstacles free of human intervention. This method is essential for applications like self-driving cars and drones and swarm-robots.
- 5. Predictive Maintenance:** AI can predict, due to data fed to it, when a robot or its components might fail or requires repair, allowing for timely maintenance and reducing downtime in fully automated production lines.
- 6. Robotic Process Automation (RPA):** AI is utilized to automate redundant tasks in various industries, improving efficiency and accuracy.

The aforementioned methods are used as part of fused-AI system in surgical and medical Robotics, especially those systems that use soft robotics manipulators. Machine learning and image processing modalities can be fused and used to identify certain features in patient's scans for full form of Augmented Reality (AR) projection on a patient to locate the operational targeted

area. Figures 3 and 4 show a part of the previous project of Dr. Al-Jaber along with his team from the Imperial College London, who were able to project a volumetric CT-Scan slice on a brain-phantom by processing the image and creating an algorithm that can predict the position of the LED in 3D-space

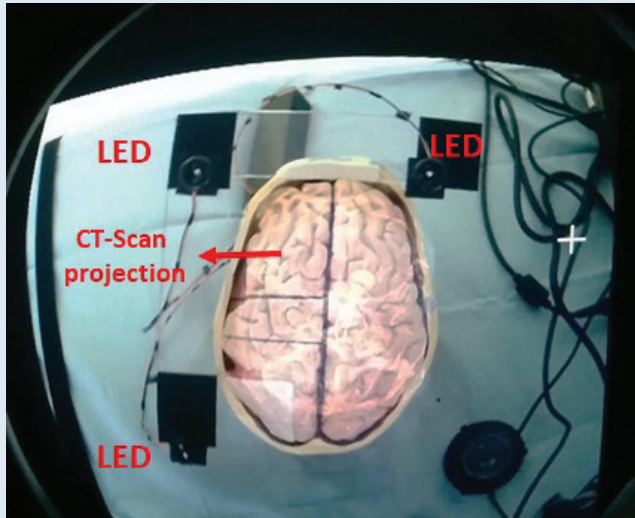


Figure 3: FPS perspective via the Oculus added cameras showing the projection of the scan over the brain model.

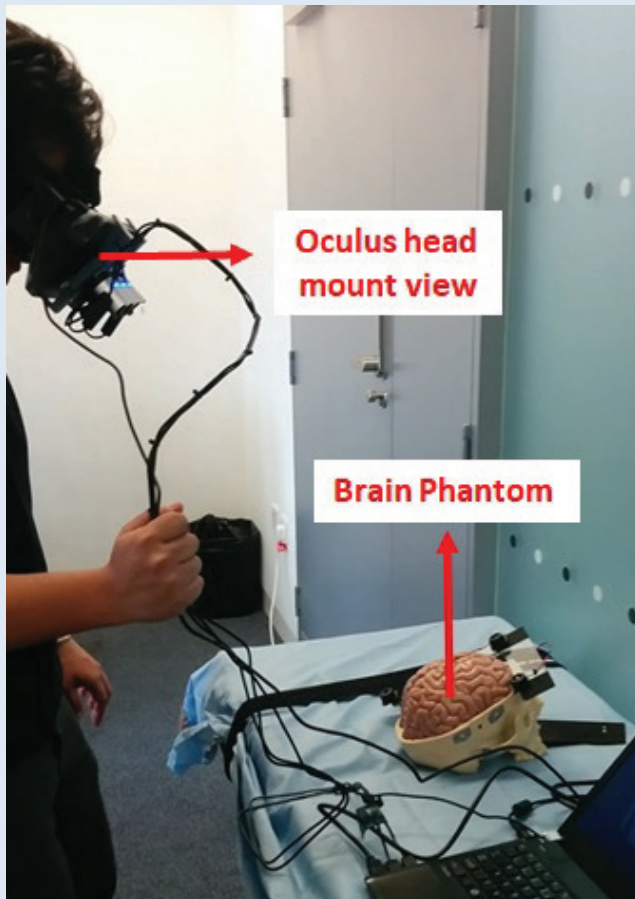


Figure 4: System setup.

and then scale each frame of the patient scans on the brain-phantom using the DEVKIT of Oculus.1 rift.

Additionally, another project involved using machine learning and image-processing tools to teach an algorithm to identify the hyper-redundant soft robot bending shape by learning to link the shape to the light-intensity of the optical sensors by extracting frames and run it against a pre-determined reference images as shown in Figures 5 and 6.

AI as a tool in robotics and medical robotics, particularly, is meant to enhance the performance of clinicians and improve outcomes. However, as a tool that is being adopted cautiously in applications that might affect the health, or compromise human privacy and rights, the advancement of ethical conduct has to improve to keep up with advancement of technology.

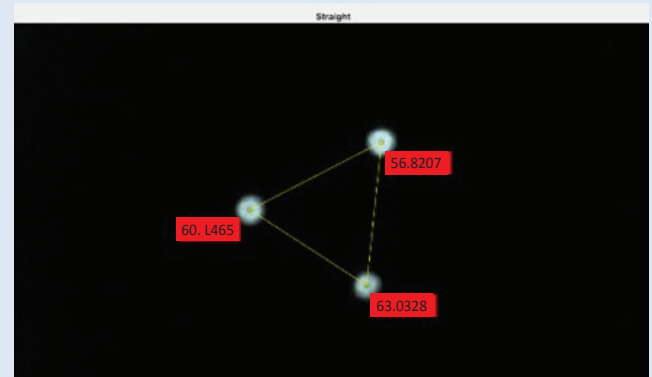


Figure 5: The algorithm is learning using the reference images and machine learning tools to compare the live-streamed images to the reference ones.



Figure 6: Graphical user interface showing the three light intensity circles are divided and compared individually to project the right shape prediction.

For any inquiries regarding the article, do not hesitate to contact the Robotics team at Kindi Center of Research.

Prof. Sumaya Al-Maadeed and Her Team Develop AI-Powered Assistive System for People with Visual Impairments

Prof. Sumaya Ali Al-Maadeed

Professor of Computer Engineering, College of Engineering - Qatar University



Prof. Sumaya Ali Al-Maadeed

Prof. Sumaya Al-Maadeed, an accomplished researcher and Professor in Computer Vision and Artificial intelligence (AI), is making remarkable strides in using artificial AI to address critical challenges in assistive technology. Prof. Sumaya, alongside her team—PhD student Jayakanth Kunhoth, Dr. Mohammed Zied Chaari, and MSc student Nandhini Subhranian—has developed an innovative assistive system called “Smart Hat” aimed at empowering individuals with visual impairments. This system enhances their ability to navigate their surroundings and perform tasks independently. Their pioneering work demonstrates the transformative potential of AI in enhancing the quality of life for people with disabilities while pushing the boundaries of innovation in assistive technologies.

The Vision behind the Invention

The motivation for the assistive system arose from the significant challenges faced by people with visual impairments in their daily lives. These individuals often encounter barriers in mobility, object recognition, and interaction with their surroundings. Prof. Sumaya and her team recognized the potential of AI to address these challenges by providing real-time solutions that combine advanced computing techniques with user-friendly interfaces.

Their goal was not just to create a functional device but to design a system that could adapt to various environments, respond intelligently to user needs, and provide continuous support. This vision aligns with Prof. Al-Maadeed broader research interests, which include leveraging AI to solve real-world problems and applying cutting-edge technology to enhance social inclusion.

Core Features of the Assistive System

The assistive system integrates multiple advanced technologies, including AI, computer vision, and sensor-based systems, to create a robust and user-centric solution. Some of the key features include:

1. Object Detection and Recognition

Using computer vision algorithms, the system identifies and labels objects in the user's environment in real-time. For example, it can recognize furniture, doorways, obstacles, and even specific items like a phone or keys.

2. Text-to-Speech Technology

The system provides audio feedback to guide users by describing objects, directions, or hazards. This allows visually impaired individuals to better understand their surroundings without relying on sight.

3. Wearable Integration

Designed as a lightweight, wearable device, the assistive system integrates seamlessly into the user's daily life. It may include cameras, sensors, and microprocessors that are compact and ergonomic, ensuring comfort and ease of use.

4. AI-Powered Navigation

By leveraging deep learning models, the system maps out the user's environment and provides step-by-step navigation instructions. This feature is particularly useful for avoiding obstacles and navigating crowded spaces.

5. Customizable User Experience

The AI in the system learns user preferences over time, adapting its responses to provide more personalized assistance. This dynamic approach ensures that the device becomes increasingly intuitive with use.



During the user's experimentation with smart hat innovation.

The Role of AI in the Project

AI plays a central role in the assistive system, powering both the recognition and decision-making processes. Deep learning models were employed and trained on diverse datasets to ensure accurate and reliable performance in various scenarios.

1. Data Processing and Training

The system's AI components were trained on large datasets of images, objects, and environmental scenarios to develop robust object detection and recognition capabilities. This training ensures that the system can operate effectively in diverse lighting conditions and settings.

2. Real-Time Processing

One of the critical challenges in assistive technology is ensuring real-time responsiveness. Prof. Al-Maadeed's team optimized AI algorithms to process data instantly, enabling the system to provide immediate feedback to users.

