BAHRAIN SOCIETY OF ENGINEERS

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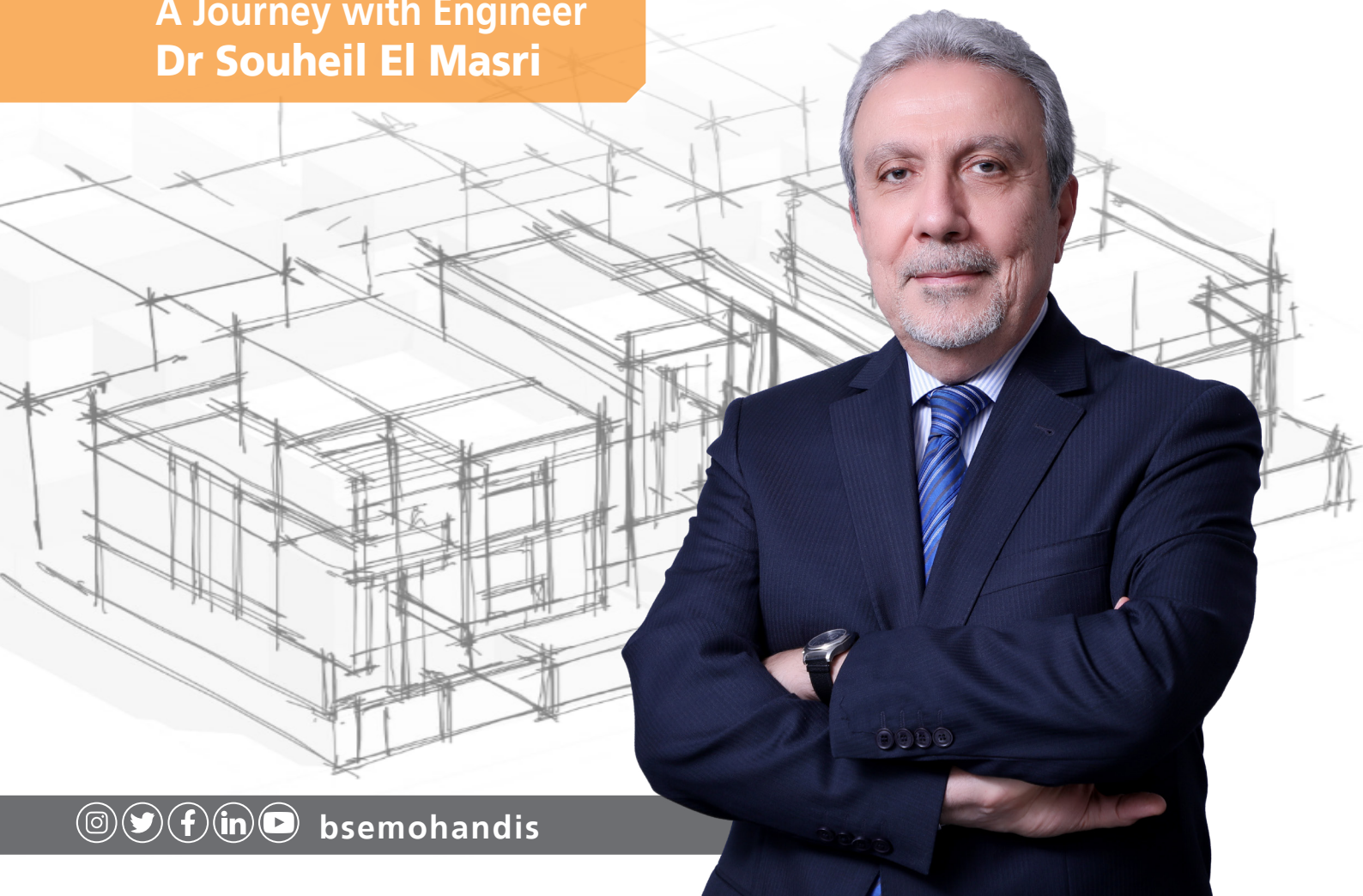
ALMOHANDIS

Carbon Dioxide Recovery Plant Project at Gulf Petrochemical Industries Company

A Journey with Engineer Dr Souheil El Masri



ALMOHANDIS

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Speech of the Editor-in-Chief

Professor
Isa Salman Qamber

ALMOHANDIS

The present issue of Al-Mohandis magazine generally highlighted on supporting engineers and the promotion of the profession through knowledge exchange and fostering competitiveness among practicing engineers and those nearing graduation. For those about to graduate, recent graduates, or those who have just graduated, the BSE opens the door to apply for the annual Engineers Society Awards. Also, in this issue Dr. Souheil El-Masri was interviewed, where he has held key roles in both professional practice and academia. At the same time and as profile of this issue the Carbon Dioxide Recovery Plant by GPIC is presented and discussed. In addition, the BSE annual award is considered in the present issue, where it focused on four winner's projects in different engineering fields. Three articles also submitted by engineers included for publication in this issue. Furthermore, Al-Mohandis magazine highlights on four engineering projects implemented by undergraduate students as part of their capstone requirements, conducted under the supervision of faculty members with expertise in the relevant engineering disciplines to earn their bachelor's degrees were highlighted.

The present issue has an interview with Dr. Souheil El-Masri. He is a Beirut-born architect and academic with over 40 years of experience in architecture, urban development, and education. He has held key roles in both professional practice and academia. Since 2006, he has led major design projects at Gulf Engineering House and Ewan Consultancy. A long-standing member of the Bahrain Society of Engineers, he has contributed to mentoring, conferences, and awards programs. His honors include research and education awards.

