

A Journey with **Engineer Yasser Abdulrahim Al Abbasi**

Investing in National Competencies
is the True Guarantee of Industry
Sustainability



"Al Masaha 2050" Vessel Construction Project

An advanced national platform for carrying out marine
and geophysical surveying work

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In this Issue

A Journey with Engineer Yasser Abdulrahim Al Abbasi

CEO, The Gulf Petrochemical Industries Company
(GPIC)

8

"Al Masaha 2050" Vessel Construction Project

An advanced national platform for carrying out
marine and geophysical surveying work

20

The Sixth Bahrain Society of Engineers Award

Winning Projects

26

Articles

The Quiet Influence of Chemical Engineers on Sustainable Systems

Dr. Majeed Safar Jasim

36

Articles

Application of Artificial Intelligence to Photovoltaic Power Generation

Dr. Fawzi AlJowder

38

Contents

Message from the Editor-in-Chief	6
A Journey with an Engineer	8
Engineer Yasser Abdulrahim Al Abbasi	8
Profile	20
"Al Masaha 2050" Vessel Construction Project	20
The Six th Bahrain Society of Engineers Award: The winning projects	26
Bahrain Fashion Institute: Reviving the authenticity of fashion Bahrain	26
Real-Time Chemical Process Fault Detection Using Simulink and Aspen Dynamics	28
Sustainable Groundwater Management through Managed Aquifer Recharge (MAR)	30
Smart CANE: Computer-Aided Navigation Empowering the Visually Impaired	32
Design and Fabrication of Air Photovoltaic-Thermal (PV-T) Solar Collector for Domestic Applications	34
Articles	36
The Quiet Influence of Chemical Engineers on Sustainable Systems	36
Application of Artificial Intelligence to Photovoltaic Power Generation	38
Students Projects	42
Flexible Differential Relay	42
PET Bottle-to-Filament Recycling Machine with an Arduino-Based Thermal Control System	44
AI Machine Monitoring, Fault Detection, and Protection	46
Soft Starter for Single-Phase Induction Motor	48

Message from the Editor-in-Chief



Professor
Isa Salman Qamber

It seems easy for the Bahrain Society of Engineers to take advantage of Bahraini knowledge that has reached high levels after the dialogue between the Engineer Yasser Abdulrahim Al Abbasi, CEO of Gulf Petrochemical Industries Company (GPIC), and then the survey ship of the Survey and Land Registration Bureau in Bahrain. But, we should not ignore that Bahrain Society of Engineers has the obligation to adapt itself according to the current era, when the artificial intelligence has entered many sciences, including the science of engineering in its various branches. It is obvious that this science has been discussed in more than one issue in the current issue of "Al-Mohandis" magazine either in the form of the society's competitions, some articles, or graduation projects. So, we cannot overlook the fact that this science can reduce cost in the cost of the project since artificial intelligence helps in reducing cost, and it also helps in quickly generating ideas for achieving the goals effectively and efficiently.

GPIC is an example to follow among organizations operating within Bahrain for having an integrated approach towards employee training and empowerment over a period of forty years. The CEO of GPIC, Engineer Yasser Abdulrahim Al Abbasi, was interviewed by Al Mohandis Magazine. During the interview, he talks about the role of youth in the field, engineer development, and the importance of investing in national human resources. Also, he elaborates on the future vision of petrochemicals as well as the contribution of the Bahrain Society of Engineers to advance the engineering profession. With more than 37 years of experience and leadership within safety associations, he became the CEO of GPIC in 2021. Besides, he has memberships with regional and international organizations for fertilizers and safety. Furthermore, his contributions include leadership in occupational safety, health, and sustainability through affiliations with bodies like the NSC, RoSPA, IOSH, and NFPA.

"Al Masaha 2050," a program undertaken by the Survey & Land Registration Bureau in Bahrain to construct a sophisticated survey vessel "Al Masaha 2050," has the objective of creating a national platform for conducting high precision surveys of the sea, geophysical information and the environment to facilitate significant projects like the "Remaal." Some of its key objectives include evaluating hydrographic sand resources, promoting sustainable development, improving maritime safety and reducing reliance on foreign companies. The construction of the vessel "Al Masaha 2050," has been divided into four phases that include planning, design, manufacturing in the UAE and operations. Benefits of this initiative include the speed of surveys, flexibility, cost reduction and accurate information. However, problems include complex technology, human resource training and reliance on external sources.

Five selected winning projects are summarized. The first project revives traditional Bahraini fashion through a contemporary lens while redefining coastal heritage. It proposes a fashion institute at Manama's historic Furdah to reconnect people with the sea, countering land privatization. The design uses a free plan, traditional alnaqda patterns, and local coral stone cladding. A central courtyard, inspired by the housh, enhances light, airflow, and sea views while concealing services. A bold pyramid form with the naqda pattern contrasts geometric structure with local ornamentation, balancing tradition and innovation. The second project develops a real-time fault detection system for a methanol plant using Aspen HYSYS, MATLAB, and PCA. It dynamically monitors process anomalies to detect faults early, enhancing safety, reliability, and cost efficiency.

The framework minimizes downtime and optimizes long-term sustainability, adaptable to other complex chemical processes. The third project investigates Managed Aquifer Recharge (MAR) using Treated Sewage Effluent (TSE) and runoff in Bahrain. It uses GIS-based spatial modeling and multi-criteria evaluation to identify suitable MAR zones in the Dammam aquifer. Recharge volumes are calculated from natural and artificial sources, comparing them with abstraction levels and safe yield thresholds. The framework supports long-term groundwater management strategies in arid regions. The fourth project designs a smart cane for visually impaired users with obstacle detection, image recognition, GPS, and temperature sensing. Using YOLOv5, LiDAR, and a buzzer, it provides audio alerts; a GPS module enables location tracking. A companion website and app allow user

preferences and real-time data, improving safety and independence. Initial trials confirm successful obstacle detection and positive user feedback on the app integration. The fifth project combines PV electricity generation with an air-based solar collector for thermal recovery. A mathematical model and CFD analysis optimize duct geometry (17 mm gap, 0.04 m height) and airflow (0.085 kg/s, 2.5 m/s). The system achieved 338.7 W useful heat gain and 59% thermal efficiency; outlet air temperature rose from 21 °C to 27 °C. Testing showed improved electrical output due to thermal regulation, confirming dual benefits for sun-rich climates.

The segmented stator permanent magnet-excited transverse flux machine (Segmented stator PM-TFM), as introduced in the work by Dr. Salwa Baserrah in her Arabic article, is one of the promising directions of research for the application of in-wheel motors, because of its good torque density and reliability. Additionally, in spite of its complicated design and control, the purpose of the article is to get a compact design out of it, which will be having the maximum power density that can make it a potential motor for low-speed vehicle propulsion applications. For this purpose, the author also made a small-scale prototype of the motor and verified it.

With the introduction of AI technology, there will be a drastic change in the design and methods of infrastructure implementation because the artificial intelligence system is used in relation to designing smart systems and collecting, managing, and analyzing data regarding the safety and quality-related concerns. As for the mentioned topic, it is also discussed in an article by Engineer Shouq Al-Koheji, written in Arabic language, because the relevant sector of the industry (i.e. roads) brings certain changes to the pathway of energy use, maintenance predictions, and intelligent control, which is due to intelligent

traffic management. Consequently, the possible challenges include expensive nature of AI implementation and security-related problems, while benefits may be demonstrated by cost savings of 20%.

The writing of English language article by Dr Majeed Safar Jasim discusses how chemical engineering contributes to sustainability through the efficient handling of processes. Chemical engineering is one field where the primary focus is on achieving efficiency and minimizing waste in processes, which is done amidst some of the strictest of environmental constraints, for instance, those related to carbon capture, hydrogen generation, wastewater recycling, and sustainable materials. They have several things to consider when it comes to sustainability to ensure that sustainability efforts do not result in the transfer of problems from one area to another. With sustainability turning out to be one of the constraints of engineering, chemical engineers turn environmental ambitions into reality.

Maximum Power Point Tracking (MPPT) increases the efficiency of PV systems. MPPT has been discussed in the article written by Dr. Fawzi AlJowder. The article is written in English. Predicting the output power by machine learning is one more advantage of AI, which also includes predictive maintenance. Also, through management of demand for supply and stabilizing the variations in voltage and frequency, AI allows PV systems to be integrated into the grid.

Four projects that are discussed in this issue are Graduate Projects. Firstly, the Transformer Differential Protection is an issue which was addressed by creating a low-cost differential relay that was programmable with the help of LabVIEW. The development was needed to fill the gap in undergrad studies and avoid problems such as CT saturation and inrush,

making use of NI hardware. Testing on the single-phase transformer ensured that the relay operated at <0.10 per-unit current level with correct harmonic restraint during inrush. However, the output test showed no results because of lack of hardware in lab. The second project focuses on the topic of PET Bottle Recycling into 3D Filament. Arduino controlled device was created with the goal to make a compact system of plastic recycling more temperature stable with multi-stage PWM pulses that were programmed based on various external variables such as temperature in a room and the amount of plastic material. Successful testing helped to produce 1.7-2.0 mm filament. Third Project covers DC Motor Fault Detection. A GOF AI based rule engine combined with EMA filters on a microcontroller has been used to distinguish between 14 possible conditions including mechanical fault, power supply anomaly, and overloading. MATLAB / Simulink simulation has verified the system functionality and practical implementation has confirmed real-time monitoring, automatic safety relay tripping, and online dashboard, all without much overhead costs and with intelligent features for predictive maintenance. Fourth Project describes Soft Starter for single-phase induction Motors. It uses TRIAC gate triggering circuit with phase angle control in order to reduce inrush currents during starting process. For capacitor start and run motors, a soft starter in MATLAB Simulink has been designed such that the gate trigger signals begin with a delay of 90 degrees (5 ms), then linearly decrease to zero. Soft start time is 10 ms and a 10 ms delay is considered for two-way control. In addition, snubber networks protect from switching noise while constant mechanical load torque ensures smooth operation. Inrush currents have been significantly lowered and any mechanical shock avoided compared to direct-on-line starting scheme.

A Journey with
an Engineer

Engineer Yasser Abdulrahim Al Abbasi

GPIC's CEO:
Youth, Innovation, Digital
Transformation, and Sustainability
are the Pillars of the Future of the
Industrial Sector in Bahrain



With all the transformations occurring in the international industrial sector and the new challenges that the fourth industrial revolution presents to engineering skills, there is a need to invest in youth and their empowerment to shape the future of the industrial sector. Gulf Petrochemical Industries Company (GPIC) is one of the national role models in the development of skills in Bahrain, having succeeded in establishing an integrated system of training and empowerment over more than four decades.

In the following interview with "Al Mohandis" magazine, Engineer Yasser Abdulrahim Al Abbasi, CEO of GPIC, talks about the role of youth in the industrial sector, the development of engineers, the requirements of future engineers, the company's experience in investing in national human capital, his vision for the future of the petrochemical industry and the role of Bahrain Society of Engineers in improving the engineering profession.

How does Gulf Petrochemical Industries Company view the role of youth in supporting its journey and achieving its future goals?

Young Bahrainis today are among the most important pillars of success and sustainability across various economic sectors. This importance takes on even greater dimensions in the industrial sector, which is witnessing rapid technological developments, digital transformation, and sustainability initiatives. Gulf Petrochemical Industries Company (GPIC) views youth as a cornerstone of its development and as true partners in shaping the company's future and enhancing its competitiveness.

The company believes that investing in human capital is no less important than investing in technologies and industrial facilities; it is the foundation upon which the journey of development and excellence rests. Therefore, the company is committed to attracting promising nationals, providing a supportive and motivating work environment that enables them to gain practical experience and specialized knowledge, and developing their professional and leadership capabilities to enhance their readiness to meet future demands.

This approach aligns with the Kingdom of Bahrain's Economic Vision 2030 and the great importance that the wise



According to Gulf Petrochemical Industries Company (GPIC), investment in human resources is equally important as investment in technologies and industries because it is the base of all success and achievements

leadership attaches to empowering youth and preparing them to contribute actively to national development. The company also draws inspiration from the vision led by His Highness Shaikh Nasser bin Hamad Al Khalifa, the Representative of His Majesty the King for Humanitarian Work and Youth Affairs, President of the Supreme Council for Youth and Sports, and Chairman of the Board of Directors of Bapco Energies, which focuses on investing in young Bahrainis, promoting innovation, and building generations capable of leading the future of vital sectors, including the energy and industry sectors.

The company's commitment to developing young Bahrainis also aligns with the directives and keen interest of the Board of Directors of Gulf Petrochemical Industries Company, chaired by His Excellency Dr. Mohamed bin Mubarak bin Daina, Minister of Oil and Environment and Special Envoy for Climate Affairs, who consistently emphasizes the importance of investing in human capital, empowering Bahraini youth, and preparing qualified national leaders capable of continuing

the journey of success and excellence that the company has achieved over more than four decades.

The company also places great importance on involving youth in various operational, technical, and administrative area, providing them with direct exposure to the nature and requirements of the industrial vocation and contributing to the development of a generation of young Bahrainis capable of continuing the company's decades-long journey of excellence.

The role of youth in the company is not limited to executing operational tasks; it also includes active participation in company committees and strategic projects. The company is keen to involve young talent in technical and development committees, enabling them to contribute to decision-making and present development ideas and initiatives. This approach helps develop innovation and creativity skills, enhances a sense of responsibility, and prepares a generation of national leaders capable of leading the future company and the industrial sector.



Gulf Petrochemical Industries Company GPIC is aware of the fact that young people have huge potentials and innovative minds along with being highly adaptable to change. That is why we are always willing to provide them with an opportunity to be involved in development projects

We believe that young people possess great energy, fresh ideas, and a high ability to adapt to changes. Therefore, we are keen to allow them to participate in developmental initiatives and continuous improvement programmes, which reinforce a culture of innovation and prepares them to take on future leadership roles within the company and the industrial sector in general.