3. Natural Language Processing (NLP)

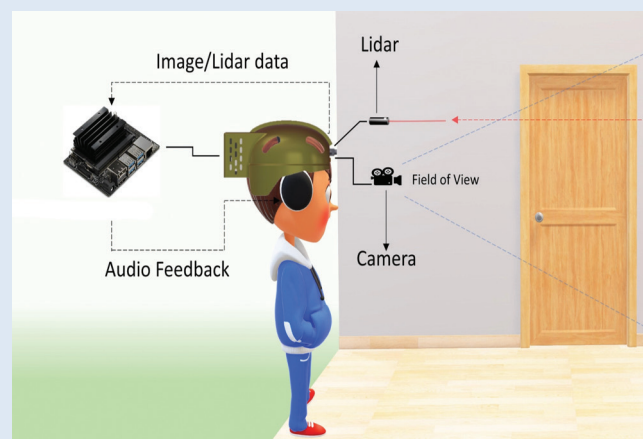
The integration of NLP technologies in both Arabic and English significantly enhances the system's communication abilities. It enables the system to describe objects and provide instructions in a natural, conversational tone, making it more user-friendly and less daunting for individuals with visual impairments.

4. Continuous Learning and Updates

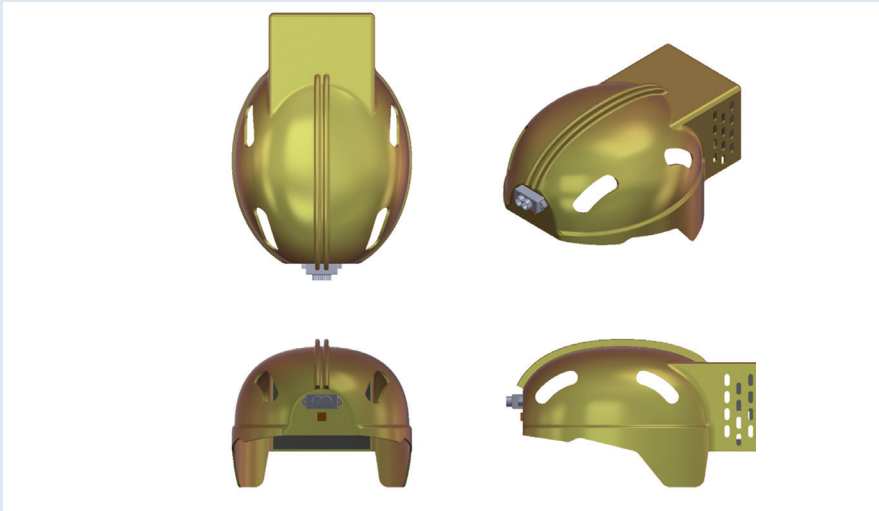
AI models in the system are designed to learn continuously from user interactions and feedback. This iterative improvement ensures that the device remains relevant and effective as user needs evolve.

Challenges and Solutions

Developing an assistive system of this complexity involved several challenges. One significant hurdle was ensuring that the smart hat device could function



Components of smart hat innovation.



Smart hat innovation.



PhD student Jayakanth Kunhoth, from the research team.

reliably in diverse and unpredictable environments. This was addressed through diversifying their training datasets and conducting extensive field tests.

Another challenge was balancing advanced functionality with user comfort and affordability. The team worked closely with potential users to refine the system's design, ensuring that it was both practical and accessible. By leveraging cost-effective components and open-source software, they were able to create a product that is both innovative and financially viable.

Impact on Users

The assistive system has the potential to transform the lives of individuals with visual impairments. By providing greater independence and reducing reliance on caregivers, the device empowers users to engage more fully in social, professional, and recreational activities.

Early feedback from users has been overwhelmingly positive, highlighting the system's ability to enhance confidence and mobility. Many users have reported feeling safer and more self-sufficient, thanks to the real-time guidance and feedback provided by the system.

Broader Implications of the Research

Prof. Al-Maadeed's work extends beyond the immediate benefits of the assistive system. Her research underscores the broader potential of AI to address pressing societal challenges, particularly in the field of accessibility.

The project also contributes to the growing body of knowledge in AI-driven assistive technology, providing a blueprint for future innovations. By demonstrating how AI can be integrated into wearable devices, consequently paving the way for similar applications in areas like healthcare,

education, and public safety.

Future Directions

Building on the success of this project, Prof. Al-Maadeed and her team plan to expand their research to include additional functionalities and applications. Potential directions include:

1. Integration with Smart Cities

Enhancing the system's connectivity to interact with smart city infrastructure, such as traffic signals and public transportation systems.

2. Advanced AI Capabilities

Incorporating more sophisticated AI models to improve scene understanding, gesture recognition, and voice interaction.

3. Broader Accessibility Applications

Adapting the technology to assist individuals with other disabilities, such as hearing impairments or mobility challenges.

4. Global Collaboration

Partnering with international organizations and researchers to share insights and further develop assistive technologies.

Prof. Sumaya Al-Maadeed and her team's assistive system for people with visual impairments exemplifies the transformative potential of AI in addressing real-world challenges. By combining cutting-edge technology with a user-focused approach, they have created a solution that not only improves the lives of individuals with disabilities but also sets a new standard for innovation in assistive technology.

Their work highlights the importance of leveraging AI for social good and serves as an inspiring example of how technology can be used to create a more inclusive and equitable world.



Pitfalls in an Artificial Intelligence (AI) Driven Audit

Saumy Thomas

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In 2023, Artificial Intelligence (AI) has made substantial progress in automating operational processes and procedures across a wide range of industries. While improving the operational efficiencies of the adopted organization, AI-driven operations have come with their own list of risks. While organizations are encouraged to adopt AI-driven audit methodologies to enhance operational efficiency, the use of machine learning (ML) and biased algorithms may negatively impact audit outcomes. In this article, we take a close look at the potential pitfalls in an AI-driven audit.

Impact of Data Quality

AI-powered audit analytics are heavily dependent on the quality of the data provided for analysis. In the event of the presence of any incomplete, inaccurate, or outdated data, the results from the AI-driven analytics may be flawed. Based on the data input to the system during the development and testing phase, biased decisions can creep into the AI-driven audits and hence potentially missing the key data interpretations. The following business cases are a testimony of the aforementioned idea:

- In 2024, Air Canada had a court settlement with one of its passengers after the airline virtual assistant gave him incorrect information which passenger acted based on the incorrect information provided.
- In 2018, Amazon scrapped its project of the AI-driven recruiting software due to incomplete data analysis performed by the software. According to Amazon, the ML models were trained on 10 years' worth of resumes submitted to Amazon and it was mainly of male candidates. Hence, during the implementation phase of the software, the system disqualified resumes with terminologies such as "women" or "women's colleges." Hence, the Amazon recruiters ended up not using the software and eventually, Amazon scrapped the project.
- In 2021, the real estate marketplace Zillow had an inventory overvalued at \$ 304 million due to

unintentional purchase of homes at higher prices than its current estimates based on the faulty purchase recommendations by its operational AI “Zillow Offers.”

Inability to “Think out of the Box”

The AI software is constrained to the parameters defined while developing the software. The AI fails to understand the implications of specific business decisions that appear to be within defined parameters but with distorted malicious intent. Most of the AI algorithms are not designed to decode unstructured and highly complex data such as complex legal contracts or financial agreements which influence multiple jurisdictions. Key organizational strategic directions such as organizational culture, tone at the top, management philosophy and stakeholder relationships are not quantifiable, consequently, not considered for decision-making by AI. In 2020, the Wirecard Scandal was a classic example of inaccurate financial reporting based on AI-driven software. Nevertheless, with a fair appearance of compliance with the established financial reporting standards, the German Payment Processor, Wirecard, was

able to fraudulently report “ghost money” of USD 2.1 billion for several years. AI systems in place could not detect and identify such deep-rooted deceit and extensive manipulations of financial statements through the sophisticated nature of transactions, including fake documents and complex schemes. Another example would be the infamous 2018 Danske Bank Money Laundering controversy. Danske Bank was involved in a money-laundering scheme where USD 236 billion was laundered through its Estonian branch. Even after multiple flags from the internal audit team and other regulatory authorities, due to the dominating tone at the top and lack of proper governance communications, Danske Bank failed to report these irregularities adequately. Unlike audit decisions taken based on professional judgement such as experience and intuitions, AI cannot assess the interpersonal dynamics influencing organizational operations.

Adaptability and Flexibility

AI software must be continuously updated to keep pace with rapidly changing regulations and standards, or it may introduce compliance risks.



Further, understanding and accurately interpreting new regulations require human judgment and expertise. The NMC Health (United Arab Emirates) scandal in 2020 sheds light on how, even with the existence of an automated financial monitoring system, the healthcare provider, had succeeded in understating debts equivalent to USD 4 billion and was able to mislead its investors.

Fraud Detection

AI softwares help to detect unusual transactions that could indicate potential fraud by analyzing and comparing them to known fraud patterns. However, in the event of sophisticated and innovative fraud schemes, AI may struggle to identify and flag such incidents. There are multiple examples that would demonstrate fraud detection. The Luckin Coffee Accounting fraud in 2020 is such an incident. As part of their expansion strategy, a whopping figure of USD 300 million was reported as revenue through fake documents and fabricated sales figures. Even with the presence of an AI-driven financial analytics tools, fraud needed to be flagged by an anonymous whistleblower.

In conclusion, AI software should be used as a tool to assist, rather than replace, human auditors. The interpersonal skills, expertise and auditor's presence of mind, are critical skills that cannot be compensated with the implementation of AI software. Nevertheless, AI software can help in some form of predictive analytics, a robust combination of technology and human expertise is what an effective auditing department needs for effective operations and the provision of independent assurance about organizational risk management, governance and internal controls.