The Carbon Dioxide Recovery Plant by GPIC is a groundbreaking environmental project launched in 2009, capturing CO_2 from methanol production and reusing it in urea manufacturing. This is the profile of the present issue. As the first of its kind in the Gulf, it reflects Bahrain's commitment to sustainability and supports national and global climate goals. Built with advanced Japanese technology, it delivers environmental, economic, and technological benefits. The project showcases industrial innovation and serves as a regional model for green development.

The Bahrain Society of Engineers Award is an annual recognition that celebrates Bahraini engineers for innovation, excellence, and contributions to society. It includes three categories; Lifetime Achievement, Outstanding Engineer, and Best Graduation Project. The award aims to inspire professional growth and national development in the engineering field. Four selected projects from different specializations are highlighted on in this issue.

In the architecture, one of the winner projects entitled "The Revive Hub" which is a state-of-the-art sports medicine and fitness complex in Bahrain, offering advanced rehabilitation and indoor sports facilities. This project serves patients with chronic conditions and injuries, as well as individuals seeking improved health and athletic performance.

One of the winning chemical engineering projects developed an AI model to predict the physical properties of lubricating base oil using process and lab data, reducing reliance on costly sensors. The research explored various modeling techniques. The used approach enables real-time monitoring, lowers costs, and minimizes human intervention in industrial settings.

The civil engineering winning project involves the complete design of a metro station, including 3D modeling and integration of virtual reality. It covers site analysis, architectural and structural design using international codes, and manual calculations for structural elements.

The electrical and electronics engineering winning project designed and analyzed a high-gain log-periodic antenna for ultra-wideband UHF spectrum monitoring (250 MHz to 3 GHz) with precise dual-polarization control via Arduino. The antenna elements were calculated in MATLAB, simulated in CST Microwave Studio, and fabricated using CNC-cut aluminum for accuracy.

Dr. Mohammed Bin Shams in his Arabic article entitled "Engineering Education in the Era of Entrepreneurship: The Necessity of Change and Adaptation!" stresses the importance of integrating entrepreneurship into engineering education to boost innovation, supported by Bahraini government initiatives like Tamkeen in his article. He calls for updated curricula and interactive programs that cultivate entrepreneurial skills while honoring societal values for sustainable economic growth.

Dr. Uneb Gazder in his English article entitled "The Impact of Climate Change on Civil Engineering Structures: Current & Future Challenges" highlights the significant challenges climate change poses to civil engineering structures, including extreme weather, rising temperatures, sea levels, and soil instability. It emphasizes the need for engineers to adapt by using innovative materials, updated designs, and construction methods to enhance infrastructure resilience. In addition, the article calls for integrating climate considerations into all stages of planning and construction to build safer, longer-lasting, and sustainable structures for the future.

The article by Dr. Fawzi ALJawder, in English Language, explores hybrid renewable power systems, which integrate multiple renewable energy sources (like solar, wind, hydro, biomass, and batteries) to improve efficiency, reliability, and grid stability. It explains three main coupling topologies—DC, AC, and dual DC-AC bus—and evaluates their design, efficiency, and performance. Despite challenges like high initial costs and complex controls, hybrid systems are seen as a key sustainable energy solution, with AI expected to play a major role in their future optimization and deployment.

Four graduate projects are included in this issue. The first project entitled "IOT-Enabled Substation Monitoring, Control and Management" presents a smart electrical substation system that integrates IoT to monitor key parameters like voltage, current, power factor, temperature, and humidity for efficient analysis and control. It includes intelligent capacitor bank switching and fan regulation based on sensor data to maintain optimal conditions and power quality. The system is demonstrated through a physical Arduino-based prototype and a detailed RSCAD simulation, both confirming its effectiveness in real-time monitoring and smart substation management.

The second graduate project entitled "A Validation Study of the Decelerative Capabilities of Eddy Currents in an Electromagnetic Braking System" explores eddy current braking, a non-contact method using electromagnets to generate resistive forces in a rotating disc, reducing wear and improving system longevity. The prototype, tested under IEEE, IEC, and ASME standards, proves effective for high-speed applications and supports the shift toward sustainable, efficient braking solutions in modern vehicles.

The third graduate project entitled "Design and Implementation of Smart Monitoring for Household Electrical Usage and Indication" introduces a smart household electricity monitor that not only tracks voltage, current, and power usage but also detects overloads and phase imbalances to prevent hazards like fires and equipment damage. It also estimates electricity bills, enhancing safety and efficiency in both homes and businesses.

The fourth graduate project entitled "Solar Powered Automatic Grass Cutting Robot" introduces a solar-powered robotic lawn mower designed for eco-friendly and cost-effective lawn maintenance. It uses photovoltaic panels to charge a battery, enabling autonomous operation with obstacle detection and navigation. The system promotes renewable energy use while reducing human effort and is suitable for homes and small-scale farming

A Journey with an Engineer

Dr Souheil El Masri

- I ultimately chose to pursue architecture, as it offers a balance between artistic creativity and engineering logic.
- My relationship with the Bahrain Society of Engineers began since 1993.
- BSE has made tangible contributions to developing the engineering sector and enhancing professional development pathways in the Kingdom of Bahrain.

In the 83rd issue of Al-Mohandis magazine, we are honored to host a distinguished figure who has made remarkable contributions in both academia and urban development. Our guest brings over 40 years of experience that bridges practice and teaching, fostering a rich connection between the two realms.