This institutional approach yields tangible results, as the company's efforts in empowering youth and developing their capabilities have been recognized at both the national and international levels by winning the King Hamad Award for Youth Empowerment to Achieve the Sustainable Development Goals, which is granted to leading institutions in supporting and empowering youth and involving them in achieving the United Nations SDGs. This achievement is the culmination of the company's ongoing commitment to providing training and professional and leadership development opportunities for Bahraini youth, enhancing their active participation in various operational, engineering, and administrative fields, thereby contributing to preparing qualified nationals

capable of leading the future of industry and supporting the sustainable development journey in the Kingdom of Bahrain.

What are the most prominent programmes and initiatives offered by the company to qualify engineers and young Bahrainis?

Gulf Petrochemical Industries Company places human capital development at the forefront of its strategic priorities, based on its firm belief that an organization's success and sustainable performance are closely linked to the competence of its employees and their ability to keep pace with rapid developments in the industrial environment.

The company provides an integrated system of training and professional development programmes, including on-the-job training, specialized technical programmes, professional workshops, future leadership preparation programmes, and mentoring and career guidance programmes that enable young employees to benefit from the expertise of their peers and those with accumulated experience.



The four pillars that form the core of the future of the industrial sector in Bahrain are youth, innovation, digitalization, and sustainability

The company also ensures that employees are given opportunities to participate in developmental projects and multidisciplinary assignments, as this positively impacts practical experience and the development of teamwork skills, analytical thinking, and decision-making.

The company's focus is not limited to technical aspects; it also extends to developing personal, leadership, communication, and project management skills, as these are essential for an engineer's success in the modern work environment. The company also encourages its employees to continue their education and professional training, and to obtain specialized certifications that contribute to raising their competence and enhancing their professional capabilities.

This commitment translates into continuous investment in training and development, with total annual training hours exceeding 30,000 and averaging 75 hours per employee. The company also annually hosts nearly 200 male and female trainees from schools and universities through practical training and professional qualification programmes, aimed at bridging academic education and industrial practice and preparing qualified Bahrainis for the labour market.

The company places special emphasis on programmes to prepare and qualify students and youth before they enter the labour market. It operates the Industrial Training & Takween programme, which continues to expand year after year, providing a comprehensive training experience for school and university students, enabling them to gain practical experience and become familiar with the industrial work environment and its requirements.

The company also supports academically distinguished students through educational and professional sponsorship programmes. Over the past three years, it has sponsored and supported the participation of 205 university students in local and international scientific and professional conferences and forums, aiming to enhance their knowledge, broaden their horizons, and provide them with opportunities to learn about the latest developments in engineering and industrial fields.

As part of its social responsibility towards youth, the company actively participates in the programmes of INJAZ Bahrain, where 73 volunteers from the company have contributed to



The role of GPIC (Gulf Petrochemical Industries Company) lies in ensuring that there will be capable nationals that can play a key role in building the future of the industry as well as the sustainable development of Bahrain

delivering mentoring and training programmes for students and youth, sharing their professional expertise with them, thereby enhancing their readiness for the labour market and increasing their ability to contribute to the national development process.

The company also adopts a range of programmes and initiatives aimed at developing leadership capabilities and enhancing personal skills among youth, including the Toastmasters programme, which contributes to developing public speaking, communication, and leadership skills, in addition to the E-Learning system that provides employees with an average of 60 electronic training courses per person in various technical, administrative, and leadership disciplines. These initiatives, along with other training and development programmes, have enhanced the readiness of young Bahrainis and empowered them to take on more impactful roles in the modern industrial work environment.

These efforts and high-quality programmes have resulted in consolidating the company's position as a pioneering national model in the field of human resource development and youth empowerment, as exemplified by its receipt of

the King Hamad Award for Youth Empowerment to Achieve the Sustainable Development Goals, in recognition of its distinguished efforts in preparing and qualifying Bahraini youth and enhancing their participation in achieving the United Nations SDGs.

How is the company preparing to keep pace with rapid industrial and technological transformations?

The global industrial sector is witnessing an unprecedented phase of transformation driven by rapid developments in artificial intelligence, digital transformation, data analytics, industrial automation, and smart technologies. These variables require industrial organizations to adopt a more flexible and innovative approach to maintain their competitiveness and enhance their capacity for sustainable growth.

This approach enjoys the support and follow-up of the company's Board of Directors, chaired by His Excellency Dr. Mohamed bin Mubarak bin Daina, Minister of Oil and Environment and Special Envoy for Climate Affairs, who places special emphasis on promoting innovation, digital transformation, and sustainability, thereby contributing



Petrochemical Industries Company (GPIIC) seeks to nurture competent citizens capable of steering the future of the industry and contributing to its sustainable development in the Kingdom of Bahrain

to consolidating the company's pioneering position and aligning its strategic plans with national directions and global best practices in the industrial sector.

Gulf Petrochemical Industries Company continues to invest in developing its operational systems and upgrading its technical infrastructure to keep pace with the latest industrial developments, alongside fostering a culture of innovation and continuous improvement among its employees and encouraging them to employ modern technologies in raising operational efficiency, improving performance, and enhancing productivity.

The company's future vision is based on integrating technological and human resource development, as it is keen to prepare qualified engineering and technical employees with the skills needed to address smart industry applications, digital transformation, and data analytics, in line with the requirements of the Fourth Industrial Revolution.

The company believes that digital transformation is not limited to adopting modern technologies, but also includes developing the work culture, enhancing human capital readiness, and enabling them to make optimal use of these technologies to achieve operational, environmental, and economic goals efficiently and effectively.

The company also places increasing importance on sustainability, resource efficiency, and energy efficiency, as they are among the fundamental pillars of the future of the global industrial sector, and seeks to integrate these concepts into its various development plans and programmes to maintain its competitiveness and industrial leadership.

What skills does the future engineer need considering these transformations?

The requirements of the engineering labour market today has become more comprehensive and complex than ever before. Professional success no longer depends solely on academic and specialized knowledge but is now linked to the engineer's ability to adapt to changes and keep pace with rapid technological developments.

The future engineer needs a solid scientific foundation in their field of specialization, along with analytical, problem-solving, critical-thinking, and innovation skills—skills that have become essential for navigating the challenges and opportunities of the modern work environment. Furthermore, familiarity with digital technologies, data analytics, artificial intelligence, and smart systems is becoming increasingly necessary, given the pivotal role these technologies play in industrial operations and in improving their efficiency.

Equally important are communication, teamwork, and project management skills, as modern engineering work environments rely on collaboration and integration across disciplines and relevant parties to achieve common goals and complete projects efficiently.

Lifelong learning has also become one of the most important requirements for professional success in the modern era, given the rapid evolution of knowledge and technologies. A successful engineer is committed to continuously developing their skills and updating their knowledge, enabling them to contribute effectively to the organization's development, enhance its ability to achieve its goals, and keep pace with future requirements.



A great deal of emphasis is placed on youth participation in numerous committees and projects whether internal or external because participation by the youths at this stage is crucial in developing their ability of leadership and innovation

What is the importance of occupational safety in the industrial sector?

Occupational safety is the cornerstone of any successful industrial organization. It is not limited to compliance with systems and procedures; it represents an integrated institutional culture and a deeply rooted value that must be reflected in the daily practices of all employees at all organizational levels.

At Gulf Petrochemical Industries Company, occupational safety and health are among the top areas of priority, treated as a core, non-negotiable value under any circumstances. Human safety always comes first, followed by the protection of industrial assets, the environment, and the community. Based on this approach, the company is committed to applying the highest global standards in occupational health and safety and providing specialized training programmes aimed at raising awareness and embedding a culture of prevention and risk management.

This commitment translates into tangible, practical initiatives and programmes, where each employee receives an average of 27 training hours annually in the fields of Safety, Health, and Environment (SHE). The company has also succeeded in training and certifying nearly 50% of its employees as first aiders, exceeding the minimum required under local

regulations of 5%, reflecting a high level of awareness and a deeply rooted safety culture in the work environment.

The company also believes that safety is a shared responsibility that starts with senior management and extends to all employees and contractors, and that the true success of any industrial organization is measured not only by production rates or financial performance but also by its ability to achieve those priorities within a safe and sustainable work environment.

What role do innovation and multidisciplinary work play in the success of industrial organizations?

Considering the increasing challenges facing the industrial sector, innovation has become one of the most important factors for success and sustainability, as organizations can no longer maintain their competitiveness without adopting a culture of continuous development, encouraging new ideas, and leveraging creative human energy.

Gulf Petrochemical Industries Company is keen to provide a stimulating work environment that fosters creativity and encourages employees to submit development proposals and participate in continuous improvement programmes, thereby contributing to improved operational efficiency, enhanced productivity, and improved performance.



Several young workers participate as members of committees related to operations and technology as well as committees involved in improvement and developmental activities that contribute towards the achievement of organizational objectives

The company also places great importance on empowering youth by involving them in various committees and projects, believing that early participation in specialized committees helps refine leadership and decision-making skills and develop innovative thinking. Many young employees participate in operational and technical committees, as well as improvement and company development programmes, which enhance their direct contribution to achieving the company's goals and supporting the continuous development journey.

This participation extends outside the company through young nationals representing the company in several specialized regional and international committees and bodies, including committees of the Gulf Petrochemicals and Chemicals Association (GPCA), the Arab Fertilizer Association (AFA), the Regional Committee for the Chemical Industry (RC), the Project Management Society (PSM), and other relevant professional organizations. These contributions facilitate the exchange of knowledge and expertise, build professional partnerships, and enhance the young employees' readiness to keep pace with global best practices in the industrial sector.

Moreover, the nature of modern industrial work requires close collaboration among various engineering, technical,

and administrative disciplines. The success of these projects and initiatives depends on the integration of efforts and the exchange of experiences and knowledge among all relevant parties.

This underscores the importance of multidisciplinary teamwork, which enables the benefit of diverse perspectives, the development of more comprehensive and effective solutions, and the enhancement of the organization's ability to address challenges and achieve its strategic goals with elevated efficiency.

Based on the company's belief in the importance of empowering youth and involving them in the company's development journey, it has launched and adopted several high-quality initiatives that foster a culture of innovation and creativity, most notably the "Rising Star Competition," which encourages young employees to propose developmental ideas, along with the "Youth Podcast" initiative, which provides a platform for communication, knowledge exchange, and highlighting outstanding experiences and initiatives within the company. These initiatives integrate youth participation in company committees and projects, reinforcing a spirit of innovation and responsibility and



Employing the youth in different spheres of operational, technical, and administrative activities, which would allow them to understand the essence of industrial work

helping prepare future national leaders capable of continuing the journey of success and excellence.

These initiatives integrate with the programmes of company committees and projects that provide youth with the opportunity to directly contribute to performance development and decision-making, thereby enhancing the spirit of responsibility and innovation and helping prepare future national leaders capable of continuing the journey of success and excellence.

How do you view the role of the Bahraini engineer in supporting national development?

The Bahraini engineer has proven over the past decades their high competence and ability to contribute effectively across various vital sectors and has been a key partner in implementing many national projects that have supported the economic and social development witnessed in the Kingdom of Bahrain.

Today, with the accelerating pace of industrial and

technological development and the accompanying transformations in the fields of energy, industry, infrastructure, environment, and digital transformation, the role of the Bahraini engineer in leading strategic initiatives and projects and contributing to developing innovative solutions that support sustainable growth and enhance the Kingdom's competitiveness, has become increasingly important.

The Bahraini engineer is distinguished by their ability to adapt to change and keep pace with rapid developments, grounded in a solid scientific and professional foundation, as well as by their sense of responsibility and hard work. The education, training, and professional development system has also contributed to the preparation of qualified nationals with the necessary competence and experience to compete and excel in various engineering fields.

We are confident that Bahraini engineers will continue to play a pivotal role in achieving the Kingdom's development aspirations, supporting its economic journey, and enhancing its competitive position at regional and international levels through their high-quality contributions across vital sectors.



The Gulf Petrochemical Industries Company (GPIC) is interested in improving the relationship between its young cadres and the international engineering community to help them develop professionally

At Gulf Petrochemical Industries Company, we are proud to have 127 Bahraini engineers working across various engineering disciplines, representing nearly 27% of the company's total workforce and performing key roles in operations, maintenance, projects, engineering, and institutional development.

How do you view the role of the female engineer in the industrial sector?

The female citizens of Bahrain have made great strides in engineering and science, demonstrating their ability to hold multiple positions in technology and leadership. They are now one of the pillars of development in the Kingdom of Bahrain.

In particular, in relation to the industrial sector, the role of the female engineer has been successful in asserting herself through proving her worth in such areas as project management, operational technical areas, and organizational development, having contributed significantly towards realizing many qualitative achievements, thus highlighting the high degree of academic and professional competency possessed by Bahraini women.

Gulf Petrochemical Industries Company (GPIC), however, recognizes the importance of fostering an encouraging and motivating environment to ensure equal opportunities for the development and growth of all employees, and is proud of the contributions made by female engineers in Bahrain who operate in different departments within the company. The company currently employs eight Bahraini female engineers who specialize in various engineering disciplines and contribute significantly to the process and development.

An increase in women's contributions in engineering will lead to a more enriching workplace environment and a wider range of contributions.

What is the importance of professional associations, foremost among them the Bahrain Society of Engineers, in the development of the engineering profession?

Professional associations play a pivotal role in supporting and developing various professions. This role is particularly prominent in the engineering sector, which is witnessing rapid developments that require continuously keeping up with scientific and technical advancements, as well as enhancing opportunities for communication and the



The Gulf Petrochemical Industries Company (GPIC) remains committed to investing in the development of human resources, technology infrastructure, and innovation and sustainability programs, which helps in contributing to the competitiveness of the company

exchange of knowledge and expertise among practitioners of the profession.

Since its establishment, the Bahrain Society of Engineers has undertaken a leading role in serving engineers and advancing the engineering profession in the Kingdom, through the conferences, scientific forums, training programmes, and professional activities it organizes that contribute to enhancing engineering knowledge and keeping pace with global best practices and developments across various specializations.