Saumy Thomas

Inventing with AI:
**Who's the Real Genius,
You or the Robot?**

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Artificial intelligence (AI) is transforming the world of innovation, offering exciting new possibilities for startups and entrepreneurs. Nevertheless, with these advancements, come significant challenges, especially in protecting intellectual property (IP). This article explores the hurdles faced by new ventures when dealing with AI-assisted inventions and what can be done to address them.

The Rise of AI in Innovation

AI is now widely used in the invention process, ranging from designing products to discovering innovative solutions. However, a major issue arises when it comes to recognizing who—or what—gets credit for these inventions. Current patent laws only recognize humans as inventors, even if AI plays a crucial role in the invention. This legal gap makes it harder for startups to protect their AI-generated ideas.

One well-known example is DABUS, an AI system that created novel designs like a fractal container* and a neural flame*. When patents were filed for these inventions, they were rejected because DABUS is not a human. This case highlights the limitations of existing IP laws and emphasizes the need for updates that reflect AI's growing role in innovation.

The Legal Hurdles

Securing patents for AI-assisted inventions is a



Dr. Lotfi Belkhir

complex process for startups. One of the biggest challenges is determining inventorship. Patent laws in countries like the U.S., Europe, and Japan require that a human be named as the inventor, which can be difficult when AI systems are heavily involved in the creation. Navigating these legal systems requires significant resources, which many new ventures lack.

Startups must also deal with varying regulations across jurisdictions. While the U.S. and European Union maintain that only natural persons can be inventors, China is more open to exploring AI's contributions. This inconsistency makes global patent strategies more challenging for startups trying to protect their inventions internationally.

Novelty and Non-Obviousness Challenges

Patents are granted only if an invention is both novel and non-obvious. Novelty means the invention must be new and not publicly known before the patent application, while non-obviousness requires that the invention isn't an obvious improvement on something already existing. These standards become tricky when dealing with AI-generated inventions.

Since AI often works with massive amounts of pre-existing data, courts may argue that AI systems are not capable of producing truly novel ideas. Critics might view AI inventions as simply new applications or reconfigurations of existing knowledge. This raises the bar for proving that an AI-assisted invention is genuinely new. Furthermore, AI can generate solutions that are not obvious to human inventors, complicating the evaluation of whether these inventions meet the non-obviousness requirement. This leads to greater uncertainty for startups when it comes to securing patent protection.

Ethical and Social Implications

The ethical issues surrounding AI in invention are also significant. AI systems may reflect biases in their training data, leading to biased outcomes in fields like pharmaceuticals or finance. There is also concern that AI-driven automation could displace human workers. On the other hand, AI creates new employment opportunities in areas like AI development and oversight, necessitating a shift in education and workforce training.

Moving Forward

Addressing these challenges requires updating legal frameworks to better accommodate AI's role in the invention process. New rules are needed to define how AI contributions should be recognized while still preserving human inventorship. Startups can manage this uncertainty by documenting the role of human inventors in guiding AI-assisted inventions and staying informed about ongoing legal changes.

In the short term, startups should focus on filing patents early, tailoring applications to specific jurisdictions, and maintaining thorough documentation of human contributions. As legal standards evolve, these steps can help new ventures protect their innovations. It's also crucial for new ventures to engage in industry discussions and policy advocacy to help shape the future of IP law for AI inventions.

Conclusion

AI-assisted inventions present both exciting opportunities and substantial challenges for startups. While AI can drive innovation, securing and enforcing IP protection for these inventions requires navigating a complex and even bewildering landscape involving technical, business and legal challenges and considerations. By continuing to explore these issues and push for updated legal frameworks, we can ensure that AI continues to drive innovation and economic growth, while offering fair and motivating protection to inventors.

This is a relatively new and exciting area of research, and a more detailed working paper will be presented at the 7th edition of the Entrepreneurship for Sustainability & Impact (ESI) Conference, organized by Qatar University's College of Business & Economics, from November 23-26 in Doha, Qatar. You can find out more about the event via the QR code below:



***Fractal Container:** The fractal container is a novel type of food container designed with fractal geometry. Its structure maximizes efficiency by enhancing the grip and insulation properties of the container.

***Neural Flame:** The neural flame is an innovative warning light or visual device inspired by a combination of fractal patterns and dynamic visual signals.



The Prospects of Granting a Legal
Personhood for Artificial Intelligence:
Comparative Analysis

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This study serves as an important resource as it explores the potential for Qatari Law to recognize the legal personality of Artificial Intelligence (AI) and examines the implications of such recognition, particularly regarding the rights AI may acquire and its civil liability when causing harm. Similar to many advanced nations, Qatar is fostering a knowledge-based economy through investments in AI technologies, which are increasingly shaping fields such as medicine, law, engineering, and human resources. Additionally, AI's role in producing creative outputs, including artistic works and written content, raises important regulatory questions. These developments have prompted Qatar's legal system, alongside others, to consider how AI should be regulated and whether it warrants recognition as a legal entity. As Qatar aims to cultivate an environment that supports investment in AI, this research seeks to address the legal and legislative challenges posed by AI and investigates the core question:

Can AI be held liable as a legal personality for the harm it causes? Should Generative AI receive legal protection for its creative outputs?

Is the traditional concept of legal personality in Latin legal systems appropriate to be extended to AI or do we need to create a new legal personality that fits the nature of AI?

The research examines conventional legal rules and compares them with modern theories. One such theory is the “human agent” which holds that a human—whether the owner, user, operator, or manufacturer—can be held liable when AI causes avoidable harm. Another theory, the “electronic personality,” suggests that highly autonomous, intelligent robots, as manifestations of AI, should be granted their own legal personality, allowing them to be directly accountable for their actions. The study assesses the various approaches that aligns best with the nature of AI, aiming to provide Qatari legislators with a framework for deciding whether AI should be recognized as having legal personality.

Since the research required the development of a methodology appropriate to the nature of the study, the researcher adopted a descriptive approach to present and define the concepts of AI and legal personality, while also explaining modern theories and jurisprudential opinions related to intellectual property protection, patents, and civil liability. The researcher further employed an interdisciplinary

approach to understand AI from the perspectives of the fields that created it, such as engineering, information technology, and computer science, in order to form a legal viewpoint aligned with its nature.

Additionally, the comparative analytical approach was used to examine and analyse legal rules and legislative proposals from both Latin and Anglo-Saxon legal systems, including the European Law on Artificial Intelligence, the European Civil Code Rules on Robotics, and the civil codes of Egypt, Algeria, Iraq, and Qatar. This study also examined laws related to the protection of intellectual property rights in Qatar, the UK, and Egypt, along with opinions of legal scholars and comparative judicial rulings from the American and the Chinese courts dealing with AI rights and the protection of others against it. This analysis aims to provide insights on the legal rules most suitable for AI, which the Qatari legislator could adopt to build a structured legislative environment that keeps pace with AI developments.

At the end of the study, the researcher concluded a set of results that can be summarized in:

First: There is no universally accepted definition of AI from technical, legal, or legislative perspectives, largely due to its complexity. However, the researcher determined that all definitions agree on one fundamental aspect which is that AI is driven by programming based on deep learning, a subset of machine learning, enabling it to analyse data and make decisions autonomously, without human intervention.

Second: AI appears in both physical and virtual forms. The virtual aspect is represented by algorithms, while self-driving cars and smart robots exemplify its physical presence.

Third: There is an absence of specific legal regulation for AI in Qatari legislation and most international legislation, with the exception of the European Union. This lack of regulation leads to AI being classified under general legal rules as a “thing,” specifically as property.

Fourth: Traditional legal theory divides legal personality into two categories: natural persons, which refers to humans granted legal personality at birth, and legal persons, which includes entities such as corporations and state institutions. Based



Marem Nasser Taleb Watan Khah

on these rules, AI is not classified as a person.

Fifth: The idea of granting legal personality to AI emerged as a solution to problems stemming from the inability of traditional general rules to protect both the outcomes of AI and others affected by it. This led to the development of modern theories, such as the “human agent” theory and the “electronic personality” theory. In 2017, the European Parliament, under the Civil Law for Robotics, adopted the concept of the human agent. The theory of recognizing AI’s electronic personality also emerged, particularly for robots that demonstrate greater complexity and independence in decision-making. Since robots are one of the applications of AI, this theory can be extended to other AI applications to safeguard both the outcomes produced by AI and to protect, and compensate those who may be harmed by it.

To conclude, the researcher presented several key recommendations:

First: The Qatari legislator needs to adopt a legal framework that recognizes the legal personality of Artificial Intelligence (AI) in a manner consistent with its unique nature, distinguishing it from other forms of property. This recognition takes into account AI’s ability to simulate human decision-making and affect the surrounding environment.

Second: If AI’s legal personality is recognized, the researcher recommends establishing a dedicated registry, similar to that used for private legal entities, such as companies. This registry would document all relevant information about the AI, including its assets, which could be used to satisfy financial liabilities. Additionally, a record of individuals connected to the AI—whether as owners or operators—should be maintained, allowing for legal actions, such as travel bans, during the enforcement of judgments.

Third: The researcher suggests that a clear criterion should be established to determine when an action is entirely caused by AI, allowing for the extension of legal protection to the outcomes created by AI.

Fourth: The researcher recommends that the Qatari legislator requires AI programmers to provide specific information, such as the sources of data fed into AI systems. This transparency would help ensure that AI decisions are made based on ethical considerations and respect for human rights, reducing the risk of AI systems that disregard these principles.

The researcher also suggests that the Qatari legislator considers the institutional regulation and oversight of AI by establishing a dedicated body responsible for supervising and controlling the data fed into AI systems.