Since 2006, he has been serving as Director of Architectural Design at Gulf House Engineering in Bahrain and Ewan Architectural & Engineering Consultants in Abu Dhabi. Under the supervision of the Managing Director and Principle Architect Ahmed Bucheeri, he has managed a wide range of projects, including residential, recreational, educational, hospitality, office, retail, environmental, and large-scale urban developments. He leads a multidisciplinary design team, coordinates with clients and specialized sub-consultants, and oversees the development of high-quality designs with a commitment to project schedules and allocated budgets. He also manages the design and presentations of numerous international competitions, several of which have won awards.

Dr Souheil El Masri, welcome as an esteemed guest in the 83rd issue of Al-Mohandis magazine.

To begin with, the readers of Al-Mohandis magazine would like to learn briefly about your background and early educational journey.

I grew up in the city of Beirut during the 1960s, witnessing firsthand its social and urban transformations. In my childhood, I knew it as a vibrant city, rich with history, bustling with traditional markets and old neighborhoods, where modern buildings stood side by side with heritage houses—a scene that reflected the cultural and social diversity that always distinguished the city. However, this image later changed, as Beirut endured periods of destruction during the years of war, followed by reconstruction efforts that radically transformed the face of the city, both in its urban fabric and demographic composition.

On the educational front, I had the privilege of studying in public schools, from elementary through

With Engineer Abbas Al-Watani in Britain - Newcastle University, 1988.

secondary levels. At that time, these schools were true beacons of knowledge and discipline, combining quality education with a strict educational system that instilled in us a love of learning and a strong sense of responsibility. This education had a profound impact on shaping the foundations of my knowledge, from which my academic and professional journey began—equipped with the values, culture, and skills I had acquired.

And what was the reason behind your choice to study architectural engineering in particular?

After completing high school, I began to seriously consider my university path and the choice of a suitable specialization. The options were narrowed down to two engineering fields that seemed different in scope, yet shared many fundamental characteristics: chemical engineering and architecture. Both disciplines require analytical and systematic thinking, combine theoretical and practical aspects, and rely heavily on creativity in problem-solving and developing innovative solutions.

At that time, information resources were not as accessible as they are today; there was no internet, which meant reliance was limited to books, the advice of teachers, and the experiences of relatives and acquaintances. This lack of modern research tools made the decision a challenging one that required deep reflection and comparison. On the other hand, it helped sharpen critical thinking skills and reinforced the value of relying on traditional yet reliable sources.

After extensive research and a careful weighing of multiple factors—including financial considerations, family expectations, and personal aspirations—I ultimately chose to pursue architecture, as it offers a balance between artistic creativity and engineering logic. I enrolled at the Arab University of Beirut, which had a profound impact on shaping my architectural awareness and refining my professional character. I hold this institution in the highest regard and appreciation for providing a stimulating academic environment and a solid educational foundation.

University of Bahrain Architectural Design Projects Jury, 1996.

After five years of study, I graduated in 1981 and embarked on my professional journey, working on a variety of projects in Lebanon, Saudi Arabia, Jordan, and France. Those five years were like a living laboratory, through which I gained rich experiences and acquired diverse expertise in different cultural and urban contexts. Then came the opportunity of a scholarship, which marked a turning point in my career. It was a difficult decision: should I continue my professional path, which had just begun to mature, or return to the classroom? After much reflection and consultation—and with a desire to broaden my horizons of knowledge—I embraced the challenge once again and chose to return to academic study, recognizing its scientific value and the chance it offered to gain a new life experience abroad.

The journey began with six months of studying the English language, after which I enrolled at Newcastle University in the United Kingdom to pursue my postgraduate studies in architecture. This phase marked a new turning point in my life, not only academically but also personally and culturally, as living in a different environment allowed me to reconsider many concepts and broaden my professional and cultural understanding and awareness.

Was the student Souheil El Masri influenced during secondary school by an engineering figure who helped shape his university path and decision to study architecture?

During secondary school, academic decisions were not formed in isolation from personal and environmental influences; rather, they resulted from accumulated experiences that shaped awareness and interests. One family member, an architect, played a particularly significant role in this process. His deep passion for the profession was reflected in everything he shared about it—about his ability to transform ideas into tangible reality, and about buildings, which he never saw as mere rigid structures but as architectural stories full of life, expressing the identity and culture of a place. This inspiring presence, with its mature experience and clear vision, awakened in me a passion for architecture and reshaped my perspective on the field—not merely as a university choice, but as a creative path carrying both purpose and value.

How did your professional journey in architecture begin? We would be delighted to

Architectural Competition Exhibition The Contemporary Bahraini House – Medium James Steel, Fahim Abdulla, Riad Tabbouni and his wife Leila Karajica, 1997.

give our readers an overview of the positions you have held throughout your career.

After my graduation, I worked at an engineering office for five years before traveling to the United Kingdom to pursue my postgraduate studies. During this period, I gained extensive practical experience by participating in a wide range of architectural projects, both in the design phases and on-site during construction. This work provided a valuable opportunity to connect the theoretical knowledge I had acquired academically with practical application in the field, significantly refining my professional skills and enhancing my ability to handle the daily challenges faced by architects during project execution. I also learned the importance of effective coordination among various technical and administrative disciplines, as well as time management and quality control, to ensure projects were delivered efficiently and professionally, while adhering to technical standards and project requirements.

During my studies in the United Kingdom, I worked as a teaching assistant in the Department of Architecture, and later as a visiting researcher within a team focusing on housing issues and post-disaster reconstruction. This academic role allowed me to deepen my theoretical and research knowledge in planning and rehabilitating affected areas, and to engage with diverse international experiences in housing and urban planning. It strengthened my holistic vision of the architect's role in serving communities and promoting sustainable development.