The Society also serves as an important platform that brings together engineers across sectors, enhances communication among them, and builds bridges of cooperation among academic, industrial, and professional institutions, thereby supporting the development of national competencies and enhancing their readiness for labour market requirements and future challenges.

We encourage young engineers to engage in the Society's activities actively and benefit from the programmes, initiatives, and opportunities it provides, as this positively impacts the development of their professional skills and the expansion of their professional networks.

Based on Gulf Petrochemical Industries Company's belief in the importance of organized professional work and its role in developing national competencies, all Bahraini engineers working at the company, including our youth, are members of the Bahrain Society of Engineers, which reflects the company's commitment to strengthening its young

employees connection to the engineering community and contributes to their continuous professional development.

What message would you like to convey to engineering students and new graduates?

My message to engineering students and new graduates is that engineering is not merely an academic discipline or a professional job; it is a calling and a responsibility that directly contributes to building societies, supporting development journeys, and improving the quality of life. The engineer's role is not limited to designing solutions and executing projects; rather, they participate in shaping the future, confronting challenges, and identifying opportunities that contribute to achieving progress and prosperity.

I call upon you to strive to build a solid scientific foundation, to take advantage of every opportunity to learn and gain practical experience, and never to stop developing your skills and knowledge throughout your professional career. I also encourage you to embrace a spirit of initiative and innovation, and to uphold the values of integrity, discipline, and professional commitment as fundamental pillars of success and excellence.

In a world witnessing rapid developments and successive technological transformations, success now requires combining technical excellence with the ability to communicate effectively, work in teams, and lead. Therefore, developing personal skills is no less important than developing technical and specialized skills.

Finally, the Kingdom of Bahrain is rich with distinguished national competencies and promising opportunities, and I am confident that the next generation of Bahraini engineers possesses the ambition, competence, and ability to innovate that qualify them to continue the journey of achievements and contribute to building a more prosperous and sustainable future for our dear nation.

How do you see the future of the petrochemical industry in the Kingdom of Bahrain?

The Kingdom of Bahrain has a strong foundation on which its industrial and petrochemical sectors can continue to develop and become more competitive, given its developed infrastructure, competent national workforce, strategically advantageous geographic position, and ongoing governmental support for the industrial sector.

The future of the petrochemical industry relies heavily on the adoption of technology and the application of artificial

intelligence, digital transformation, data analytics, value-added product development, and resource and energy efficiencies, in compliance with global trends toward sustainability, emissions reduction, and responsible growth.

For our company, Gulf Petrochemical Industries Company, the future of the petrochemical industry will be associated with much more than just production growth. We at Gulf Petrochemical Industries Company believe that the future lies in innovation and sustainability, as well as in attracting and qualifying a competent national workforce capable of leading the next phase of development. This perspective allows us to focus our investments on human resource development, digital infrastructure improvement, and innovation and sustainability initiatives, which help support the company's competitiveness and its contribution to the national economy.

Profile of Engineer Yasser Abdulrahim Al Abbasi

Engineer Yasser Abdulrahim Al Abbasi is the CEO of Gulf Petrochemical Industries Company (GPIC). He holds a Bachelor of Science (BSc) in Electrical Power Systems from the University of Bahrain and an MBA in Financial Management from Hull University in the United Kingdom.

He has more than 37 years of professional experience in the petrochemical and agri-nutrient sectors; over the years, he held various supervisory and

management positions at the company, culminating in his appointment as CEO in 2021.

Yasser is a member of various specialized regional and international institutions and organizations, including the International Fertilizer Association (IFA), Gulf Petrochemical & Chemical Association (GPCA), and Arab Fertilizer Association (AFA). In addition, he was also a member of the Supreme Council of Occupational Safety and Health for the Ministry of Labour and Social Affairs in Bahrain and

served as the Deputy Chairman of the Bahrain Health and Safety Society. Also he actively involved with prominent international organizations including the USA National Safety Council, where he has served as a judge for the Campbell Award; the UK's Royal Society for the Prevention of Accidents (RoSPA), where he served as a judge for the International Dilmun Environmental Award; the Institute of Occupational Safety and Health (IOSH), UK; and National Fire Protection Agency (NFPA), USA.



"Al Masaha 2050" Vessel Construction Project

An advanced national platform for carrying out marine and geophysical surveying work

Introduction:

"Al Masaha 2050" vessel construction project aims to provide an advanced national platform for conducting hydrographic survey (bathymetry) and geophysical survey (identifying the locations and quantities of marine sediments) operations, as well as supporting and coordinating the collection of marine samples for analysis purposes in line with the needs of the Supreme Council for the Environment. This serves major national projects, foremost among them the "Remaal" project, in addition to other coastal and marine projects in the Kingdom of Bahrain.

The general objectives of the project are as follows:

- Conduct high-precision marine, geophysical, and environmental surveys within territorial waters.
- Support projects for the exploration and assessment of marine resources, particularly marine sand within the Remaal project.
- Provide reliable marine data to support planning and sustainable development.
- Enhance navigational safety and produce official nautical charts and products.
- Reduce reliance on external companies and build sustainable national capabilities.

Strategic Objective of the Project

The "Masaha 2050" vessel construction project is directly linked to the strategic objectives of the Kingdom of Bahrain and is a key enabler for the implementation of the Remaal project. It aims to:

- Enable Bahrain to assess marine natural resources (marine sand) in a precise scientific manner.
- Support decision-making for reclamation projects, urban development, and infrastructure.



His Royal Highness Prince Salman bin Hamad Al Khalifa, Crown Prince and Prime Minister, may God protect him, delegated Lieutenant General His Excellency Shaikh Rashid bin Abdullah Al Khalifa, Minister of Interior, on Sunday, September 7th, 2025, to inaugurate the advanced research vessel "Al-Masaha 2050", in the presence of a number of Their Excellencies and Highnesses, senior officials

- Ensure the establishment of a national marine database to support long-term projects..
- Achieve optimal utilization of marine natural resources in line with environmental sustainability requirements.
- Enhance institutional integration among entities involved in major marine projects.

Project Implementation Phases

The "Masaha 2050" vessel project has been implemented in well-studied phases to ensure its readiness to serve complex projects such as Remaal:

First: Planning Phase

- Identifying Bahrain's needs for marine data and supporting natural resource projects.
- Studying the requirements of the Remaal project in terms of marine and geophysical surveys.
- Preparing appropriate technical specifications for Bahrain's marine environment.

Second: Design and Technical Selection Phase

- Issuing a public tender to select a reliable company for vessel construction.
- Designing the vessel to meet the highest international standards, enabling it to carry out:
 - Hydrographic surveys
 - Geophysical surveys
 - Environmental sample collection
- Selecting equipment and systems compatible with the requirements of the Remaal project.

Third: Implementation and Instrumentation Phase

- Constructing the vessel in the United Arab Emirates.
- Equipping the vessel with modern systems.
- Ensuring the vessel's readiness for long-term projects such as Remaal.
- Testing system integration and accuracy.



Lieutenant General His Excellency Shaikh Rashid bin Abdullah Al Khalifa, Minister of Interior, and His Excellency Engineer Basim bin Yacob Al Hamar, Head of the Survey and Land Registration Bureau, and in the presence of a number of Their Excellencies and Highnesses, senior officials, during the launch of the advanced research vessel "Almasaha 2050".







Fourth: Operation and Field Support Phase

- Operating the vessel to support studies and surveys for the Remaal project.
- Providing accurate data for analysis and decision-making.
- Continuous hands-on training for national personnel.

Importance of the Project

Technical Importance

- Providing high-precision bathymetric and geophysical data.
- Supporting the identification of marine sand locations and assessment of their characteristics.
- Improving the quality of data used in Remaal project studies.

Operational Importance

- Enabling survey work for the Remaal project to be carried out locally with high flexibility.
- Reducing study completion time compared to relying on external parties.
- Ability to re-survey and conduct regular follow-ups as

required by the project.

National and Economic Importance

- Supporting the Remaal project as one of the national strategic projects.
- Reducing costs associated with external contracting.
- Enhancing sustainable utilization of marine natural resources.
- Building long-term national expertise in marine sand assessment.

Challenges Associated with the Project

Despite the strategic importance of the "Al Masaha 2050" vessel project and its vital role in supporting major national projects such as "Remaal," the project faces several key challenges that require careful and continuous management, most notably:

- Technical and technological complexity: Operating the vessel equipped with state-of-the-art marine survey, geophysical survey, and sample collection systems requires high precision and specialized expertise to ensure data reliability.
- Qualification of national personnel: The ongoing need



to train national teams on operating modern equipment and analyzing data to ensure operational efficiency and maximize the vessel's benefits.

- Dependence on external suppliers: Construction and equipping phases abroad require meticulous coordination to avoid delays or defects in equipment supply and installation, and to ensure the vessel's timely readiness.
- Ensuring quality and accuracy of marine data: The changing marine environment poses a continuous challenge in obtaining accurate and reliable data to support planning and decision-making for national projects.
- Operational sustainability and institutional integration: Vessel and equipment maintenance, updating survey systems, and coordination among relevant entities are essential to ensure project sustainability and achieve long-term national benefits.

The team responsible for project implementation

The project was implemented and operated by:

The Survey and Land Registration Bureau – Marine Survey Department.





Bahrain Society of Engineers Award

Introduction

The Bahrain Society of Engineers Award is an annual award aimed at motivating Bahraini engineers to innovate and excel in the engineering field, while recognizing their outstanding achievements and contributions to society and the nation. The award is divided into three main categories:

1. Lifetime Achievement in Engineering Award
2. Outstanding Engineer Award
3. Best Graduation Project Award

There are four main objectives of the award, summarized as follows:

1. Honoring Excellence:

Highlighting the remarkable achievements of Bahraini engineering professionals throughout

their careers and their service to Bahrain's industrial community.

2. Supporting Innovation:

Encouraging creativity and innovation in the engineering field by promoting smart and sustainable solutions.

3. Inspiring Students:

Fostering a spirit of creativity and innovation among engineering college students and encouraging their outstanding graduation projects.

4. Enhancing Competitiveness:

Creating an environment of scientific and creative competition among engineers.

This issue highlights five award-winning projects.

1

Architecture

Student:

Amina Selail

Bahrain Fashion Institute: Reviving the authenticity of fashion Bahrain

Supervisor:

Dr. Ranjith Dayara
University of Bahrain

The project is rooted in reviving traditional Bahraini fashion and reinterpreting it through a contemporary lens—drawing inspiration from the rich essence of the past while aligning with modern fashion standards. At the same time, it redefines Bahrain's coastal heritage through contemporary architecture. Situated at the historic Furdah of Manama, once a central trade hub, the design proposes a fashion institute that

reconnects people with the sea—socially, culturally, and spatially—in direct response to land privatization and the loss of public access to the waterfront.

This vision is realized through a free-plan concept that connects users to the sea, the integration of traditional crafts such as the alnaqda pattern, and the use of local materials like coral stone cladding to reflect Bahrain's identity. At the heart of the institute



lies a central courtyard inspired by the traditional houth—a breathable space that draws in natural light, links the interior to sea views, enhances spatial flow, and conceals building services within the thickness of its peripheral walls. Together, these architectural solutions preserve cultural memory while fostering open, inclusive coastal spaces.

A bold pyramid form was chosen to symbolize the strength and timelessness of fashion as an art.

Serving as a contrasting element for the exhibition area and entrance, the pyramid features the naqda pattern, which creates a dynamic interplay of light and shadow—evoking the craftsmanship and movement found in traditional clothing. This contrast between geometric structure and local ornamentation highlights the project's core balance of tradition and innovation.



Back View



Side View



2

Chemical Engineering

Students:

Amal Alqallaf

Kamal Bukamal

Rayan Albasri

Real-Time Chemical Process Fault Detection Using Simulink and Aspen Dynamics

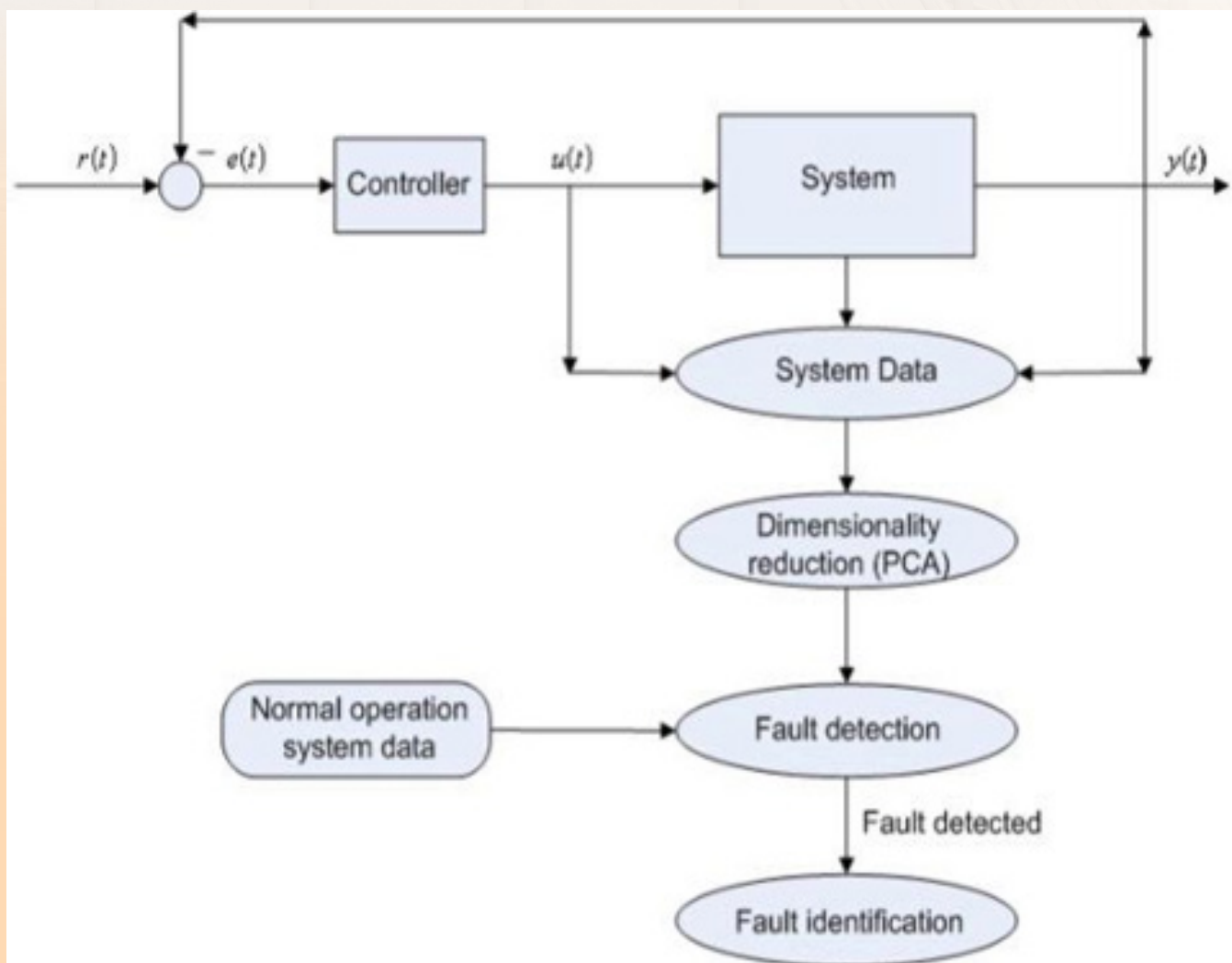
Supervisor:

Dr. Bassam Alhamad

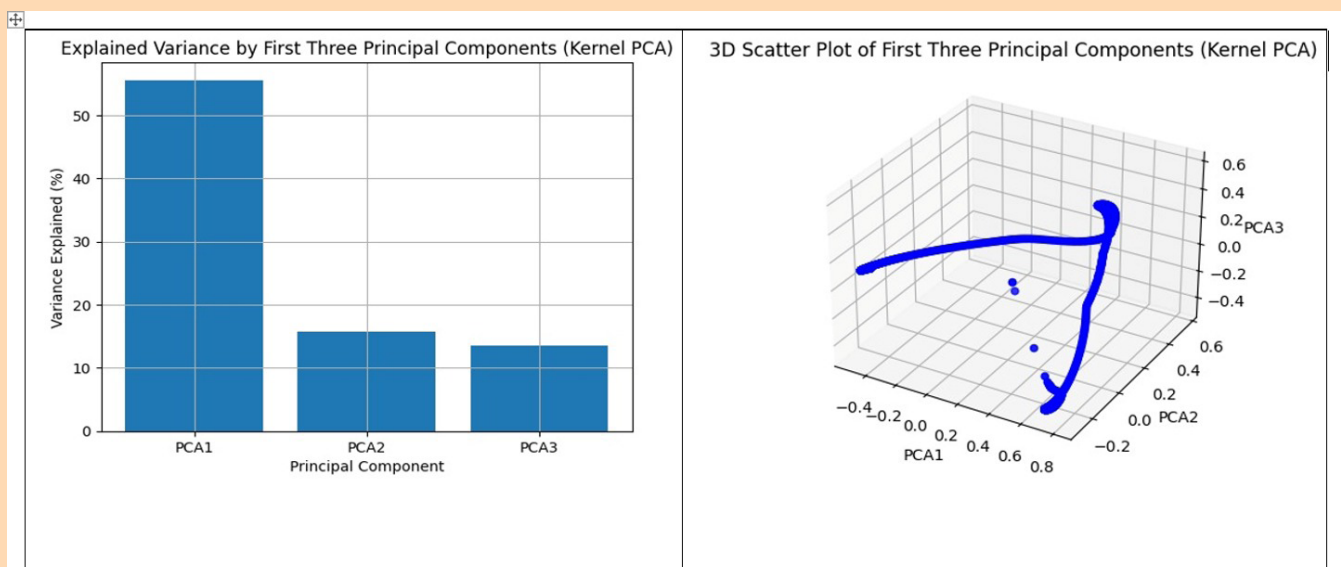
University of Bahrain

The aim of the project is to develop and implement a real-time fault detection system for a methanol plant by integrating Aspen HYSYS, MATLAB, and Principal Component Analysis (to reduce dimensionality and monitor process anomalies under statistical process monitoring dynamically detecting faults before they cause significant damage or disrupt desired outputs. The system enhances safety, operational reliability, and cost efficiency. This approach demonstrates the ability to detect various types of faults during production, ensuring timely interventions to minimize downtime, reduce risks, and optimize long-term sustainability and process excellence. Additionally, the project highlights the potential of modern data analysis techniques

in transforming industrial fault detection, offering a framework adaptable to other complex chemical processes. Furthermore, this project is motivated by the need to enhance plant safety, optimize performance, and reduce downtime, aligning with the broader goals of sustainable and efficient industrial operation. Developing a robust fault detection framework will not only benefit methanol production but also contribute to the growing body of knowledge in process safety and control systems. Moreover, this project represents an exciting opportunity to bridge academic research with real-world applications, showcasing the potential of cutting-edge technologies to revolutionize industrial practices.



Flow-Chart for the System-System



Dimensionality Reduction and Visual Representation for Non-Linear Data



3

Civil Engineering

Student: Hawra
Almanami

Sustainable Groundwater Management through Managed Aquifer Recharge (MAR)

Supervisor: Dr. Rouya
Bassem Hdeib
Applied Science University,
Kingdom of Bahrain

This project research investigates the potential of Managed Aquifer Recharge (MAR) as a sustainable solution to groundwater depletion in Bahrain.

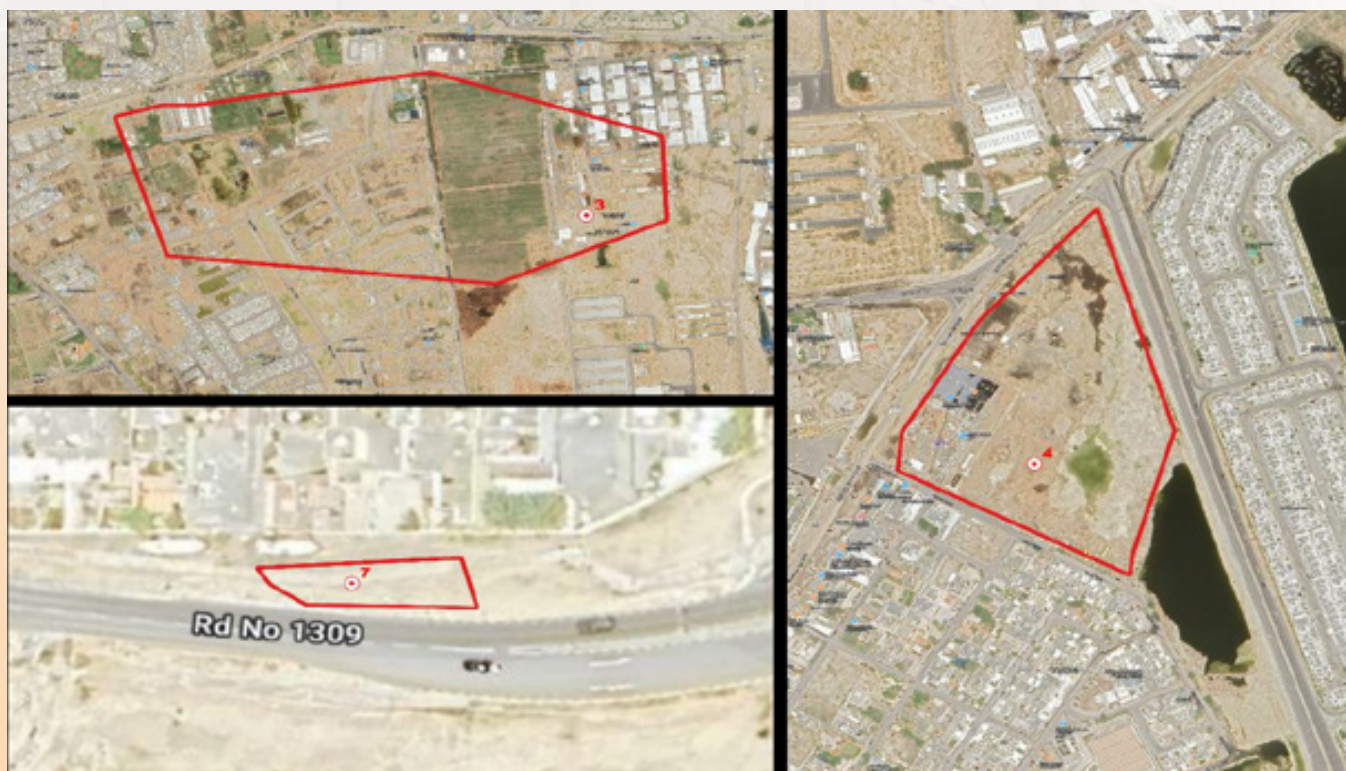
The project evaluates the integration of Treated Sewage Effluent (TSE) and natural runoff into the Dammam aquifer system through GIS-based spatial modeling and hydrological analysis.

The study identifies suitable MAR zones using multi-criteria evaluation based on land classification, soil type, slope, flow accumulation, proximity to TSE reservoirs, and infrastructure.

A methodology was developed to calculate recharge volumes from both natural and artificial sources across selected sites.

TSE data was analyzed from official records and interpolated using reservoir capacities and production ratios. The recharge efficiency was then evaluated against the estimated storage volume of the aquifer and compared with current abstraction levels and safe yield thresholds.

This comprehensive approach provides a framework for assessing MAR feasibility and supports the development of long-term groundwater management strategies in arid regions.



Land cover of selected sites



Final Selected Sites for MAR with Zoomed-In Locations



4

Electronic Engineering

Students:

Amna Jamal Bubshait
Zahraa Maher
Alshehabi
Rawan Ahmed
Albinzayed
Reem Abdulaziz
Bureshaid

Smart CANE: Computer-Aided Navigation Empowering the Visually Impaired

Supervisor:

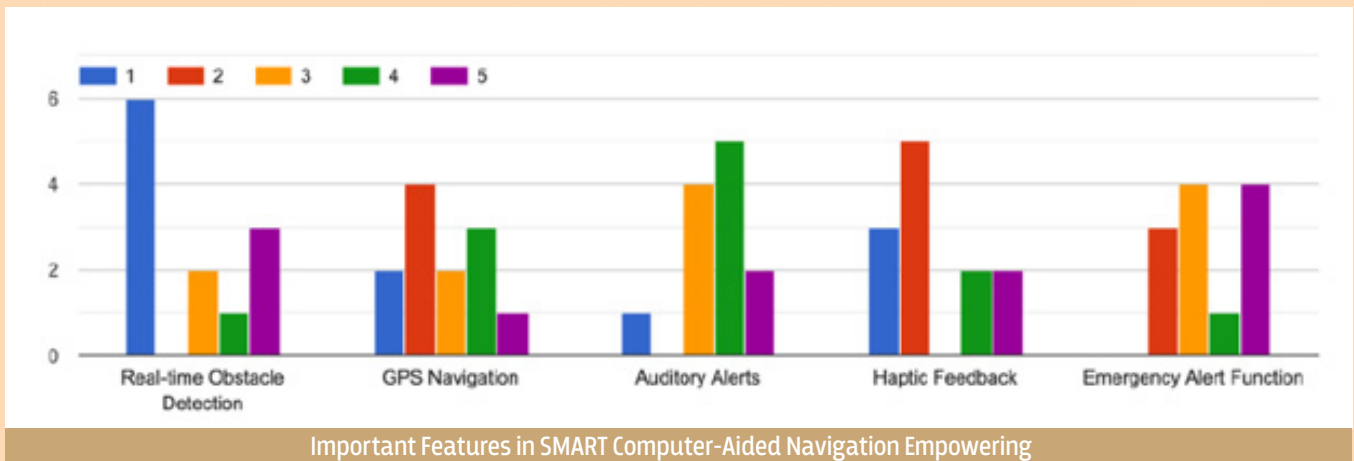
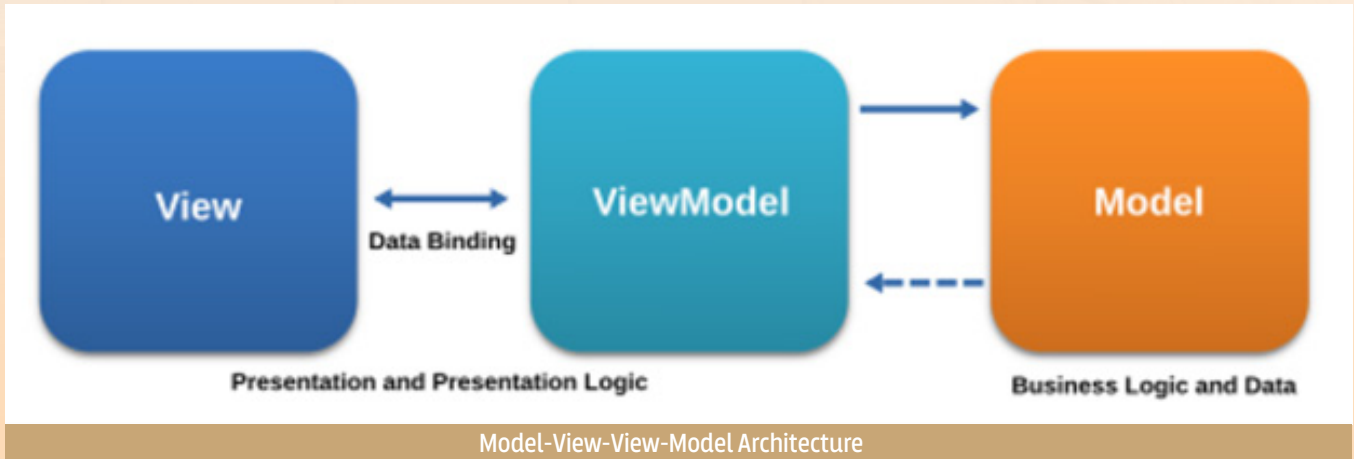
Engineer Herbert Azuela

University:

American University of
Bahrain

Daily tasks pose significant challenges for people who are visually impaired, especially in navigating the environment. That emphasizes the crucial need for advances in the use of modern technologies in assisting equipment. The objective of this capstone project is to design and develop a smart cane that assists the visually impaired by improving mobility using obstacle detection, image recognition, GPS tracking, and temperature detection. The cane is connected to a website and an application dedicated to both users and caregivers. In this project, a mixed-method approach was employed, in which qualitative user requirements and feedback were collected and

quantitative performance metrics were used. Obstacle detection was achieved with YOLOv5 by pairing a LiDAR sensor and a buzzer with a camera to protect the user via audio alerts. In addition, a GPS module is utilized for the location tracking feature, in addition to the temperature sensor that identifies potential hazards from sudden temperature changes. User-friendly applications are responsible for accompanying the device by allowing users to access settings, choose preferences, and provide them with real-time data. Initial trials have proven that the cane is successful in obstacle detection with immediate alerts. Furthermore, positive user feedback was received, specifically with



the integration of the mobile and web applications. With the help of its website and app, the smart blind cane has the potential to significantly improve the safety and independence of people with visual impairments, opening the door for more advancements and use of technological aids. The findings of this project are

intended to substantially contribute to the field of wearable technology and accessibility technology.