Digital Peace Revolution:

How AI Can Boost Qatar's Diplomatic Efforts to Resolve Conflicts

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As it is well known nowadays, and as Karim Lakhani said, “Artificial intelligence will not replace humans, but humans who use artificial intelligence will replace those who don’t.” This underpins the impact of AI on human undertakings and its role in shaping the future across various sectors. AI technologies can play a crucial role in resolving conflicts by facilitating peace negotiations. Through their ability to analyze massive volumes of data, AI can identify patterns and trends, enabling more informed assessments and forecasts that support conflict resolution and negotiation efforts. This new revolutionary capability should elevate the effectiveness of the tool in dealing with the myriad wars and conflicts that we are currently experiencing in the Middle East. The transformative impact of AI demands rethinking some of the ways in which conflict resolution strategies have been evaluated. At least, AI has the potential to support the analysis of data to identify early warnings and help track potential scenarios linked to cases of conflict issues.

Moreover, AI can support and analyze data to provide early warnings, and monitor possible scenarios in relation to the status of conflict issues to drive negotiations. In addition, AI has a capability to analyze landscapes in ways that could further bolster diplomatic relations. The whole thing whirls around the fundamental question of how Qatar, as a reliable mediator, can integrate this tool into its conflict resolution approach? Indeed, Qatar showed participation in peace processes. A good example is the highly complex “Afghan Peace Process” that has been successfully ended with Doha Agreement 2020. Qatar has also assumed a leading role in facilitating dialogue to resolve the protracted conflict between the Palestinian resistance group Hamas and Israeli Occupation, widely known as one of the most problematic conflicts in the Middle East. Although Qatar has mediated a number of conflicts since attaining this mediator’s position with results such as ceasefires and prisoner exchanges, the use of AI tools could also be promising for favorable outcomes in conflict resolution and negotiation strategies.

An array of creative ways in which AI is being applied is to enhance conflict resolution globally; for this reason, it holds prospects of providing some indication as to what could indeed be achieved

by Qatar's diplomatic efforts. Among the topical applications is AI-powered data analytics for early warning systems. Such systems sift through enormous quantities of data—from social media, via satellite images, to historical patterns of conflicts. According to the United States Institute of Peace (2023), one such use is the attempt by AI to monitor ceasefire violations and online hate speech, which are various forms of early warnings for conflict. This AI system can thus constitute timely warning to allow preventive diplomacy before the conflicts get out of proportion.

Other areas where AI comes in real handy are predictive models. Through the analysis of historical data and current geopolitical dynamics, AI may forecast the likeliest outcome in some instances of conflict. By doing so, it gives diplomats strategic insights into peace negotiations. The National University of Science and Technology (2024) highlights the fact that some peacekeeping operations have employed AI models to forecast results, thereby permitting the stakeholders to adjust their strategies based on what scenario is most likely to develop (NUST, 2024). Furthermore, NUST (2024) showed how AI improves peace efforts in-depth by supporting a shared global AI-based system that can manage all disputes in human civilizations depending on common aims and values. This model can be applied to many other international conflicts, and thus serves as a potential tool which Qatar could adopt into its peace talks. The success that this kind of system has had in dissipating tensions and entertaining solutions of cooperation is a prime example of how AI has the potential to raise global conflict resolution to the next level.

Nevertheless, one of the most characteristic uses of AI is online dispute resolution. Though the title may sound fairly peculiar to some people, AI virtual mediation systems allow for independent settlement by parties through fully automated or semi-automated platforms, capable of conducting legal and diplomatic mediations at much less cost and with high effectiveness and efficiency. Mitch Jackson (2023), a lawyer and developer of the "Maneuver Mediation" platform, who employs tools like "active listening" among other skills, showed how artificial intelligence may already

help settle international dispute resolution. AI can analyze transcripts of the parties' conversations to identify key points and common themes and key words that reveal the real motivations underlying the positions being expressed, thereby facilitating mediators in grasping the essential issues. To elaborate, AI could identify points of agreement or dispute in conversations and suggest ways forward based on such trends. Also, AI might assist in peace negotiations by offering neutral data-driven proposals from previous negotiations. AI systems may study the reactions of potential stakeholders and come up with proposals based on cooperation.

A few of the advantages accruable to AI in conflict resolution have many facets. Of all these benefits, one of the highly salient structures realized is through real-time decision support. In fast-moving diplomatic scenarios where timely decisions may prevent conflicts from scaling, AI can process big datasets and spot patterns. Additionally, the data-driven approach of AI ensures objectivity to shepherd diplomats through the complex dynamics in international disputes.

However, application of AI in the conflict resolution raises ethical concerns. That introduces a big concern: if there is any skew or an inbuilt bias in the data that an AI system has been trained upon and thus yielding biased results, that just could ramp up tensions rather than dampen them, especially when geopolitical situations are sensitive. The greater the integration of AI into conflict mediation, the greater the anonymity and need for discussion on the importance of human oversight.

With Qatar having established credibility in the field of diplomacy, together with long-standing networks, its ambition for AI tools would lead to a unique positioning of the country in conflict mediation. With the integration of AI, Qatar's peacebuilding endeavor will be amplified to a position where data insights could be derived and negotiation outcomes are improved by catching emerging conflicts in the region before they escalate to higher levels. Taking this in mind, such applications of the AI technologies would bring simplicity to the process of mediation in order to save time and resources while providing balanced outcomes. This is where developing a holistic AI framework within the foreign policy machinery would be a prudent step for Qatar.



Systematic Review of Artificial Intelligence
(AI) Research in Higher Education:

Practice, Gaps, and Future Directions in the GCC

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Acknowledging its potential for diversifying the economy and attaining sustainable development, the Gulf Cooperation Council (GCC) countries, comprising Bahrain, Kuwait, Oman, Qatar, Kingdom of Saudi Arabia (KSA), and the United Arab Emirates (UAE), have been investing heavily on digital transformation and keeping pace with technological advancements. To elaborate, with unified efforts to transition to a knowledge society and enhance educational outcomes over the last years, GCC countries have demonstrated a solid dedication to integrating artificial intelligence into education. However, the current literature shows that the state of knowledge regarding the application of AI within the GCC region is scattered and incomplete. Uncertainties persist in many aspects, such as effectiveness, implementation strategies, and potential impact of AI interventions.

We conducted a systematic review to analyze and synthesize the current knowledge on AI in higher education in the GCC region, providing evidence-based directions for practice, policy, and research. Specifically, this study addressed the following research questions:

1. What are the advantages and disadvantages of using artificial intelligence in higher education?
2. What are the main gaps and issues highlighted in artificial intelligence research in higher education across the GCC countries? What are the corresponding directions for future research in the region?

In the Scopus database, 32 studies were analyzed, all open access documents affiliated to a GCC country, having artificial intelligence and higher education, or related terminologies as keywords. As for the advantages of using AI in higher education, this review showed that the most striking benefits are improving educational outcomes, enhancing institutional decision-making, and advancing institutional systems. Regarding educational outcomes, the results showed that AI was implemented in the region for various academic purposes, including enhancing students' reading skills, measuring anxiety levels, promoting class participation, motivation, knowledge retention, and detecting cheating. While for decision-making, the findings indicated that AI was implemented for several institutional purposes, such as making

predictions for at-risk students, no-detriment rate, and student academic success, to assist in the long-term institutional decision on the admission process, curriculum, and learning. Finally, for advancing institutional systems, the results highlighted that AI was implemented for developing a biometric authentication system and creating an outlier detection system to enhance institutes' cybersecurity systems and for developing a personalized framework to enhance institutes' processes of information collection, development, and accessibility.

As for disadvantages, no study reported any disadvantage, weakness, or negativity from leveraging AI in higher education. This could imply that the application of artificial intelligence in higher education was found to be beneficial from all aspects of the GCC region. Nonetheless, in the literature, there have been various notes on some of the drawbacks of using artificial intelligence in education, such as ethical issues, increased unemployment, difficulty understanding the algorithms, interpretation of data, and poor quality, biased or incorrect output. Yet, the studies analyzed in this review do not seem to have these issues on their radar. There is still much to learn about what is applicable regarding applying artificial intelligence in higher education.

Regarding gaps, issues, and future directions, the findings showed that although there is an established research base on AI research in higher education, nevertheless this topic is still in its infancy form in the GCC region. The most evident gaps are lack of knowledge about AI, poor technology skills of faculty and students, and inadequate technology infrastructure at the institutes. Additionally, major challenges include resistance to traditional educational methods and the conflicting beliefs and values of the local community regarding AI implementation. Higher education institutions must explicitly teach how to use AI technologies and tools, and embed experiential implications into their curriculum. Moreover, studies have stated challenges related to the structural complexity of the Arabic language and have called for more research to tackle Arabic sentiment analysis. Researchers highlighted the security and privacy issues in AI applications and called for more exploration to ensure safe AI adoption in education.

Results suggest a range of implications for practice, policy, and research. As for practice, it is evident that administrators can improve institutional quality by making informed decisions using AI-supported systems that turn large datasets into practical recommendations. They can improve educational quality by providing the latest AI-driven educational technologies to practitioners, students, and staff, and offer training to strengthen their AI literacy and technology competencies. Practitioners can implement AI for e-teaching and learning purposes, creating a supportive and positive educational environment where AI tools provide personalized learning for students to progress at their own pace, consequently, adjusting the difficulty level based on their needs and giving real-time feedback. Furthermore, with immersive learning technologies, such as virtual and augmented reality, practitioners can simulate authentic scenarios, offering students practical and hands-on learning experiences in virtual settings.