While reviewing your CV, we see that your career in the engineering sector included an academic tenure at the University of Bahrain as an Associate Professor from 1994 to 2006. Could you share with the readers of Al-Mohandis magazine your academic contributions during this period?

Before joining the University of Bahrain, I had visited the Kingdom in 1993 as part of a three-member team to conduct a training course on designing buildings for people with special needs. During that visit, I also toured the University of Bahrain, where it was agreed that I would send my CV, especially

With Engineer Faeq Mandeel at the Urban Indicators Workshop, 2000.

since the university was at that time in the process of developing its architecture department. In 1994, I received an official invitation to join the university, marking the start of my academic career. I worked with colleagues in the Department of Architecture to develop the academic curriculum for the architecture program and contributed to establishing a diploma program in interior design. Additionally, I organized and conducted numerous training courses in architectural design and urban planning.

I had the honor of contributing to the organization of the "Architectural Competition: The Contemporary Bahraini House – Heritage Perspectives," which served as a platform to encourage creative thinking rooted in local identity. I also participated in numerous academic and specialized committees both within and outside the university. The most significant achievement for me, however, has always been maintaining continuous engagement with students and working to develop teaching methods that make the educational process more interactive and closely connected to practical reality, thereby enhancing students' understanding of the architect's role in serving society.

Regarding the relationship between academia and work in the private sector, it is possible for a PhD holder to work in companies in an academic capacity, where their expertise and knowledge contribute to developing the work environment and fostering innovation. They can also work in various areas within companies, such as research and development, consulting, senior management, training, and more. What is your perspective on this idea?

I fully agree with the idea presented, and I even believe that the relationship between academia and the private sector is not only possible but essential for fostering innovation and achieving development in both spheres. It is mistaken to view a PhD as merely a specialization in a narrow field of knowledge; it often represents a set of skills that can be applied in multiple contexts, such as deep analytical thinking, the ability to solve complex problems, project management, and leading research teams. These skills are a genuine added value to any work environment, especially in companies striving for excellence through the development of innovative products and services. Accordingly, most research centers in Western universities are closely linked to the private sector, industries, and even local issues.

During the Urban Indicators Workshop and moderating a session on data collection and analysis, 2000.

The overlap between the two sectors creates mutual benefits: the private sector gains from academic knowledge, while academics acquire a deeper understanding of market needs, enriching their research with real-world issues worthy of study and analysis. Ultimately, academia and the private sector should not be viewed as separate worlds but as interconnected systems. Their integration builds bridges of fruitful collaboration and reciprocal professional development. My own career, which has combined both practical and educational aspects, has provided a genuine opportunity to bridge the gap between these two domains.

Now, speaking of the Bahrain Society of Engineers, Dr. Souhail has made numerous contributions and participated in various activities of the society. However, we would like to inform the readers of Al-Mohandis about your early beginnings with the society, including when you joined and your contributions to its activities and events.

Since 1993, my relationship with the Bahrain Society of Engineers began through two dear friends and colleagues from my studies in the United Kingdom: Engineer Abbas Al-Watani and Engineer Faiq Mandil, who played a prominent role in introducing me to the society and its diverse professional activities. Since then, I have participated in numerous events and activities organized by the society, which have served as an important platform for dialogue and the exchange of experiences among engineers from within Bahrain and abroad.

One of my most notable contributions was participating in the international conference on "Heritage, Globalization, and the Urban Environment," which reflected the society's focus on issues related to urban identity amidst global changes. I also had the honor of chairing the judging committee for the Best Graduation Project competition, an experience I deeply value for the opportunity it provides to support young talents and stimulate engineering creativity among the new generation. Today, I continue to contribute to the BSE journey through my membership in the Awards Committee, which oversees the Best Graduation Project Award and the Distinguished Engineer Award. These initiatives play a significant role in honoring excellence and professionalism in the engineering field and encouraging a spirit of innovation among engineers in the Kingdom of Bahrain.

On duty in my office at Gulf Engineering House, 2018.

What memberships or committees have you joined within the society, and what are the most important events in which you have participated?

As mentioned earlier, I was a member of the organizing committee for the international conference on "Heritage, Globalization, and the Urban Environment," where I contributed a research paper addressing the topic from an architectural and cultural perspective. I also prepared an informational booklet on engineering disciplines to serve as a comprehensive reference for students wishing to enroll in universities across various engineering fields, aiming to help them choose an academic path suited to their interests and abilities.

In addition, I chaired the Best Graduation Project Committee and served as a member of the judging panel for architectural projects for several consecutive cycles, which gave me the opportunity to follow young talents' creativity and support promising professionals in the field. Currently, I participate in the committee overseeing the Bahrain Society of Engineers Awards, which includes three main categories: Lifetime Achievement in Engineering Award – recognizing an outstanding professional career and sustained contributions to the profession and society; Distinguished Engineer Award – honoring innovative achievements and significant contributions within the field of specialization; and Best Graduation Project Award – supporting and encouraging the new generation of engineers and motivating them toward creativity and excellence. These activities, in all their forms, reflect my commitment to advancing the engineering profession, supporting national talent, and maintaining connections across generations within a stimulating and inspiring professional environment.

After all these years with the society, how would you evaluate its performance as a professional organization working to develop the engineering profession, and architecture in particular, in the Kingdom of Bahrain?