5

Mechanical Engineering

Students:

Mohammed Ahmed Abbas
Sultan
Hussian Saeed Hussian
Salman Mohamed Salman

Design and Fabrication of Air Photovoltaic-Thermal (PV-T) Solar Collector for Domestic Applications

Supervisor:

Dr. Abdul-Waheed
Badar
University of Bahrain

The project presents the design, fabrication, and performance evaluation of a solar energy system that combines electricity generation with thermal energy recovery using an air-based solar collector. The system was developed in response to the inherent limitation of conventional photovoltaic modules, which suffer from reduced electrical efficiency at elevated operating temperatures. By integrating an airflow mechanism beneath the solar panel to extract excess heat, this project improves overall energy utilization and provides a sustainable thermal source for domestic applications, such as drying.

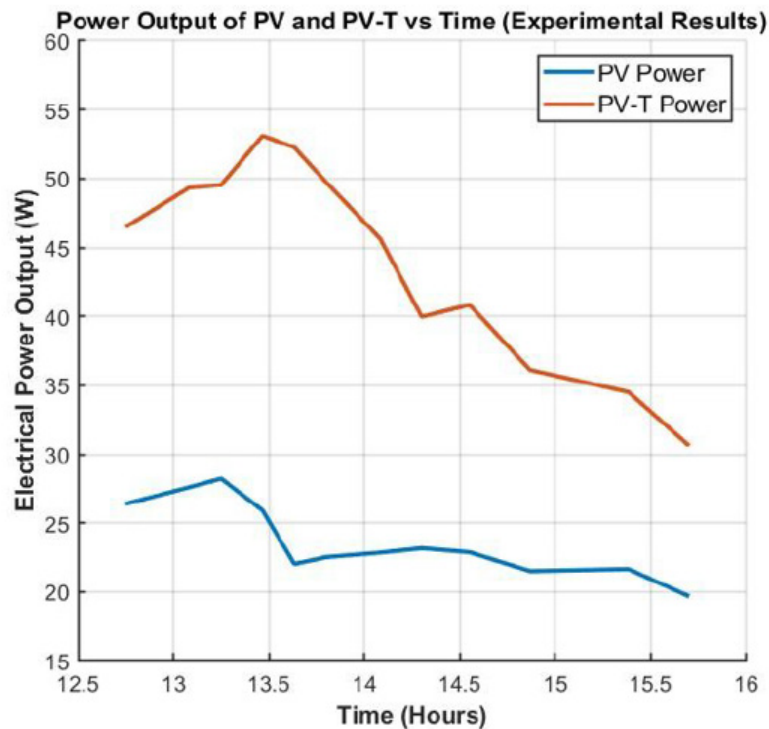
A mathematical model was developed to simulate the thermal performance of the collector by calculating critical parameters including solar absorptance, overall heat loss coefficient, and heat removal factor. Using an iterative numerical approach, the model estimated key temperatures within the collector, such as absorber plate temperature, glass temperature, duct air mean temperature, and outlet air temperature. The model was validated under typical environmental conditions in Bahrain, where solar irradiance reaches 859 W/

m². The system achieved a useful heat gain of 338.7 W and a thermal efficiency of 59%. Optimal values for geometric and operational parameters were also identified, including a 17 mm gap between absorber and glazing, a 0.04 m duct height, and a mass flow rate of 0.085 kg/s at an air velocity of 2.5 m/s. In addition to mathematical modeling, a computational fluid dynamics (CFD) analysis was performed to evaluate the impact of duct design enhancements such as triangular fins and internal baffles. The introduction of these features caused flow disturbances, which enhanced the convective heat transfer and reduced stratification of temperature.

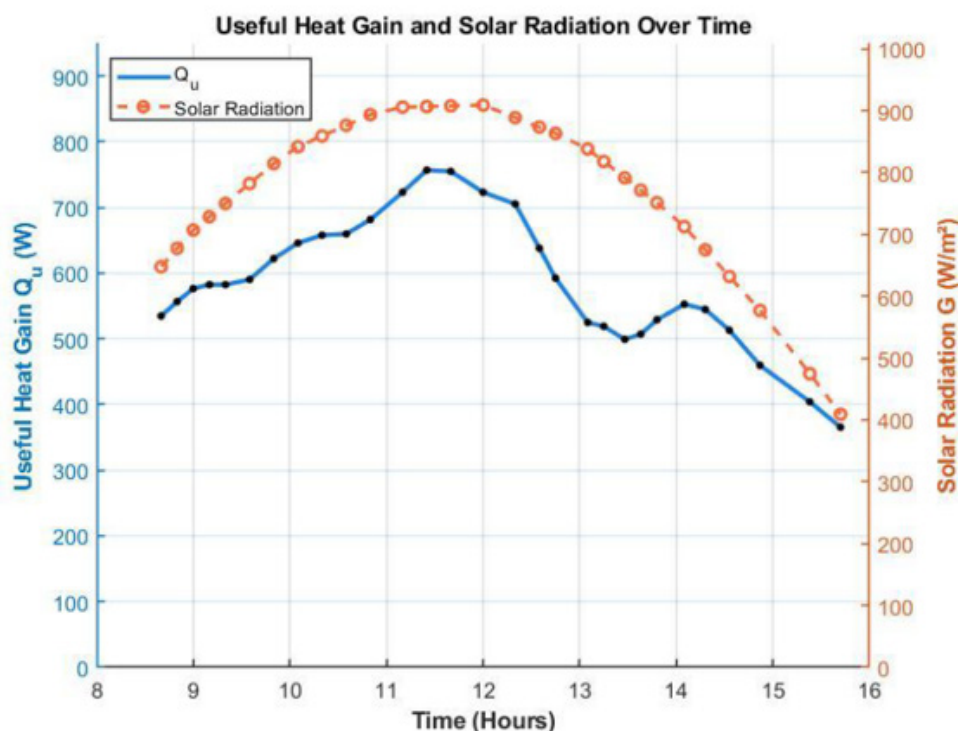
Based on the results from CFD, outlet air temperature increased from 21 °C to approximately 27 °C, confirming the ability of the system to extract thermal energy. In order to guarantee the accuracy of simulation, the process required an exquisite focus on mesh quality, turbulence modeling as well as convergence behavior.

The fabricated system was tested alongside a conventional photovoltaic panel to assess electrical performance. The hybrid collector demonstrated

improved thermal regulation, resulting in higher electrical output by maintaining lower PV cell temperatures. This confirms the dual benefit of the system—simultaneous electricity generation and heat recovery—making it suitable for domestic and light industrial applications in sun-rich climates.



Experimental Results: Power of PV and PV-T Vs Time



Experimental Results: Useful Heat Gain (Q_u) Vs Time



Dr. Majeed Safar
Jasim
Associate
Professor, Chemical
Engineering
Department,
University of
Bahrain.



The Quiet Influence of Chemical Engineers on Sustainable Systems

Sustainability has moved from a secondary consideration to a defining constraint on modern engineering. Design decisions are increasingly shaped by climate objectives, regulatory frameworks, and growing boundary constraints on resources across energy systems, industrial facilities, and infrastructure. Much of the public debate centres on policy and innovation yet delivering sustainability at scale is an engineering challenge. Chemical engineers are central to that effort.

The profession of chemical engineering operates at the intersection of energy, materials, water, and industrial production. These systems underpin modern society and account for a significant share of global environmental impact. The discipline's relevance to sustainability is therefore structural rather than incidental. Chemical engineers do not simply support sustainability initiatives; in fact, they design and optimise the processes that determine whether environmental targets are technically and economically achievable.

The connection between chemical engineering and sustainability dates to the discipline's origins. From the outset, chemical engineers focused on efficiency,

minimising waste, and safely scaling chemistry from the laboratory to industry. Long before sustainability became a formal objective, the profession was concerned with maximising resource use and reducing losses. Those same principles remain central today, though they are now applied under far tighter environmental constraints and greater public scrutiny.

The global energy transition highlights the importance of chemical engineering expertise. While electrification and renewable power are essential, they cannot decarbonise all sectors on their own. Energy-intensive industries such as chemicals, metal production, and refining require process-level solutions. Chemical engineers are central to the development

of technologies such as carbon capture, hydrogen production, synthetic fuels, and energy storage. These systems depend on a deep understanding of thermodynamics, reaction engineering, mass and energy balances, and heat, mass and momentum transfer, which are core competencies of this profession.

Equally important is the ability to evaluate trade-offs. Reducing emissions in one part of a process may increase energy demand, water use, or capital cost elsewhere. Chemical engineers are trained to quantify these interactions and optimise across competing objectives. This systems perspective is essential for ensuring that sustainability measures deliver genuine net benefits rather than shifting environmental burdens from one part of the system to another.

Water management provides another clear example of chemical engineering's role in sustainability. Growing populations, climate variability, and industrial demand are placing increasing pressure on water resources. Chemical engineers design desalination plants, wastewater treatment facilities, and reuse systems that strike a balance between reliability, energy efficiency, and environmental impact. Increasingly, these systems are designed as integrated and circular processes that recover energy and materials while reducing waste, reflecting core chemical engineering principles.

Materials and waste management further demonstrate the discipline's relevance. Modern economies rely on plastics, metals, and advanced materials that are difficult to replace but environmentally costly to produce and dispose of. Chemical engineers are developing recycling technologies, alternative feedstocks, and material recovery pathways that enable circular material flows. From chemical recycling of polymers to the recovery of critical metals, these efforts translate sustainability goals into industrial practice.

What distinguishes chemical engineers in addressing

sustainability challenges is not only technical capability, but also the way problems are framed and solved. Sustainability rarely presents single-variable solutions. Instead, it requires balancing technical performance, safety, economics, and environmental impact across entire systems. Chemical engineers are trained to manage this complexity using modelling, optimisation, and engineering judgement to support informed decisions.

As sustainability becomes embedded in engineering standards, regulation, and investment decisions, the role of chemical engineers will continue to grow. They work at the interface between environmental ambition and practical delivery, translating targets into designs and operating conditions that can be implemented at scale. In doing so, chemical engineers help shape how sustainability is achieved in everyday engineering practice.

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 Energy Consultant
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Application of Artificial Intelligence to Photovoltaic Power Generation

As the world transitions toward renewable energy sources continue to grow, Photovoltaic (PV) power generation has emerged as a driving competitor in replacing traditional fossil power generation. PV power generation is an intermittent source of power and depends on the weather conditions. In addition, the integration of PV power generation into the grid faces challenges which have been well addressed in the literature. With Artificial Intelligence (AI), the PV power generation is reshaped and becomes a revolutionary method to enhance the operation, efficiency, reliability, and predictability of solar power production. Artificial Intelligence (AI) is a branch of computer science which involves designing computational systems that are able to comprehend reason and solve problems in a similar way to humans [1]. AI can be classified as shown in Fig.1 [2]. In this article, five areas of application of AI to PV power generation are briefly explained.

1-Photovoltaic (PV) Power Generation Performance Optimization:

The performance of PV power generation is influenced by various factors such as weather conditions (temperature variation and clouds), shading, dust accumulation, solar cells cracks, short circuit due to bypass diode, solar panel cracks. Artificial intelligence (AI) can be used to optimize the performance of the PV power station under different operating conditions. For instance, AI can be used to determine the best tilted angle of the solar panels throughout the day to capture the maximum sunlight and consequently operate at the maximum power point (MPP) during the day and under different weather conditions. The technique, used for maximum power point tracking (MPPT), involves using

Neural network and/or Fuzzy logic controllers which have shown remarkable success in maintaining optimal performance even under partial shading or fluctuating environmental conditions. Fig.2 presents an illustrative diagram of PV power generation performance optimization.