For policies, AI practices still present ethical issues regarding personal data privacy and protection,

thereby, institutions can develop policies to guard against these issues and ensure the responsible deployment of AI technologies in higher education. Moreover, higher education institutions must become involved in creating institutional collaborations and public-private collaborations with educational stakeholders to build guidelines, protocols, and policies for the collective good.

For future research, with an increasing number of studies on AI in education, researchers should keep a close eye on AI development and include both content analysis and in-depth quantitative analysis of relevant studies. More reviews are needed to synthesize how AI technologies can be applied in higher education to promote quality teaching and learning, improve users' confidence in using AI technology-assisted tools, and ensure safety, robustness, and prevention against cyberattacks. Furthermore, researchers must be involved in collaborative studies and projects to set research priorities, address current gaps and challenges, and expand AI implications to a broader level to benefit the society.

From the left: Dr. Saba Qadhi, and Dr. Fatma Kayan Fadlelmula.



Leveraging Artificial Intelligence to Revolutionize Research Funding Processes

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Introduction

The allocation of research funding is a complex process critical to driving scientific innovation, economic growth, and societal development. Funding agencies, ranging from government bodies to private foundations, are responsible for distributing limited resources to projects aligned with their strategic goals. However, these agencies face challenges, including inefficiencies, biases, and a lack of transparency in decision-making. As demand for research funding grows, adopting new technologies to enhance efficiency and fairness is increasingly necessary. This article explores how Artificial Intelligence (AI) can be integrated into the funding process, focusing on a strategic AI framework to optimize decision-making and improve transparency.

Challenges in Research Funding

Traditional methods, such as peer-review, have long been the gold standard of evaluating research proposals. However, these methods are not without inherent flaws. The peer-review process can be susceptible to biases, inconsistencies, and conflicts of interest, consequently, compromising the integrity of funding decisions. Additionally, the sheer volume of proposals can overwhelm reviewers, leading to delays and errors. Moreover,

the lack of transparency in decision-making often results in skepticism and mistrust among stakeholders, including researchers and the public.

Landscape Analysis

Before designing our AI framework, we conducted a landscape analysis to understand how funding agencies operate and whether they currently use AI tools. This analysis involved studying various funding agencies, their existing processes, and their challenges. We also examined AI tools available in the market, assessing their capabilities and limitations. This comprehensive study provided valuable insights that guided the development of our framework, ensuring it effectively targets the specific needs and gaps within the existing funding landscape.

AI's Potential in Addressing Challenges

AI offers a transformative solution to these challenges by automating and enhancing various aspects of the funding process. AI can streamline proposal evaluation, reduce bias, and increase the accuracy of funding decisions. To elaborate, AI algorithms can analyze the novelty and potential impact of research proposals more objectively than human reviewers alone. Additionally, AI can optimize the assignment of peer-reviewers to

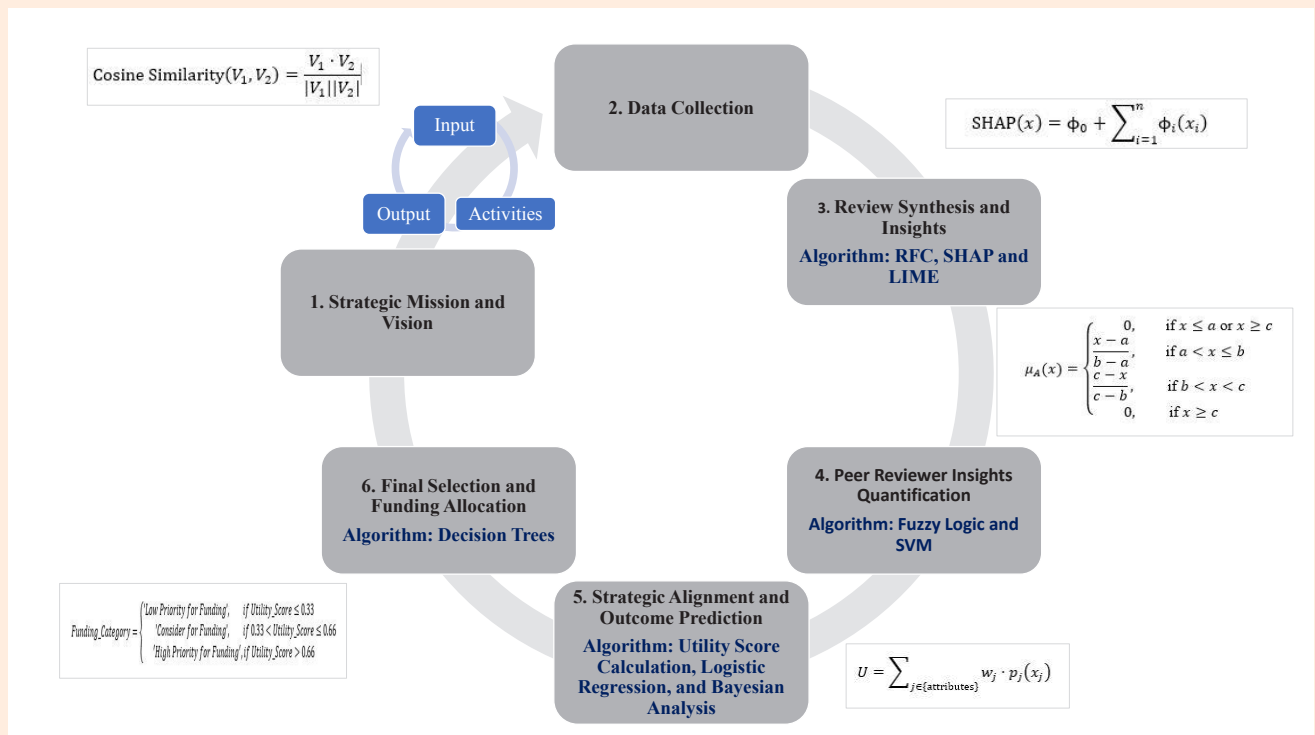


Figure 1: Proposed AI Framework for Decision-Making Processes in Funding Agencies.

proposals based on their expertise, ensuring that each proposal is reviewed by the most qualified individuals.

Proposed AI Framework for Funding Agencies

Integrating AI into the funding process requires a strategic framework. Our proposed AI framework for funding agencies, illustrated in Figure 1, consists of several key components, each designed to address specific challenges within the decision-making process. Below, we outline the primary stages of the funding process and the corresponding AI algorithms that can enhance each step:

1. Proposal Submission and Preliminary Screening

Algorithm: Natural Language Processing (NLP) and Semantic Analysis

At the initial stage, AI can conduct a preliminary screening of proposals. NLP algorithms analyze the text to identify key themes, objectives, and potential impact. Semantic analysis refines this by assessing alignment with the agency's strategic priorities. This automated screening filters out proposals that do not meet basic criteria, allowing human reviewers to focus on the most promising submissions.

2. Peer-reviewer Assignment

Algorithm: Machine Learning-based Expertise Matching

Assigning peer-reviewers to evaluate proposals is traditionally manual and time-consuming, often resulting in mismatches between reviewers' expertise and the content of proposals. A machine learning-based expertise matching algorithm can analyze past publications, research interests, and academic networks of potential reviewers to identify the best matches for each proposal. This ensures that proposals are evaluated by individuals with the most relevant expertise, improving the quality and reliability of the reviews.

3. Proposal Evaluation and Scoring

Algorithm: Fuzzy Logic and Multicriteria Decision Analysis (MCDA)

Evaluating research proposals is inherently

complex due to the subjective nature of the criteria involved, such as scientific merit, feasibility, and potential impact. Fuzzy logic and MCDA can handle uncertainty and subjectivity in this process. Fuzzy logic models' vague criteria, while MCDA weighs these criteria to produce a comprehensive evaluation score for each proposal. This approach ensures a more nuanced and balanced assessment of proposals, considering multiple factors influencing funding decisions. (Figure 2).

4. Decision Transparency and Explainability

Algorithm: SHAP (SHapley Additive exPlanations) and LIME (Local Interpretable Model-Agnostic Explanations)

Transparency and explainability are critical in ensuring trust in AI-driven decisions, particularly in research funding. SHAP and LIME are two algorithms that provide insights into how AI models arrive at their decisions. SHAP values offer a global interpretation by quantifying the contribution of each feature to the final decision, whereas LIME provides local interpretability by explaining the model's predictions for individual cases. By incorporating these tools, funding agencies can ensure that AI-driven decisions are transparent and



Dr. Hamad Al-Ibrahim

easily understood by stakeholders, as illustrated in Figure 3.

Ethical Considerations and Implementation Challenges

Integrating AI into research funding processes brings several ethical considerations. Algorithmic bias is a significant concern, particularly where funding decisions can profoundly impact careers and knowledge advancement. To mitigate this risk, AI systems must be trained on diverse datasets and continuously monitored for bias. Additionally,

funding agencies must ensure AI tools are used as decision-support systems rather than replacements for human judgment. Human oversight is essential to validate AI recommendations and to account for factors that may not be fully captured by algorithms.

Implementing AI systems in funding agencies requires careful planning and investment in technical infrastructure and expertise. Agencies must have resources to maintain and update AI tools, and staff must be trained to work alongside these systems effectively.