The Bahrain Society of Engineers has made tangible contributions to developing the engineering sector and enhancing professional development pathways in the Kingdom of Bahrain. These contributions have been reflected through the organization of specialized seminars and conferences, as well as establishing

At Ahlia University - Design Trends Conference, 2025.

channels of communication and collaboration with engineering societies and institutions at local, regional, Arab, and international levels, which has facilitated the exchange of expertise, knowledge transfer, and increased professional awareness. The society also plays a pivotal role in representing engineers before official and unofficial bodies, advocating for their interests, and strengthening connections among its members through social and professional initiatives that contribute to building a cohesive and dynamic engineering community.

What are the most notable professional or community honors that Dr. Souheil El Masri has received?

Throughout my professional career, I have received several honors and recognitions that I deeply value, whether through my participation in scientific conferences as a researcher, as a member of organizing committees, or as a member of architectural judging panels. Some of the most notable awards include: Best International Research Award at the 9th Urban Planning Symposium in Sharjah; Royal Institution of Chartered Surveyors (RICS) Award – United Kingdom for the best research paper in the GCC region, which I received during the 7th Urban Planning Symposium in Sharjah; Excellence in Teaching Award from the University of Bahrain, recognizing my academic and educational contributions; and Outstanding Performance Award in the final year from the Department of Architecture at the Arab University of Beirut, which I take pride in as one of the earliest academic recognitions in my career. I have also had the honor of participating in several judging committees, including the Nasser International Award for Youth Creativity, and the Best Architectural Project Award organized by the Ministry of Housing.

However, the highest form of recognition for me remains my repeated encounters with former students, many of whom now hold influential positions in ministries, public institutions, and private companies. Seeing their success and professional progress represents the truest form of appreciation and the deepest sense of accomplishment.

After your long career in architecture and work in the private engineering sector, what has Dr. Souheil El Masri contributed to the field of architecture and to the engineering sector?

During a panel discussion on smart cities, 2025.

In addition to the diverse projects, I have had the honor of participating in and the research I conducted on heritage, globalization, and urban planning issues, I take particular pride in editing the book "Muharraq: Traditional Architecture of a Bahraini City", which I prepared in collaboration with the Sheikh Ibrahim Bin Mohammed Al Khalifa Center for Culture and Research. This book serves as an important reference documenting the unique architectural characteristics of Muharraq and contributes to preserving its urban and cultural memory for future generations by highlighting its heritage features and historical value within the context of urban development. I also participate in several advisory boards at various universities, including the University of Bahrain, Kingdom University, and the University of Ahlia, where I provide academic and professional guidance to support the development of educational programs and align them with labor market requirements.

Among the academic achievements I cherish most is the large number of students I had the opportunity to teach and mentor during my university career. I had the honor of teaching and providing academic supervision for twelve years, from 1994 to 2006. Many of these students have gone on to achieve remarkable professional success, becoming leaders in their respective fields—an outcome I consider the highest proof of the impact of education and mentorship, and the greatest reward an academic can receive.

What are the most important urban development projects that Dr. Souheil El Masri has worked on or supervised?

Every project I have worked on holds a special place in my heart, regardless of its size or nature, whether small or large. Each project comes with its own challenges and opportunities, contributing to the enrichment of my professional experience. However, if I were to highlight some notable projects, the most prominent would be Diyar Al Muharraq, where I participated as part of a team in reviewing the master plan and developing building codes and regulations, as part of efforts to create an integrated and sustainable urban environment. I also take

University of Applied Sciences – Keynote Speaker at Engineering and Industry Day, 2025.

pride in my involvement in the design of the American School, East Sitra City, and in developing the architectural concept for Al Baraha Market, as well as the Sudanese Embassy in Bahrain—projects with diverse natures, ranging from educational, urban, to diplomatic, each requiring a vision and design tailored to its specific character and function.

What unites these projects is that they were all the result of integrated teamwork under the umbrella of Gulf House Engineering, and under the direct supervision of the Managing Director and Principal Architect, Ahmed Bucheeri who played a pivotal role in guiding the team and ensuring the highest quality standards. We operate like

a hive of bees, with each member complementing the others, moving together according to clear visions and a shared strategy, making each project a unique experience and a source of pride for everyone involved.

After more than four decades of work and contribution, Dr. Souheil El Masri may wish to reflect on an experience that he considers a summary of this distinguished professional journey, adding a new memory to the minds of Al-Mohandis readers.

The Summary

After all these long years in the engineering field, moving between teaching, practice, and academic research, I still begin each day with a passion akin to that of a newly graduated architect, yet enriched by experience accumulated through multiple and diverse endeavors. I always start my day with a sincere awareness: that I do not know everything, but I possess enough knowledge and experience to overcome challenges and seek solutions.

I begin with a line, or a word, on a blank page... and the rest unfolds gradually, because design is never ready-made; it is a journey of exploration during which knowledge is created and solutions are invented. I reflect on the outcome of this journey, at each of its milestones, and I always thank Allah for the deep conviction that dwells within me: that I have been, and wish only to be, an architect. It is not merely a profession, but a way of life, a vision of the world, and a passion that never fades.

We would like to conclude this interview by inviting you to share a word of advice or a message for our young engineers across all engineering disciplines, from someone with extensive experience and a long-standing career in architecture and the engineering field in general.

At the conclusion of this interview, I would like to share a heartfelt message with young engineers across all disciplines—those who carry the torch of the future and stand today at the threshold of a professional journey full of opportunities and challenges. Engineering and technology, in all their branches, are not merely a profession or a means of earning a living; they are a mission and a responsibility. They are the ability to transform dreams into reality, and ideas into tangible achievements that improve people's lives and enhance the quality of our urban and natural environments.