2-Output Power Forecasting of the PV Power Generation:

The output power forecasting of the PV power generation is vital to (1) better coordinate the supply and demand between the PV power generation and the conventional power generation in power systems, (2) plan the scheduling and operation strategies to ensure the stability of the power system and (3) size and design the PV power generation. There is different AI methods used

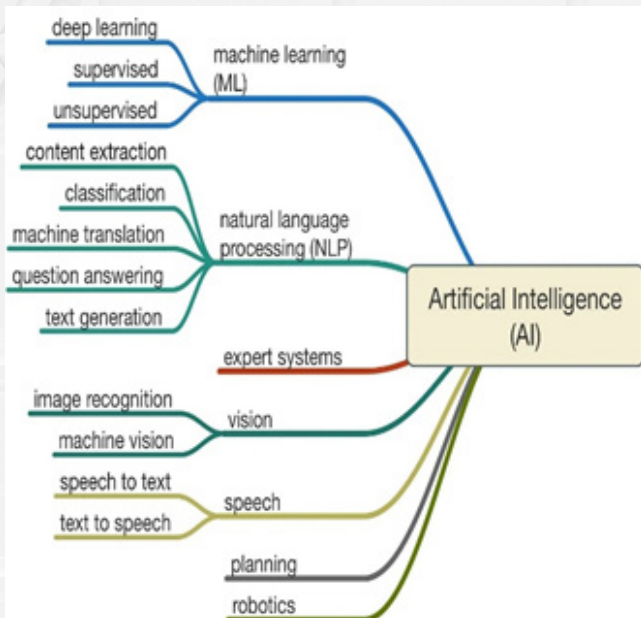


Fig.1 Classification of AI [2].

to perform this task which are well explained in the literature. Machine Learning (ML) is one of the AI techniques which involves Algorithms like Support Vector Machines (SVM), Gradient Boosting, and Random Forests. Machine Learning (ML) can analyze historical weather data and PV power generation measurements to predict output power of the system. These models constantly enhance their accuracy as more data become available. Another AI technique is deep learning like Neural network which is also used to anticipate the output power of the PV power generation. Neural network can process large and complex data to produce a reliable output power forecast. Fig.3 depicts a schematic diagram of output power forecasting of the PV power generation.

3-Predictive Maintenance of the PV Power Generation Components:

In addition, AI can be used for predictive maintenance of the PV power generation components such solar panels, inverters and batteries. Maintenance is a essential aspect of keeping PV power generation operating optimally. Conventional maintenance methods involves scheduled inspections which is time consuming. AI can analyze real-time data (weather conditions, solar panel output voltage and current, inverter DC voltage, output voltage and current, state of charge of Battries) from sensors and the historical maintenance records (rate of failure of each component, percentage of failure type). Then, it can predict when a PV power generation or individual solar panel or inverters or battries is expected to fail and require to be repaired or replaced. This

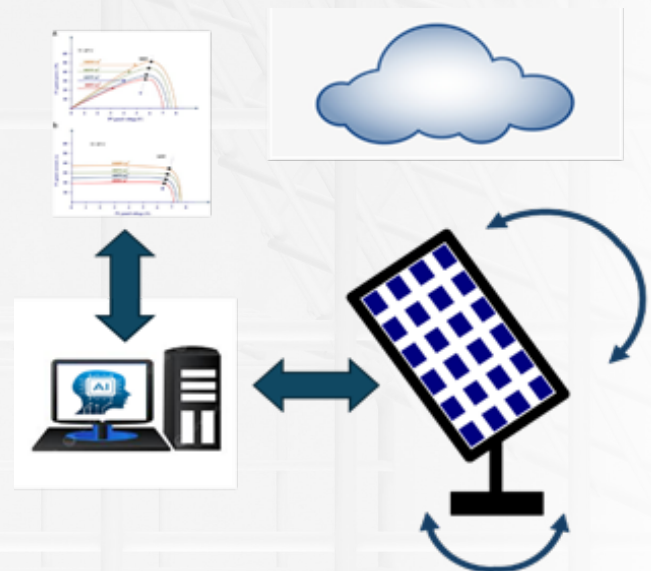


Fig.2 PV power generation performance optimization

reduces shutdown time and maintenance costs. Fig.4 presents an illustrative diagram of predictive maintenance of the PV power generation components.

4-Grid Integration of PV Power Generation:

The PV power generation is an intermitted source of power, and it varies during the day and the season. Therefore, the integration of the PV power generation into the grid becomes a complex task. AI plays a crucial role in managing this integration in an efficient way. Fig.5 shows a schematic diagram of grid integration of PV power generation. AI can predict power demand patterns and enable better integration of PV power generation by balancing generation with demand.

In addition, AI algorithms can handle voltage and frequency fluctuations introduced by the variable nature of the PV power generation, ensuring grid stability. This is done in coordination with the other conventional power generations in the power system. Furthermore, AI can also simulate many scenarios to assess the influence of integrating PV power generation into the grid and help in long-term planning and decision-making.

5-Protection of PV Power Generation:

The PV power generation consists of many solar panels connected in series and in parallel forming the PV arrays to achieve the required output power and voltage level. Most of the PV power generations use string inverters to convert the DC power to AC power and connect the PV power generation to the Grid. Therefore,

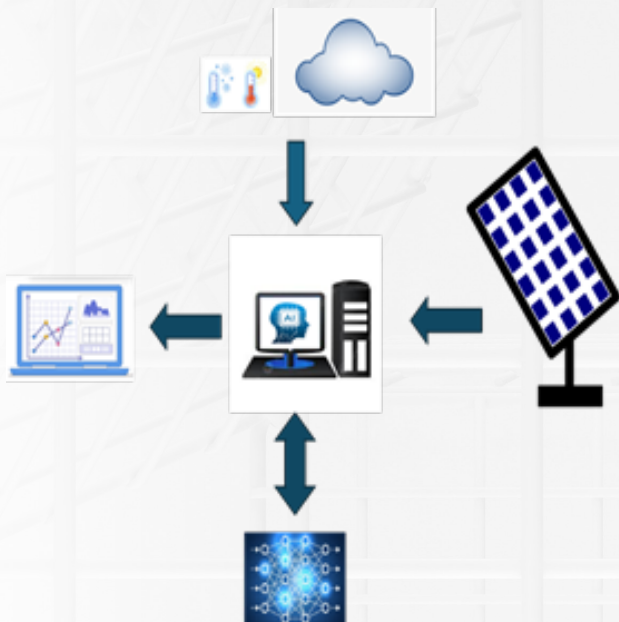


Fig.3 Output Power Forecasting of the PV power generation

the control system of the PV power generation has to deal with many signals in and out from the solar panels, PV arrays and inverters in order to manage the operation and protection of the whole system. AI has the capabilities to treat massive amounts of data, identify patterns, and make real-time decisions, which indeed revolutionize the methods used to monitor, maintain, and protect all components of PV power generation. AI can analyze data from sensors, inverters, batteries (if exist) and other components to detect abnormalities and faults in real time. Neural networks and/or fuzzy logic and support vector machines can detect patterns associated with regular issues like panel degradation, wiring faults, or inverter failures or transformers overheating. By detecting problems early, AI helps prevent system downtime and costly repairs. Fig.6 presents a diagram of AI based protection scheme of PV power generation.

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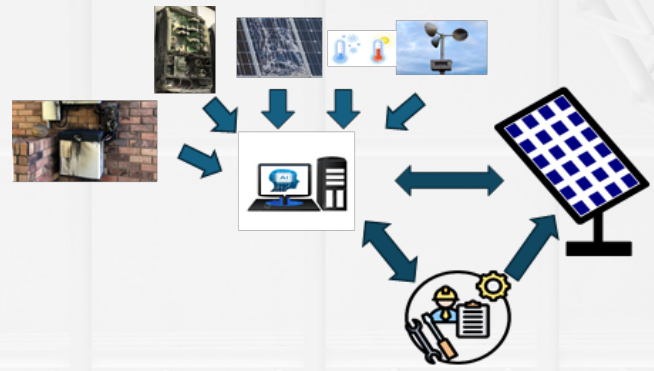


Fig.4 Predictive maintenance of the PV power generation components

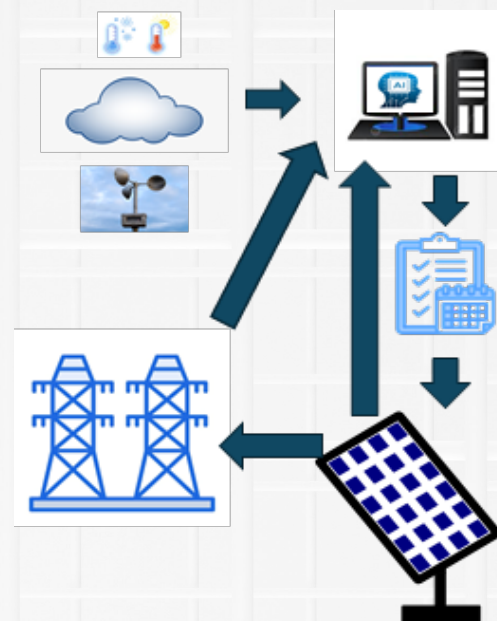


Fig.5 Grid integration of PV power generation

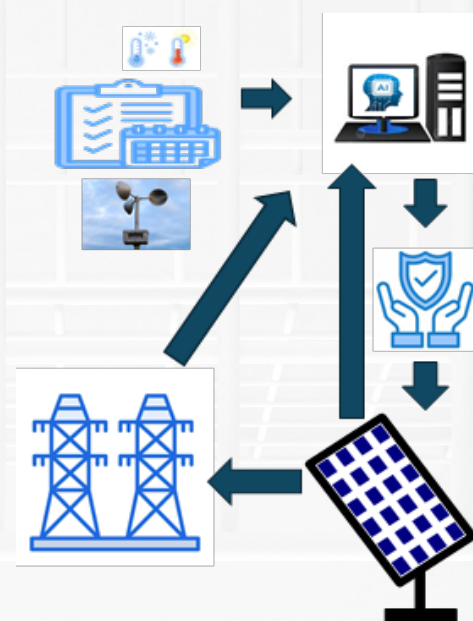


Fig.6 Protection of PV power generation

Students Projects

Students:

Mortadha Nasser Edress
Jaffar Jamal Abdulla
Redha Isa Abdulla Abbas

Supervisor:

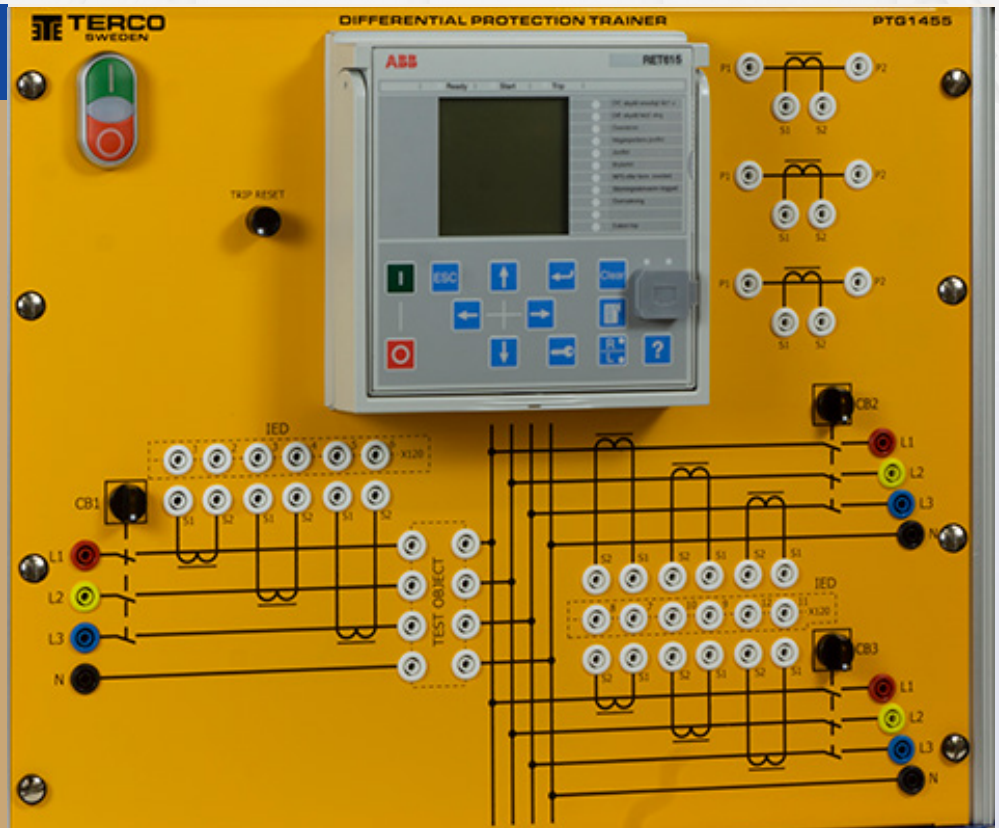
Dr. Ebrahim Abdulrahman
Hassan

Co-supervisor (s):