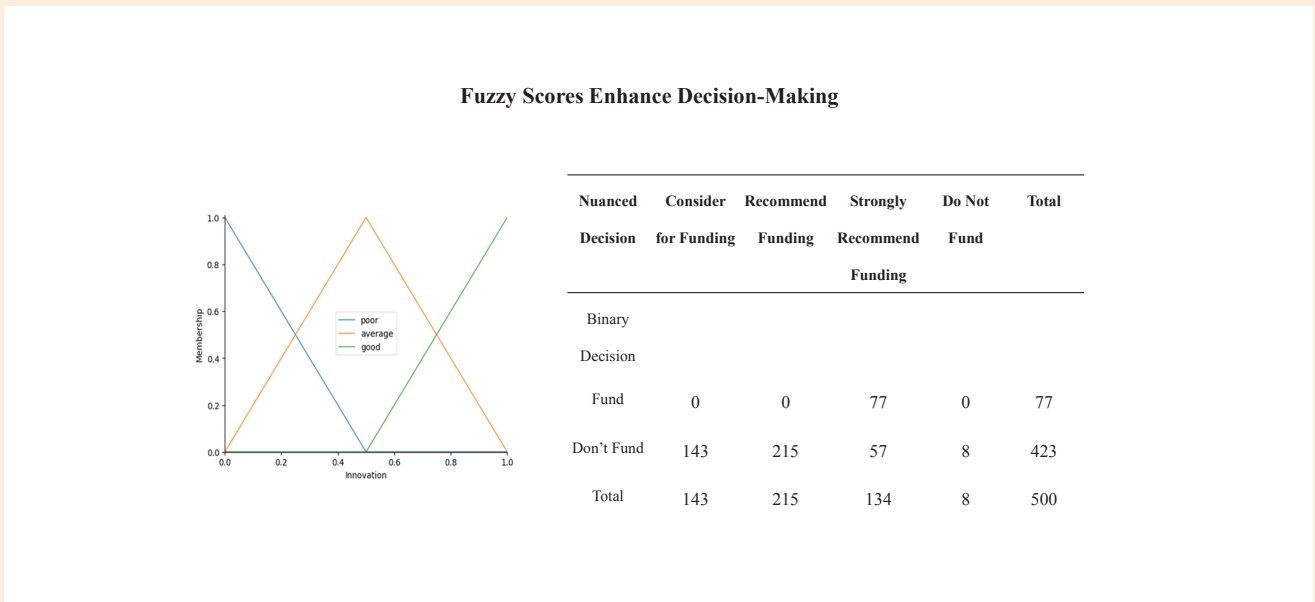


Figure 2: Fuzzy Scores for Proposals Evaluation.

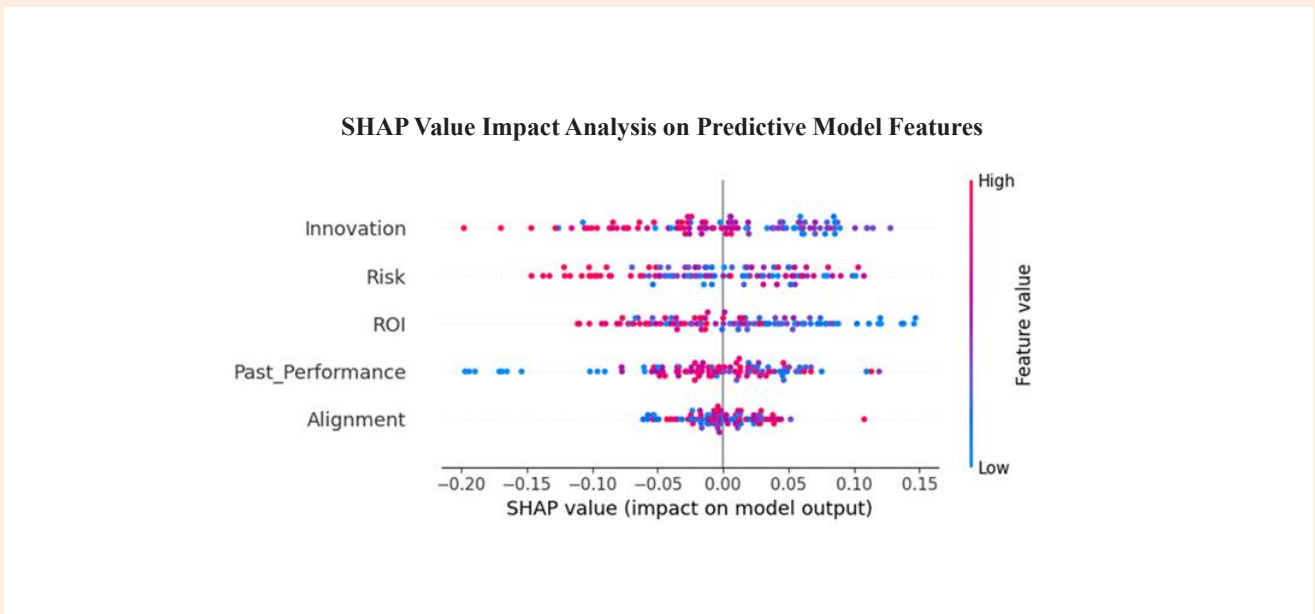


Figure 3: SHAP Value Scores for Feature Importance Evaluation.



Artificial Intelligence as a Mufti

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Note: The fatwas of this article are not intended to deliver reliable legal opinions, but they are illustrative examples.

First: Starting point

I asked, its Eminence, the Artificial intelligence (AI) Mufti, ChatGPT, about divorce, marriage, abortion, inheritance, oath, expiation, prayer, and circumambulation. It replied as follows:

Q1: Is it permissible for a Muslim woman to marry a non-Muslim man?

“In Islam, according to some jurists, a Muslim woman is allowed to marry a non-Muslim man provided that he shall be one of the People of the Book (a Jew or a Christian). However, there are varying opinions between scholars on this issue, as some of them consider that the marriage of a Muslim woman to a non-Muslim is not permissible.

“If you are considering this issue, it is important to consult a religious scholar or Islamic affairs specialist for guidance tailored to your conditions.”

Q: I asked it again, and it replied as follows:

“In Islam, marriage to non-Muslims is a controversial issue among scholars. In general, a Muslim woman is only allowed to marry a Muslim man. Marriage to non-Muslims is forbidden according to the majority of the schools of jurisprudence. However, there are some juristic opinions that consider this issue from a different perspective. They may refer to the possibility of marriage in certain cases, while emphasizing the importance of Islamic values and principles in marital life. **“It is always preferable to consult a reliable scholar for proper guidance depending on each respective**



Prof. Nouredine Khadmi

case.”

Q2: I swore that my wife would be divorced if she did such and such with the sole intention of threatening her. Please take into consideration that this matter happened three times. In the three cases, I had intercourse with her after swearing but I did not ask about the relevant juristic ruling. I did not intend that such oaths are valid or oaths of divorce, but they were oaths with the intention of threatening her. I swore a fourth oath with the intention of divorcing her. I want the legal opinion on this incident.

A: In your case, if you swear to divorce your wife with the intention of threatening her but you did not intend to divorce her, this is not considered divorce. However, if there are certain cases where you clearly harbor the intention to divorce her, especially in the fourth oath which was accompanied with the intention to divorce her, this is considered a valid divorce. **“It is preferable to consult a competent jurist or religious scholar to accurately identify your case and research the options available to you.”**

Second: Artificial Intelligence does not provide fatwa when it is unthoughtful

Meaning of unthoughtful (Ghaflan in Arabic).

The Arabic word “Ghaflan” has the same morphological feature of “Fa’lan”. It is derived from the verb Ghafal, which means to neglect or overlook something. This sentence is referring to the Ḥadīth which says **“Let the judge (Qadi) not pass a judgment when he is angry”**. This means that anger is considered a reason that shall make the judge refrain from issuing a legal ruling because justice may not be realized. The same ruling applies to excessive joy and extreme hunger and other such instances.

When delivering fatwa, it is noticeably known that AI is unthoughtful. This is manifested in its inattention to human intelligence in terms of the mufti’s acumen, talent, and skill. How can AI identify the feelings of anger, joy, and intention although all of them are closely related to divorce, financial transactions, litigations, trusts, etc.?

I am really satisfied that an artificial mufti is not suitable for providing fatwa, because it is inattentive to the senses and meanings. It is also absent-minded, disturbed, and holds multi-faceted views on the same issue. It is not a proper means to hopefully fix a problem with a reasonable fatwa. It is not equipped with the abilities of inference and deduction derived from the divine revelation and the science of jurisprudence. On the contrary, it is merely a reckless and inattentive

collection of information and sayings. Such collection could be an asset for a researcher, student, or mufti who shall employ their creative minds in discerning such collected information.

I became more satisfied with the incompetence of AI when I noticed the conditions of some of its audience who only search for quick information. They are enthusiastically superficial in terms of learning and awareness. They just lean on the rule: "Assign the issue to a scholar and you are safe".

The third recommendation of the conference on "Artificial Intelligence between Reality, Hope and its Legitimate Applications" stated: **"It is not permissible to rely on AI in issuing a fatwa. Artificial Intelligence is not suitable to be a source of fatwa or to play the role of the Sharia mufti."**

This recommendation is based on legitimate rules and considerable conditions, such as the rule of knowing the inquirer's conditions, intentions, sayings, objections, prerequisites, and all other respective circumstances. Such factors make the answer to the question conditional on all these requirements, while the mufti shall be concurrently armed with a comprehensive vision, deep thought, and solid skills. In addition, he should be characterized by piety, religiousness, foresight, and guidance, stemming from his legitimate and moral responsibility and his competence as a reference scholar. All such characteristics qualify him to attain the inquirer's trust and acceptance of his fatwa. In addition, the mufti may play a reformist and mentoring role which may drive the inquirer to change his mind and abandon some acts which he may intend such as divorce, litigation, filing claims, or initiating disputes.