First, I advise you to persevere and commit to continuous learning. Knowledge in our world evolves at an astonishing pace, and those who do not keep up risk being left behind. Do not limit yourself to what you learned at university; treat every project and every challenge as an opportunity to acquire new skills.

Second, uphold professional ethics. Integrity, commitment, and respect for the rights of others are not mere slogans—they are the foundation upon which every successful project must stand. Trust is built through professional conduct and can be easily lost if principles are neglected.

Third, do not fear making mistakes. Errors are part of the learning process. What matters most is to learn from them and have the courage to review and improve. Every successful engineer today was once a beginner, making mistakes, learning, and developing their skills.

Finally, work with passion. If you do not love what you do, you will not excel in it. The architecture with all branches of engineering requires both heart and mind; they require someone who sees beauty in details and feels responsible for everyone who will interact with what is created.

I wish you a bright future filled with achievements and contributions, and I am confident that you will be pioneers in building a better tomorrow.

With sincere regards and best wishes for your success.

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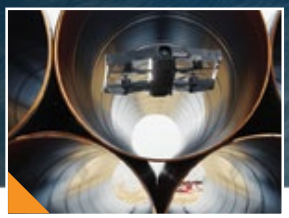

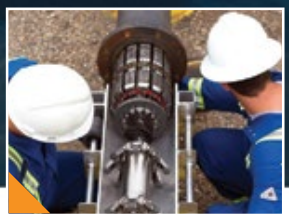

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The winning project of the Gulf Engineering Union Award:

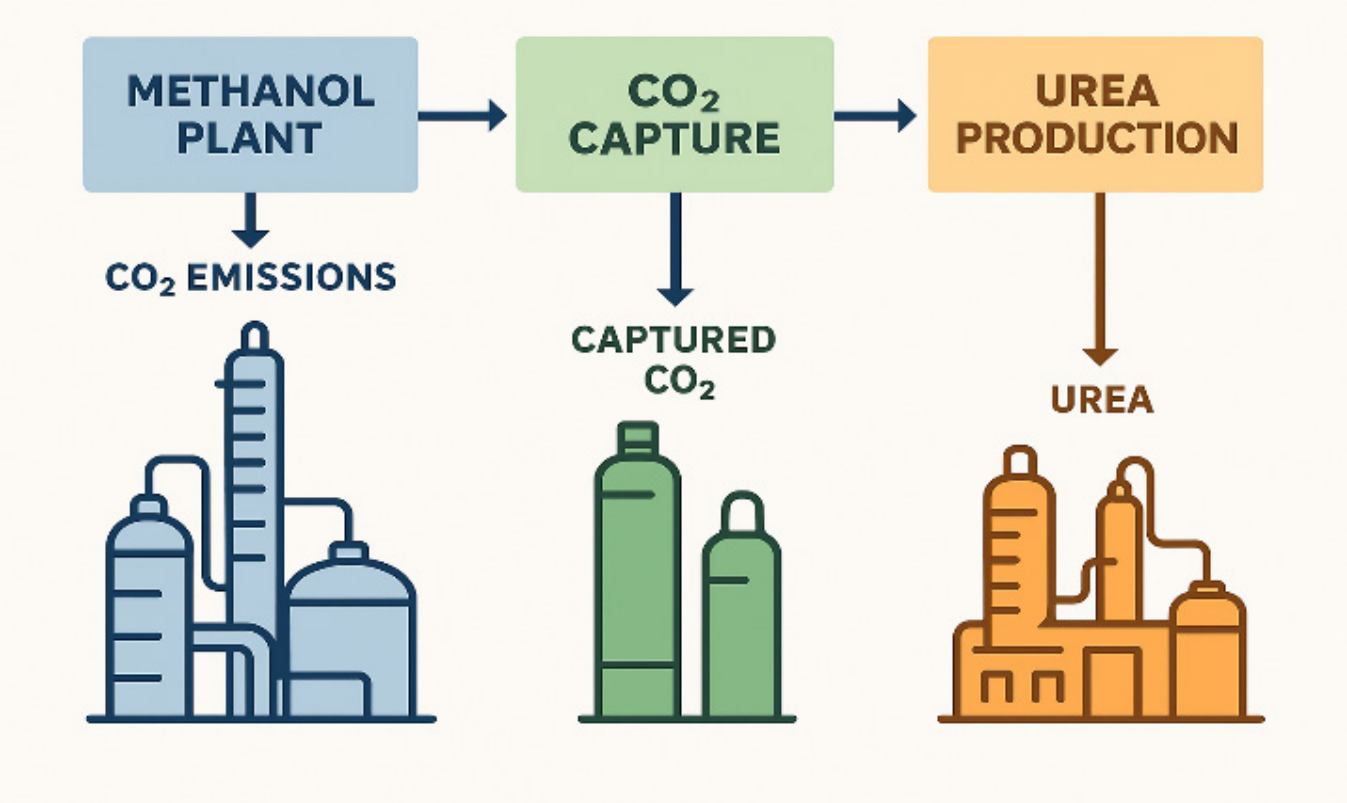
"Carbon Dioxide Recovery Plant Project at Gulf Petrochemical Industries Company"

As a strategic step reflecting a forward-looking vision and a clear anticipation of future environmental requirements and stemming from its deep commitment to environmental and social responsibility.

Gulf Petrochemical Industries Company (GPIC) launched in December 2009 a pioneering industrial project: the establishment of an advanced plant for the recovery and recycling of carbon dioxide.

This initiative stands as one of the region's most prominent environmental efforts. The project represents a practical embodiment of the company's ongoing commitment to promoting environmental sustainability practices and achieving the desired balance between industrial development and environmental protection.