Dr. Fadhel Abbas Mahdi
Al-Basri

University of Bahrain

Department of Electrical &
Electronics Engineering



Flexible Differential Relay

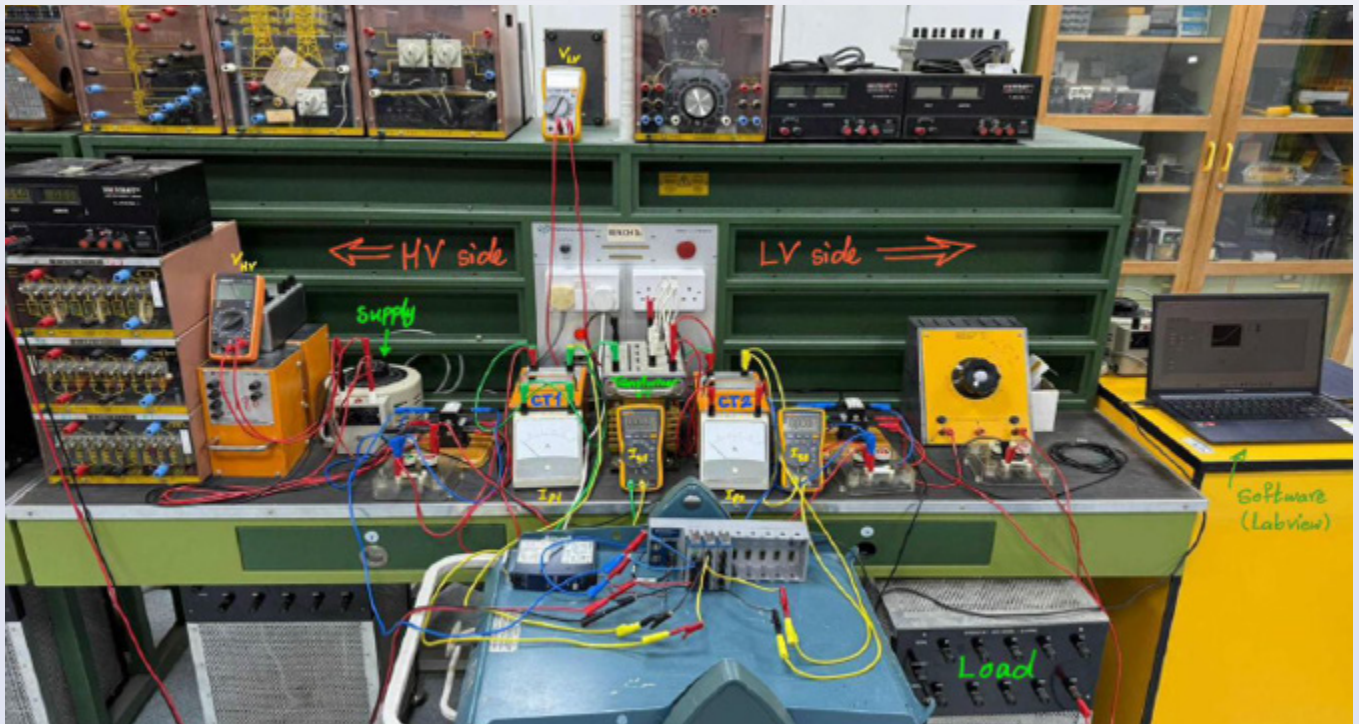
Transformer differential protection remains the most reliable scheme for detecting internal faults in power transformers. Yet, its practical deployment is complicated by current transformer (CT) saturation, ratio mismatch, magnetizing inrush, and overexcitation. Commercial numerical relays handle these challenges through proprietary algorithms, but their cost and closed architecture leave a gap in undergraduate education where students cannot inspect or modify the internal logic. This project addresses that gap by designing a flexible, low-cost differential relay implemented in National Instruments LabVIEW and built around two NI 9227 current input modules and an NI 9474 digital output module, hosted on an NI cDAQ-9178 chassis.

Although the LabVIEW software was developed with three-phase capability in mind, the practical hardware verification was carried out on a single-phase Terco MV1911 transformer because three-phase laboratory transformers were not available and only four current transformers could be borrowed from the University

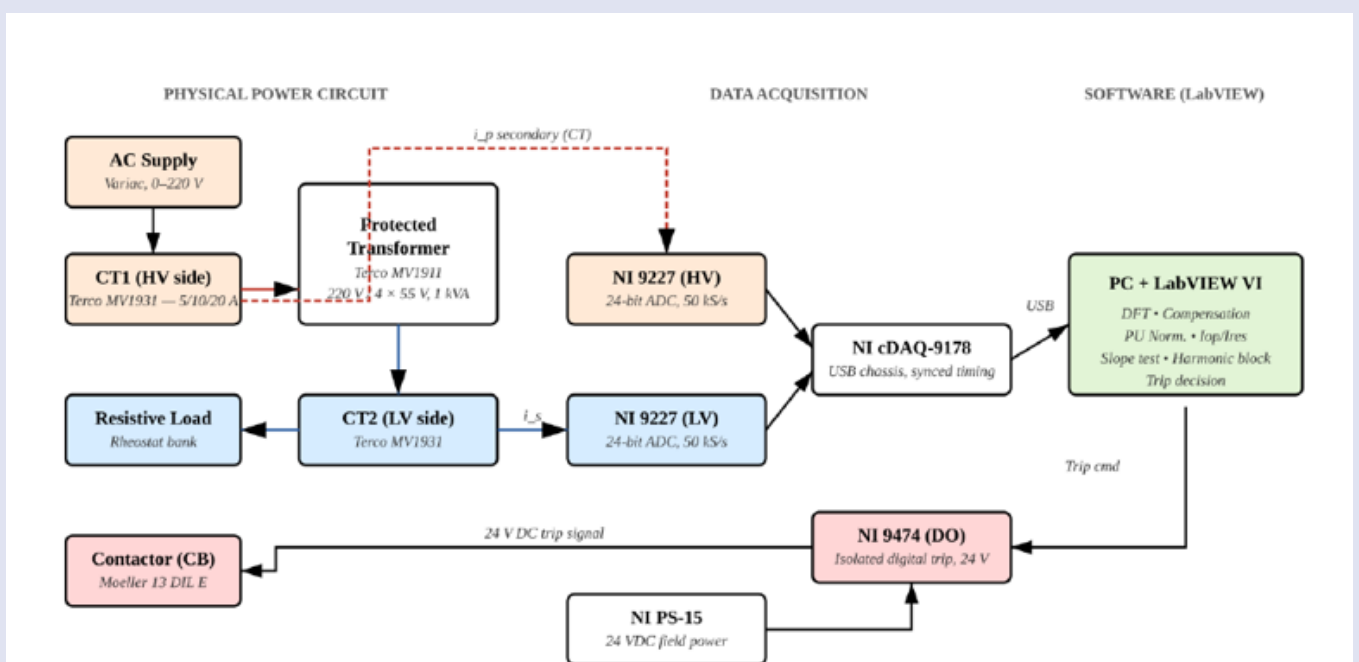
of Bahrain power-systems laboratory. The system performs simultaneous current acquisition on both the primary and secondary sides of the protected transformer, applies a Full-Cycle Discrete Fourier Transform (DFT) to extract the 50 Hz fundamental together with the 2nd and 5th harmonics, and conditions the resulting phasors through a per-unit normalization stage. The operating and restraint currents are then evaluated against a dual-slope percentage characteristic with a bounded transition that prevents logic overlap between Slope 1 and Slope 2. A supervisory cross-blocking layer issues a global trip veto whenever the second-harmonic or fifth-harmonic ratio exceeds its respective threshold.

Laboratory testing on the Terco MV1911 transformer, energized through two Terco MV1931 current transformers, was carried out across two configurations: a matched 220 V / 220 V tap arrangement, and a mismatched 220 V / 110 V tap arrangement. The operating current remained below 0.10 per-unit during balanced operation in both

configurations, and the harmonic-restraint layer correctly identified the asymmetric inrush captured during energization. The contactor-driven trip output, however, could not be exercised on the physical hardware: although the LabVIEW trip flag asserted correctly on every simulated internal fault, the NI 9474 digital output could not be coordinated with the manually-operated contactor available in the laboratory, so the full electromechanical trip sequence was demonstrated in software only. This limitation is documented honestly in Chapter 4 and is the principal item retained for future work. The platform delivers a transparent, fully programmable replacement for commercial trainers at a fraction of the cost.



Complete laboratory implementation of the Flexible Differential Relay, showing the HV-side Variac, MV1911 transformer, MV1931 CTs, NI cDAQ-9178 chassis and LabVIEW host PC.



System block diagram: power circuit, data-acquisition path, and trip-actuation loop

Students Projects

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PET Bottle-to-Filament Recycling Machine with an Arduino-Based Thermal Control System

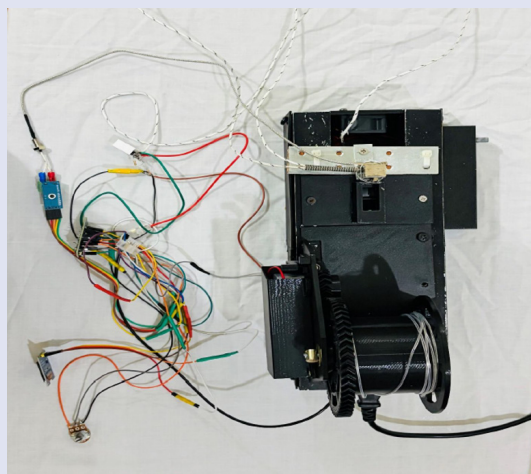
The project is a practical response to the growing problem of plastic waste, focusing on the development of a compact machine that transforms used PET bottles into 3D printing filament. As the world moves toward sustainable manufacturing, the ability to recycle at a local level has become a necessity. My goal was to take existing open-source mechanical designs a step further by building a custom Arduino-based controller to manage heat more reliably than standard, basic components.

At its core, the machine combines a mechanical extrusion frame with a tailored thermal control unit. By writing a multi-stage pulsing logic (PWM) into the Arduino, I managed to significantly reduce the temperature fluctuations that often ruin filament quality in simpler DIY setups. Throughout my testing, I learned how external factors like room temperature and the actual 'load' of the plastic inside the heater impact the results. These insights

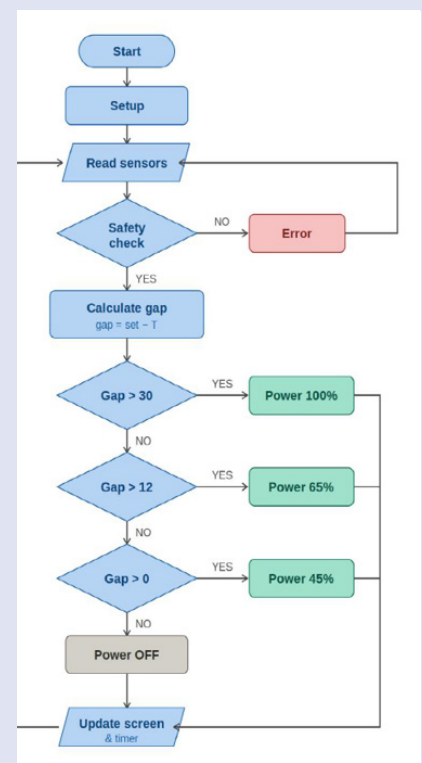
allowed me to refine my custom firmware, creating a system that is much more responsive to the physical realities of the melting process.

The final trials were successful: by finding the right balance between the plastic strip width and heat levels, I consistently produced a solid, circular filament between 1.7 mm and 2.0 mm. While there is still room to improve the precision of the diameter, the modular

code I developed is built for exactly that it provides a flexible foundation that can be continuously tweaked for better performance. Ultimately, this project serves as a proof-of-concept for an affordable, smart recycling tool that truly empowers individuals to turn trash into something valuable.



Comprehensive top-down electro-mechanical layout of the completed prototype, illustrating the full integration between the open control circuitry subsystem (left) and the mechanical extrusion chassis assembly (right)