Third: Machine simulation of abstract tales in the world of fatwas

The problem with AI in issuing fatwas is that it is an automatic mufti. It is similar to an ATM when provided with the necessary information. The ATM performs its role without asking you about the nature of the money, its sources, or channels of expenditures. The ATM has nothing to do with halal or haram, or the morals of the drawer of money, his nationality, or his relation with his wife in a shining morning or a dark night. Smartness of the ATM is restricted by its identity and its actions are governed by its technical components. The same applies to a device that is expected to be an alternative to a skilled and smart mufti who discerns into the personalities and diagnoses their features. He employs his sight, hearing, understanding of the rituals, and even his taste of poetry when assuming

his role. Technical automatic simulation is not a proper factor in the world of fatwas which is full of stories, narratives, facts and psychological conditions.

Fourth: Breathtaking stories of our Artificial Intelligence

Artificial Intelligence is a treasure of information used for socialization and studies. It is a powerful innovation with remarkable impacts due to the tremendous development of systems and technologies. It is an excellent tool for research, education, service, awareness and culture. It is a base and starting point for development, improvement, and advancement. We need to view it from the perspectives of permissibility and legitimacy. Such permissibility is manifested in terms of the useful achievements realized by people, scholars, institutions and various industries. Its legitimacy is measured in terms of its compatibility with moral values, Sharia rules, privacy and identity.

Scientists pointed out the limits of the use of AI, despite its importance and necessity. It became an indispensable necessity according to the terminologies of jurists. It should be used for useful purposes while its adverse effects should be avoided. Artificial Intelligence includes sets of systems and programs which could be used as a means to achieve public and personal interests. On the other hand, its potential negative effects should be avoided according to the rules of weighing pros and cons, considering actions and their consequences, as well as reasoning, facts and their practical applications. All such topics are researched in the valuable sciences of Sharia and occupy a notable place in the Islamic creed.

Fifth: Our Artificial Intelligence in Sharia research discussions and institutions

Our AI stems from human intelligence. Its course is identified by human intelligence which shall tame and harness such AI, so that it shall neither tyrannize nor violate the sanctities, especially in exclusive fields such as issuing legal Islamic rulings. In the discussions of legal stakeholders and the policies of university institutions in particular, there is an interactive and argumentative communication to adopt and develop useful techniques. The domains of such intelligence cover research, learning, planning, and service sectors. In this area, the institutions are inconsistent and may be competitive. However, the College of Sharia at Qatar University has been incredibly fortunate as it is steadily progressing in the field of information technology and digitalization, thanks to its accumulated strategic planning, innovative and original academic efforts, Islamic principles, national priorities, and extrovert attitude.

Harnessing Artificial Intelligence for Company Legitimacy

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In recent years, Artificial Intelligence (AI) integration has gained considerable attention due to its transformative potential across various company sectors. While numerous studies have explored AI's contributions to operational efficiency, competitiveness, and innovation, the extent to which companies align their AI practices with stakeholder expectations remains underexplored. This gap is particularly significant, as companies are under growing pressure to demonstrate that their AI strategies not only enhance company performance but also contribute positively to society. This study delves into this unexplored area, examining how companies use AI in their operations to align with societal expectations and maintain company legitimacy.

Company Legitimacy and AI Practices

Company legitimacy refers to the perception that a company's actions are appropriate and acceptable within societal norms, values, and beliefs. A company's legitimacy is essential for maintaining its reputation and fostering trust with stakeholders, including shareholders, employees, customers, regulators, and the general public. AI, as a rapidly evolving technological innovation, plays a critical role in shaping these perceptions. When AI is used ethically and responsibly, it can enhance company legitimacy by demonstrating the company's commitment to societal well-being, transparency, and innovation. However, irresponsible or opaque AI practices can damage a company's legitimacy, as stakeholders may view these actions as misaligned with societal values.

To examine how companies use AI to enhance their legitimacy, this study draws on the principles of legitimacy theory. According to this theory, companies must continuously adjust their activities to align with evolving societal expectations. This dynamic interaction between company actions and societal values is especially relevant in the context of AI, which affects various dimensions of company performance, including transparency, sustainability, and governance. By leveraging AI in a way that aligns with stakeholder expectations, companies will not only gain legitimacy, but also sustain it in the long-term.

UK AI Disclosure Practices

The United Kingdom serves as an ideal context for this study due to its strong regulatory framework surrounding AI development. The UK government's "AI Sector Deal" initiative, launched in 2018, has spurred significant investment in AI, positioning the country as a global leader in this technology. Consequently, UK-listed companies are under increasing pressure to disclose their AI activities in their annual reports.

This study examines AI-related disclosures in the annual reports of UK companies listed on the FTSE100 index from 2020 to 2023. These reports provide an important source of information for stakeholders and offer insights into how companies align their AI practices with societal expectations. This study analyzes these reports using a meaning-oriented content analysis approach, a qualitative method that goes beyond word counting to explore the deeper meanings and themes conveyed through corporate narratives.

Impression Management in AI Disclosures

Companies often employ impression management strategies to shape how stakeholders perceive their activities. These strategies can be categorized as either assertive or defensive. Assertive strategies are proactive and aim to highlight positive company achievements, whereas defensive strategies are reactive and seek to mitigate negative perceptions. In the context of AI disclosures, companies may use assertive strategies to emphasize their technological advancements and contributions to society, positioning themselves as leaders in innovation. Defensive strategies, on the other hand, might involve explaining or justifying controversial AI practices, such as data privacy concerns, to protect the company's reputation.

Findings and Implications

The findings suggest that UK companies use AI disclosures as a key tool for managing company legitimacy. By aligning their AI practices with stakeholder expectations, companies can enhance their reputation, demonstrate accountability, and foster trust with stakeholders. The study identifies several key themes in AI disclosures, including

transparency, sustainability, governance, and ethical compliance. Companies use these themes to convey a narrative that aligns with stakeholder expectations and enhances their social legitimacy.

One of the most significant findings is the dynamic nature of companies' usage of AI disclosures during periods of crisis and recovery. For instance, during the COVID-19 pandemic, many UK companies adopted defensive strategies in their AI disclosures, focusing on transparency and accountability to address the challenges posed by the crisis. These disclosures emphasized how AI technologies were used to maintain business continuity, ensure employee safety, and support affected stakeholders. In the post-pandemic recovery phase, companies shifted to more assertive strategies, highlighting their technological innovations and contributions to societal well-being. This shift underscores the importance of adaptability in company communication strategies, particularly in times of uncertainty.

This study also highlights the importance of transparency in AI disclosures. Stakeholders increasingly expect companies to provide clear and comprehensive information about their AI practices, particularly in areas such as data privacy, algorithmic fairness, and ethical governance. Companies that fail to meet these expectations risk damaging their legitimacy, as stakeholders may perceive them as lacking accountability or operating in ways that are misaligned with societal values.

Conclusion and Recommendations

This study provides important insights into how companies use AI disclosures to manage company legitimacy. By strategically aligning their AI practices with stakeholder expectations, companies can enhance their reputation, build trust, and sustain their social legitimacy. This study contributes to the literature on legitimacy theory and impression management by demonstrating how AI disclosures serve as a critical tool for navigating the complex relationship between company actions and societal expectations.

However, the study also acknowledges certain limitations. The qualitative nature of meaning-

oriented content analysis, while useful for uncovering deeper themes, is inherently subjective and may be open to interpretation. Future research could build on these findings by incorporating interviews with company managers to gain insights into the decision-making processes behind AI disclosures. Additionally, further research could explore how internal company entities, such as governance committees, influence AI disclosure strategies.

In summary, this study underscores the critical role of AI disclosures in maintaining company legitimacy. As AI continues to transform various sectors, companies must ensure that their use of this technology aligns with stakeholder expectations. By doing so, they can navigate the challenges and opportunities presented by AI while maintaining the trust and support of their stakeholders.

Dr. Nader Elsayed





Applications of Artificial Intelligence in
Special Education:

Towards Empowering and Enhancing the Capabilities of Students with Disabilities

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In recent years, the rapid advancement of technology has revolutionized numerous aspects of daily life, with computing power becoming a central force in modern society. One of the most ambitious goals of computer science is to understand and replicate human intelligence in its many forms. This pursuit has driven the development of Artificial Intelligence (AI) over the past five decades. AI is now recognized as a powerful tool in various fields, including education. This literature review aims to achieve two main objectives: Firstly, to create a comprehensive and systematic framework for classifying existing studies and research, which allows for a more in-depth analysis and broader understanding of the field. Secondly, to highlight critical research gaps and urgent needs, and to make them available to researchers and practitioners in the field, so that it goes beyond merely compiling existing literature, but also to stimulate progress in the field by identifying promising research paths that require further investigation and in-depth research. Additionally, aspiring to provide a solid foundation for researchers to build their future studies on, which contributes to the development of theoretical and applied knowledge in this field.

Project Overview

The research project involves conducting a systematic literature review to investigate the applications of Artificial Intelligence (AI) in special education, with a particular focus on supporting students with disabilities. This study aims to provide a comprehensive overview of how AI technologies are being utilized to enhance learning outcomes, increase engagement, and address the unique challenges faced by students with disabilities in educational settings.

Significance and Impact

The integration of AI into special education represents a significant leap forward in the ability to provide personalized, adaptive, and inclusive learning experiences for students with diverse needs. This research highlights several key areas where AI is making a substantial impact:

- 1. Personalized Learning:** AI-powered tools offer customized educational content tailored to each student's unique needs, knowledge levels, interests, and abilities. This personalization helps to optimize the learning process and improve academic performance.
- 2. Communication Support:** AI-driven assistive devices help students with disabilities overcome

communication barriers, fostering greater inclusion in the classroom and enhancing their ability to participate in educational activities.