The launch of this pioneering project came as a living embodiment of the company's advanced forward vision, which is founded on embedding the principles of environmental sustainability at the core of its



operational and production systems. It reflects the company's constant commitment to adopting the best global practices in environmentally friendly industries and strengthening the role of the industrial sector in addressing global environmental challenges such as climate change, pollution, and harmful emissions.

The plant's operating mechanism relies on capturing carbon dioxide emitted during methanol production at the industrial complex and then reusing it in the production of urea. This provides an intelligent and sustainable solution for carbon recycling and emission reduction. Through this initiative, the company achieves dual benefits: reducing environmental impact and increasing the efficiency of natural resource consumption—contributing directly to lowering the carbon footprint and enhancing environmental balance in the long term.

The project was executed in collaboration with specialized international partners. Technimont ICB (TICB), an Italian-Indian joint venture, served as the main contractor for the Engineering, Procurement, and Construction (EPC) contract, while Bahrain's MCSC carried out the civil and mechanical construction works.

The project utilized advanced technology from Japan's Mitsubishi Heavy Industries (MHI), known as the "KM CDR Process," which employs a proprietary amine-based solvent called KS-1 to capture carbon dioxide from flue gases produced during methanol production.

Undoubtedly, this milestone achievement has strengthened Gulf Petrochemical Industries Company's position as a leader in the Gulf industrial sector. It became the first company in the Arabian Gulf—and among the first in the Middle East—to own an industrial facility of this specialization and technical precision, built specifically to address climate change challenges, reduce gas emissions, and achieve maximum efficiency in resource management.

CDR plant Design information

Owner	Gulf Petrochemical Industries Company (GPIC)
Project	Carbon Dioxide Recovery From Methanol Flue Gas
Design Capacity	450 MTPD of 99.9 vol% CO_2 product
Process Licensor	Mitsubishi Heavy Industries (MHI) – Japan
LSTK Contractor	Tecnimont ICB (TICB) – India
Effective Date of Contract **Date of Completion**	25th October 2007 24th December 2009
Project Duration	26 Months
Turn Down Ratio	The unit is designed to operate between 40% and 100% of its design capacity

The design of the plant and the technology used in its operation reflect the company's progress in keeping pace with global advancements. The latest technologies and standards in carbon capture and recycling were adopted, making the facility a comprehensive model for applying clean technology in heavy industries. Since its commissioning, the plant has contributed to tangible environmental outcomes, including reduced emissions and improved air quality in neighboring industrial areas-demonstrating the project's success in achieving both environmental and developmental goals simultaneously.

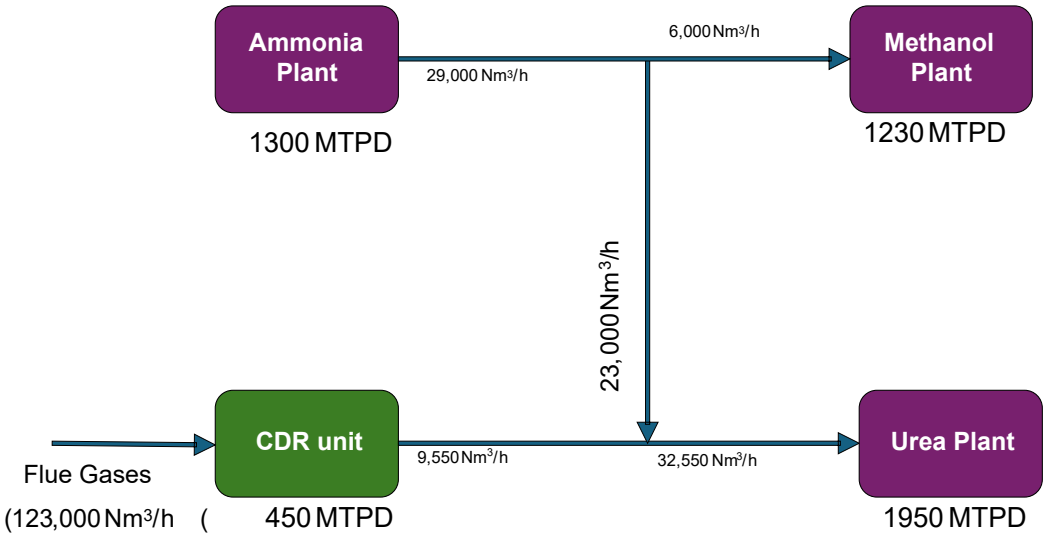
The impact of the project extended beyond its operational scope, serving as a catalyst for industrial innovation in the region. The plant enabled the company to harness advanced technology that enhances production, reduces waste, and embeds a culture of sustainability within the workplace-forming a fundamental pillar for building a modern, advanced industrial sector aligned with smart development goals.

In the context of community commitment, Gulf Petrochemical Industries Company believes in the importance of serving as an inspiring model for other industrial institutions—both in Bahrain and across the region. The company continuously strives to encourage others to adopt sustainable environmental solutions and to contribute to building a responsible industrial society that balances technological advancement with environmental preservation.

Through this project, the company reaffirms its support for the Kingdom of Bahrain's initiatives related to environmental protection and green development, in alignment with national efforts to achieve carbon neutrality and embrace a low-emission economy.