System flowchart

Students Projects

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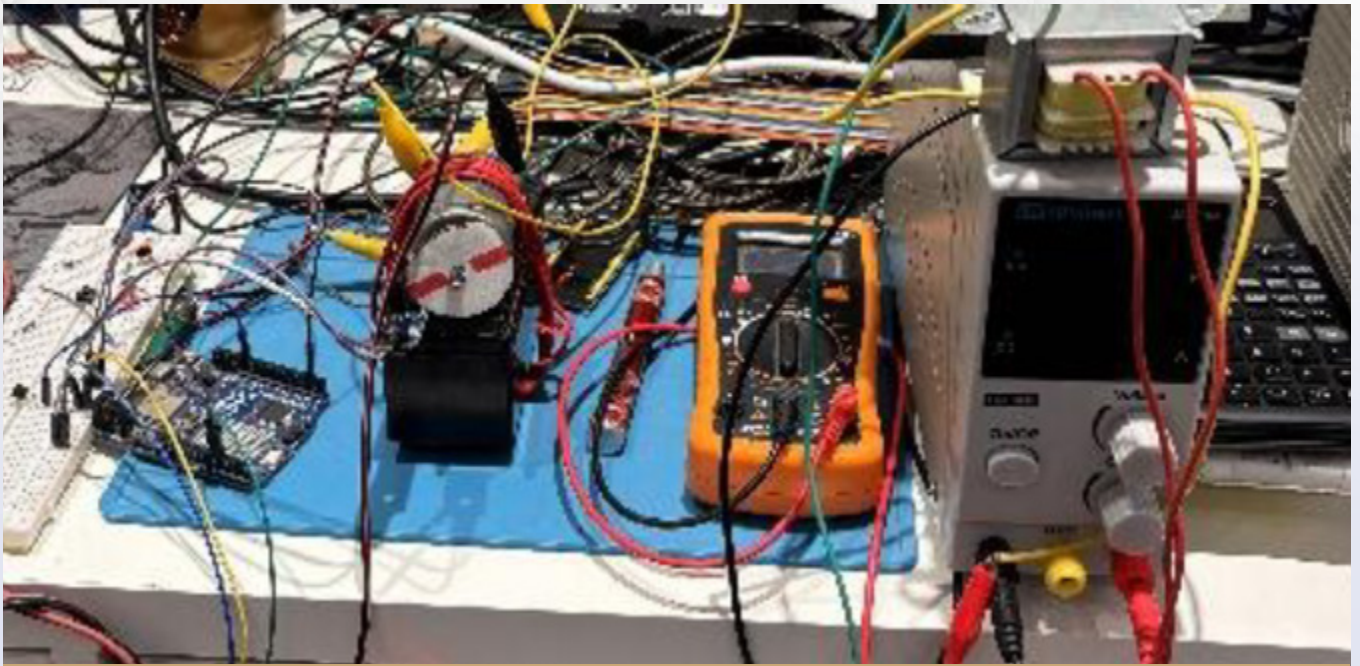
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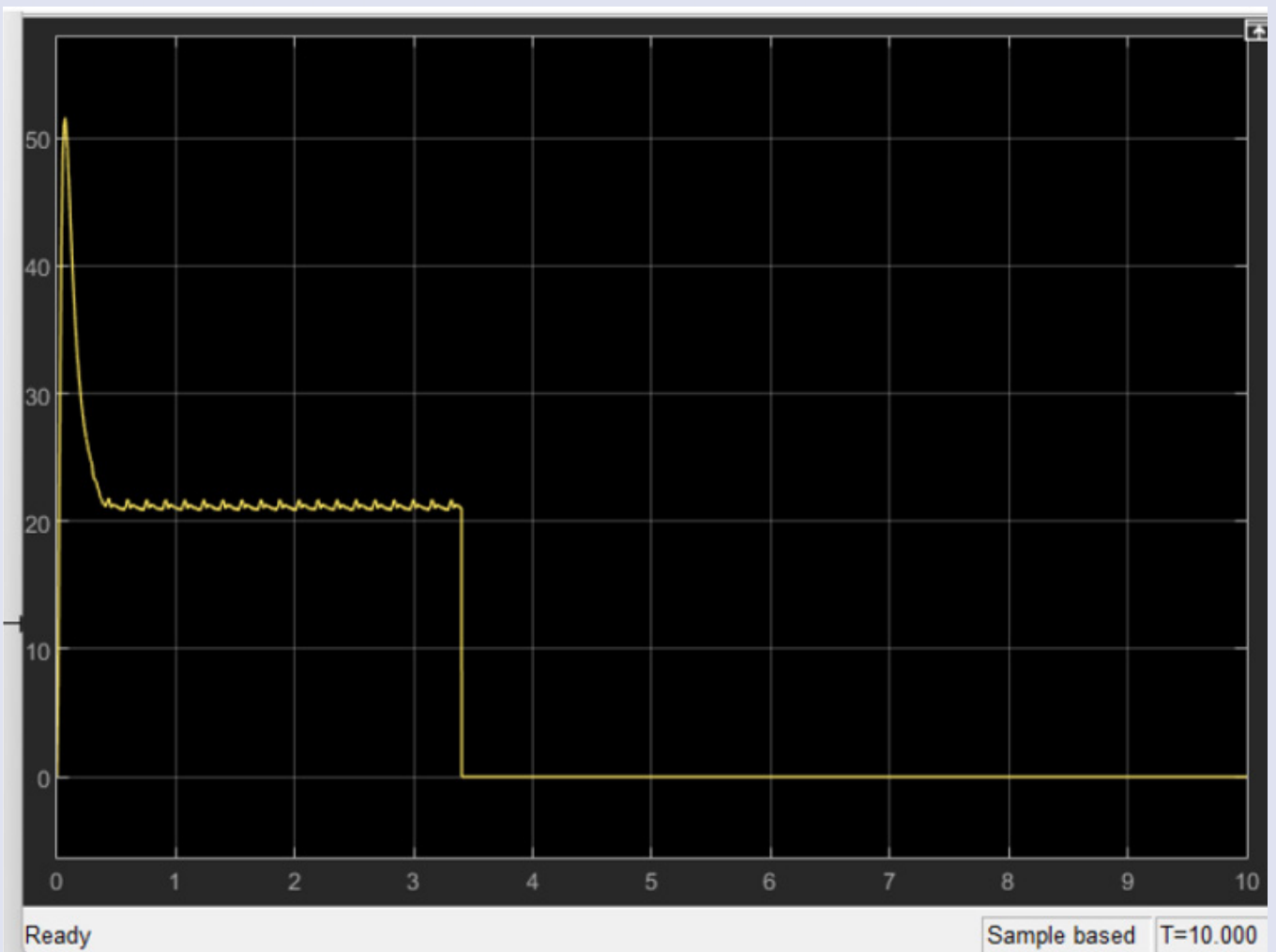
AI Machine Monitoring, Fault Detection, and Protection

Industrial automation and electrical systems heavily rely on the continuous operation of DC motors, making robust fault detection critical for maintaining efficiency, preventing cascading failures, and ensuring safety. Conventional protection systems often lack the diagnostic intelligence to identify the precise origin of a fault, leading to prolonged troubleshooting and broad, unspecific hardware shutdowns. This project presents the design, simulation, and practical implementation of a unified power monitoring and fault detection system utilizing a Good Old-Fashioned Artificial Intelligence (GOF AI) rule-based decision algorithm. The system utilizes a hardware-software co-design centered around a microcontroller unit to acquire and process real-time terminal voltage, armature current, rotational speed (RPM), and DC ripple percentage. To ensure high fidelity in noisy industrial environments, raw sensor signals are stabilized using Exponential Moving Average (EMA) filtering and analyzed through a deterministic, priority-based state machine. The implemented GOF AI algorithm successfully classifies

14 distinct operational conditions, differentiating between critical mechanical faults (such as stalls and bearing friction), electrical supply anomalies (such as rectifier degradation, battery depletion, and PSU sag), and general overloading. Prior to physical deployment, the hierarchical fault detection logic was rigorously validated within a MATLAB/Simulink environment via targeted fault injection methods to ensure algorithmic stability and correct threshold triggering. The subsequent practical implementation confirms the system's ability to seamlessly monitor the motor and actuate a physical safety cutoff relay during critical faults. Simultaneously, the non-blocking software architecture provides real-time diagnostic data to a dynamic web-based dashboard, enabling continuous operator monitoring. Ultimately, this research demonstrates that interpretable, rule-based AI remains a highly effective, low-computational-overhead solution for real-time predictive maintenance and mission-critical machine protection.



Practical Hardware Setup



Protection Activation due Emergency Button

Students Projects

Students:

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Osama Mohammed Ali

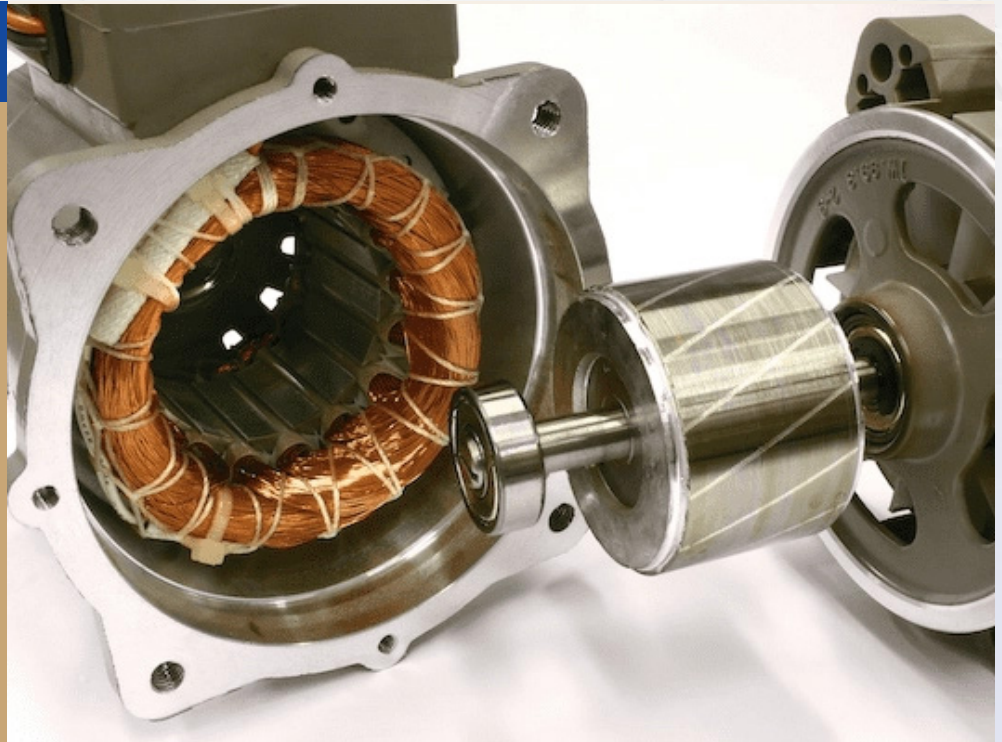
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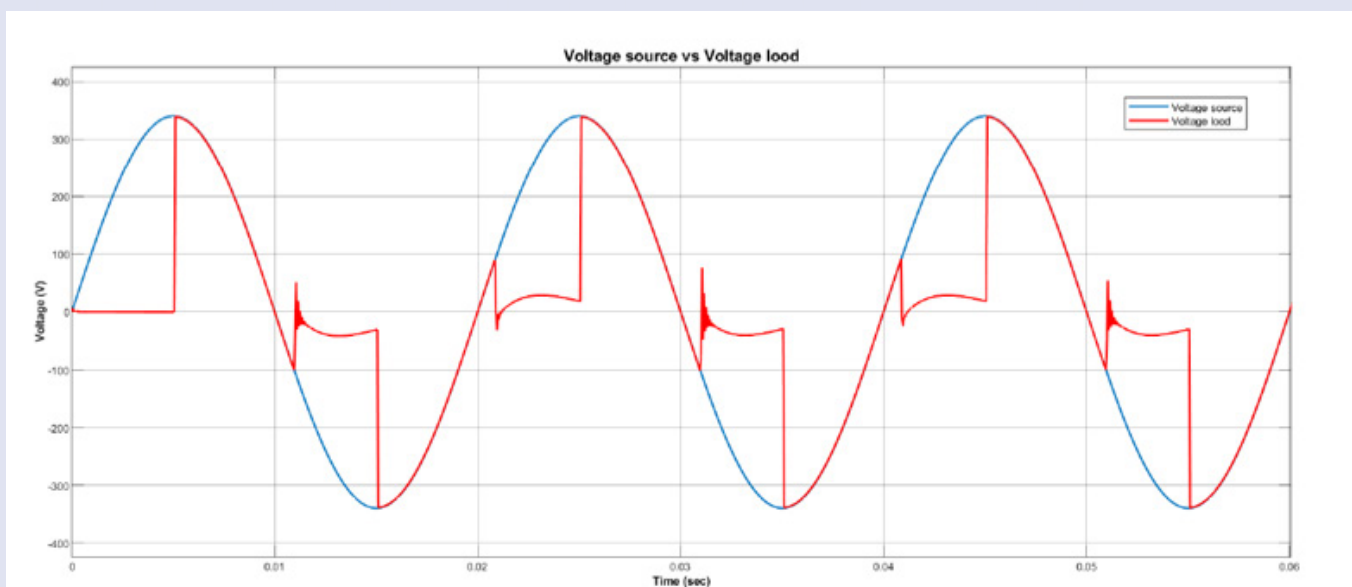
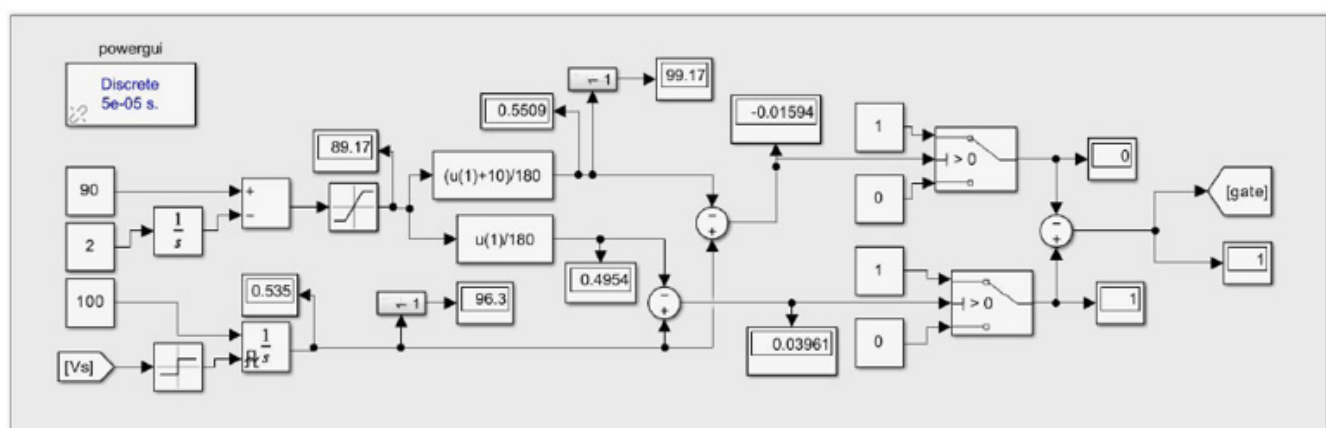
Soft Starter for Single-Phase Induction Motor

Single-phase induction motors are the most widely used motors in residential, small workshops, and light commercial environments. However, upon direct connection to the supply, the stationary rotor generates no back-EMF, causing an inrush current typically five to eight times the rated value. This surge causes voltage dips on the supply line, thermal stress on the winding, and abrupt mechanical shock to the driven load — all of which degrade motor life and can damage connected equipment. Traditional starting methods address this problem in part but share a common limitation: they apply voltage in discrete steps rather than continuously, introducing transient spikes and torque dips at each switching event.

This project designs and validates a TRIAC-based soft starter for a capacitor-start capacitor-run single-phase induction motor through MATLAB Simulink simulation.

The system uses two back-to-back Detailed Thyristors forming a TRIAC equivalent, driven by a phase-angle control scheme. The control logic generates precisely timed gate pulses using a variable time delay that starts at 5ms corresponding to a 90° firing angle and ramps linearly to zero over the soft start period, delivering progressively increasing voltage to the motor. A transport delay of 10ms shifts the positive half-cycle gate pulse to drive the negative half-cycle thyristor, ensuring bidirectional control. Built-in snubber circuits on each thyristor suppress switching transients generated by the inductive motor load.

The simulation model includes a Single-Phase Asynchronous Machine (capacitor-start-run) operating under a constant mechanical load torque, with voltage and current measurement blocks monitoring both the supply and motor terminals. Simulation results confirm



that the first gate pulse fires at approximately 90° , with the second gate pulse following at 270° , demonstrating equal voltage extraction from both half-cycles. The output voltage rises gradually from the initial low level to full supply voltage as the firing angle ramps down, with motor

speed, electromagnetic torque, and main winding current all reaching steady-state values smoothly. Comparison of direct-on-line starting confirms a significant reduction in peak inrush current and elimination of the abrupt mechanical shock that characterizes DOL starting.



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