- 3. Cognitive and Behavioral Interventions:** AI systems support the management of classroom behavior and encourage positive social interactions, which is particularly beneficial for students with cognitive or behavioral challenges.
- 4. Emotional Support:** Applications such as virtual reality and emotion recognition tools provide real-time feedback to assist students in regulating their emotions, an essential skill for many learners with disabilities.
- 5. Physical Support:** AI technologies, including robotic aids and smart prosthetics, enhance mobility and independence for students with physical disabilities, allowing them to engage more fully in educational activities.

The importance of this research cannot be overstated. As we move towards more inclusive educational models, AI offers the potential to revolutionize special education by providing tailored support that addresses the individual needs of each student. This not only improves learning outcomes but also has the potential to enhance the overall quality of life for students with disabilities by fostering greater independence and social integration.

Importance for Arab Countries

The literature review has revealed a significant gap in research on AI applications in special education within the Middle East. Out of the numerous studies examined, only three were conducted in this region. This underrepresentation highlights a critical need for increased investment in AI research and development, particularly in the context of special education, within Arab countries.

The limited research in this area suggests that the region may be at risk of falling behind in the global advancements of AI-driven education. This gap is particularly concerning given the potential of AI to address unique educational challenges faced in the Arab world, such as:

- 1. Inclusive Education:** Many Arab countries are working towards more inclusive educational systems. AI can play a crucial role in this transition by providing tools that support diverse learning needs within mainstream classrooms.

2. Language and Cultural Adaptation: AI systems can be developed to address the specific linguistic and cultural needs of Arab students with disabilities, ensuring that educational content and support are culturally relevant and accessible.

3. Resource Optimization: In areas where special education resources may be limited, AI can help extend the reach of existing resources through virtual tutoring, automated assessment tools, and adaptive learning platforms.

4. Teacher Support: AI can assist teachers in Arab countries by providing tools for early identification of learning difficulties, personalized lesson planning, and progress monitoring, enhancing the overall quality of special education.

5. Remote Learning: In regions where access to specialized education may be geographically challenging, AI-powered remote learning solutions can bridge the gap, providing quality education to students with disabilities in rural or marginalized areas.

By investing in AI research and development tailored to the unique cultural, linguistic, and socio-economic context of the Arab world, countries in the region can leapfrog existing educational challenges and create innovative, inclusive learning environments for students with disabilities.

Conclusion and Future Directions

This systematic literature review highlights the transformative potential of AI in special education. From personalized learning experiences to advanced assistive technologies, AI is opening new doors for students with disabilities, helping them overcome barriers and achieve their full potential.

However, the lack of research in this field within the Arab world presents both a challenge and an opportunity. There is an urgent need for increased investment in AI studies and development in special education across Arab countries. This investment should focus on:

1. Developing AI solutions that are culturally and linguistically appropriate for Arab students with disabilities.

2. Conducting rigorous studies to evaluate the effectiveness of AI interventions in local educational contexts.

3. Training educators and special education professionals in the use of AI technologies.

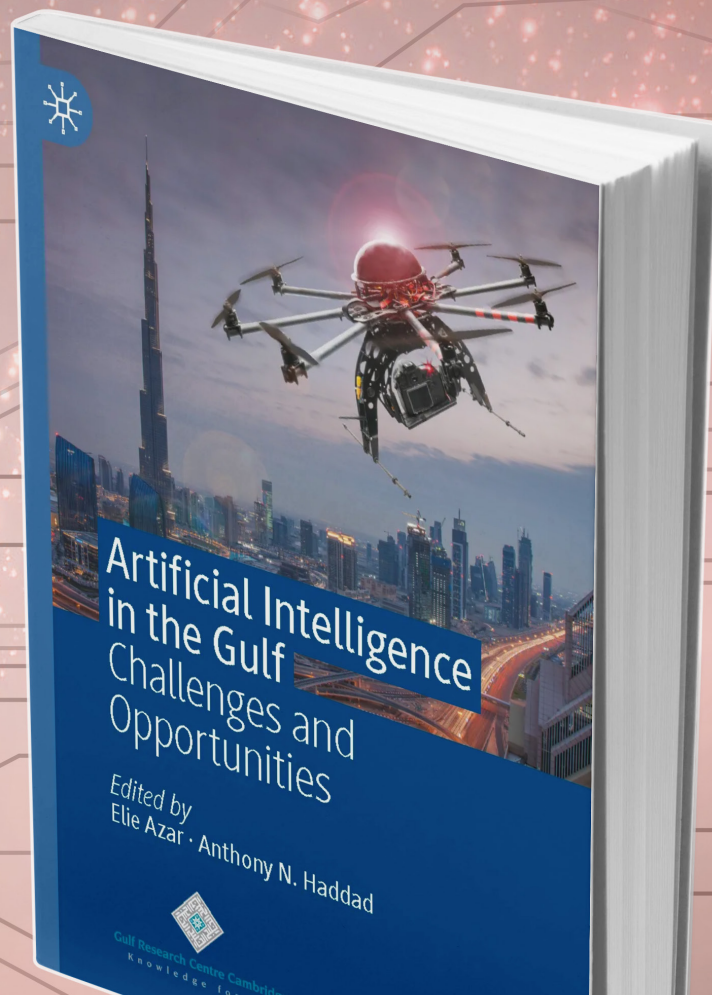
4. Fostering collaborations between educational institutions, technology companies, and government bodies to drive innovation in this field.

By prioritizing these areas, Arab countries cannot only catch up with global trends in AI-driven special education but also become leaders in developing innovative, culturally-sensitive solutions that benefit students with disabilities worldwide.

As we look into the future, the integration of AI in special education holds immense promise for creating more inclusive, effective, and empowering learning environments. This research serves as a call to action for increased focus and investment in this critical area, particularly within the Arab world, to ensure that all students, regardless of their abilities, have the opportunity to thrive in the digital age.



Prof. Maha Al-Hendawi



“Artificial Intelligence in the Arab Gulf States: Challenges and Opportunities”

**An upcoming publication by
Qatar University Press**

Qatar University Press (QUP) seeks to keep pace with global developments in thought and reading to benefit the Gulf and Arab readers with the latest developments, especially in artificial intelligence (AI).

QUP focused on searching for new publications in this field until it touched on one of the most prominent ones that dealt with AI; a book titled “**Artificial Intelligence in the Arab Gulf Countries - Challenges and Opportunities,**” covering the challenges and future opportunities for the Arabian Gulf countries in particular. The work was originally an edited book published in English by the Gulf Research Center in Cambridge at the end of 2021. QUP has obtained exclusive rights for translating the book into Arabic, and it will be available to readers in a few months.

The book is based on a selection of research papers presented at the “Artificial Intelligence in the Gulf: Prospects and Challenges” workshop, held on 15-18 July 2019 at the University of Cambridge in the United Kingdom as part of the annual Gulf Research Forum. Participants, including academics, practitioners, and policymakers in AI-related disciplines from the Gulf Cooperation Council (GCC) countries extensively discussed the research papers.

The book fills an important gap in the research published in this field, providing a comprehensive thought experiment that is the first of its kind on the challenges, opportunities, and impacts of AI in the GCC countries. In this regard, case studies were conducted to derive distinctive results and insights in various disciplines including engineering, policy building, governance, economics, social sciences, and data science. This book also includes the essence of a variety of ideas and lessons learned in AI, targeting professionals, academics, government officials, policymakers, decision-makers, business people, and non-governmental organizations.

The book consists of five main parts. Part I: **Introduction**; It includes two chapters, introducing the reader to the concept of AI in addition to reviewing previous works in the international and local contexts of the GCC countries, and identifying the gaps in the research works. Part II: **Data,**

Governance, and Regulations; includes three chapters that cover case studies on the enabling environment needed to leverage developments in the context of several cities in the GCC. Part III: **Existing Opportunities and Sectoral Applications**; includes three chapters that cover case studies of AI initiatives and applications in various sectors such as the financial sector, the economy sector, and the healthcare sector. Part IV: **Society, Utopia, and Dystopia**; includes four chapters that offer a unique social perspective on AI, as well as some insights drawn from studies on gender, religion, psychology, and happiness. Part V: **Conclusion**; provides an overview of the themes covered in the book’s chapters, and highlights the most important findings and recommendations for future research.

The work comprises sterile analyses of various aspects of AI at the national level in each of the Gulf countries. For example, Chapter 5 discusses ideas and perceptions about AI in the State of Qatar, trying to answer important questions, such as the necessity of subjecting AI to legal legislation, and the role of the government in developing legal legislation for AI in light of the increasing ethical, legal and security concerns about this technology.

For the UAE, Chapter 3 examines current procedures, barriers, and possible solutions for disclosing public sector information for academic research purposes in the country. It provides a framework for these solutions after they have been approved by government officials to facilitate data sharing in the country at the best level, which is considered one of the important prerequisites for research in data-based fields such as AI.

Moreover, Chapter 4 sheds light on the AI strategy in the Kingdom of Bahrain after analyzing the multiple stakeholders, and then discussing the strategy from different perspectives, including the availability of human capital, support from economic and financial institutions, as well as its alignment with national development plans, strategies, and priorities.

Thus, each chapter deals with a focused AI-related issue or question, in addition to discussing and centering on the challenges and opportunities it brings to the scene.