The project received widespread acclaim from official, environmental, and industrial bodies at

CO_2 Gas Balance Post CDR



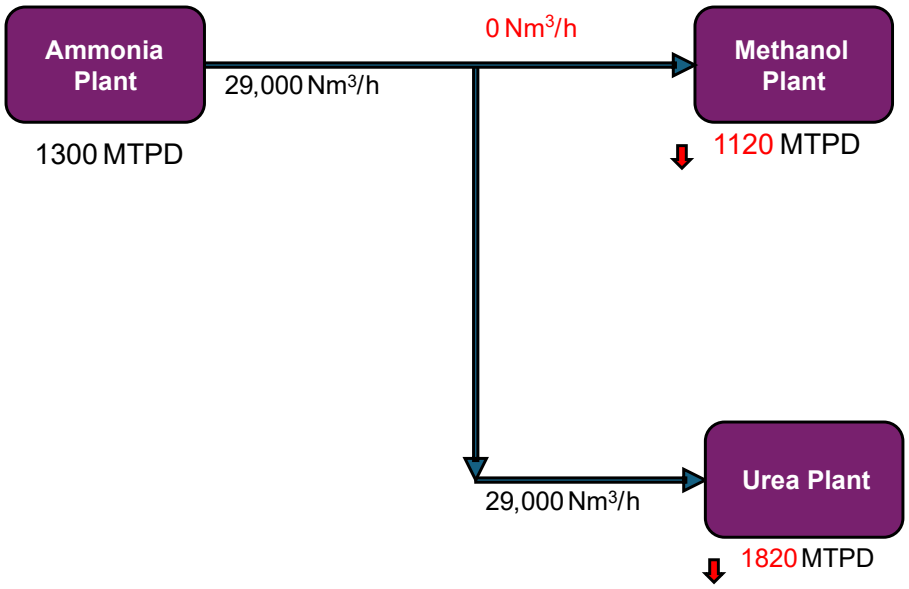
both the local and regional levels. It was regarded as a successful model that embodies the integration of economic development and environmental preservation. The project was honored with several prestigious awards, most notably a Gulf award during the 26th Gulf Engineering Forum-further affirming the company's leadership in applying sustainability standards within the industrial sector.

The Carbon Dioxide Recovery Plant is not merely an industrial project; it stands as a living testament to the company's firm commitment to supporting the Kingdom of Bahrain's vision of transitioning toward a sustainable green economy. It reflects a belief that industrial innovation can go hand in hand with environmental protection and the preservation of natural resources-ensuring a safer, more sustainable future for generations to come.

CDR Plant Production

CDR Production	Plant Load in%	CO_2 Production
Daily Production	84	378 MT/D
Average production	81	365 MT/D
Maximum Production	94	423 MT/D
Cumulative Production* *2024 end		2,400,000 MT

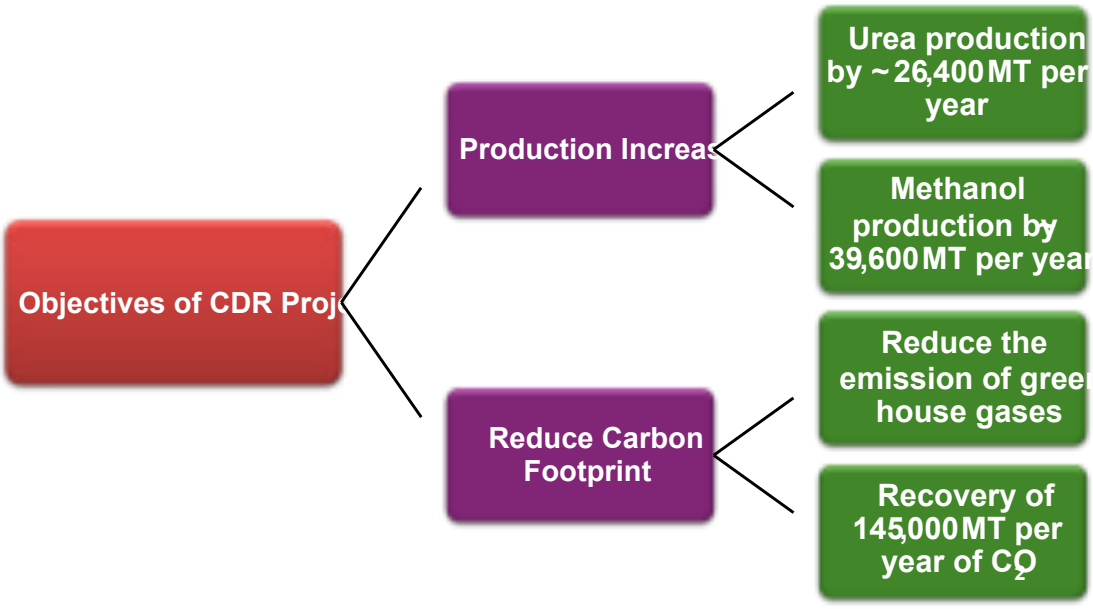
CO_2 Gas Balance Prior To CDR



This project comes within a national context that reflects the overarching directions of Bahrain's Economic Vision, which places sustainability at the forefront of its priorities and elevates innovation as a tool for achieving excellence and leadership. The project also aligns with the global sustainable development agenda, particularly Goal 13 related to «Climate Action» and Goal 12 concerning «Responsible Consumption and Production.»

Such pioneering projects contribute to advancing comprehensive development and affirm the Kingdom of Bahrain's commitment to achieving its environmental goals-particularly the reduction

CDR Project Objectives



of greenhouse gas emissions by 30% by 2035 and reaching carbon neutrality by 2060. These ambitious steps are supported by quality projects like this plant, which embodies the convergence of national will with innovative industrial initiatives.

Technical and economic studies conducted in collaboration with one of the leading specialized consulting firms confirmed the outstanding feasibility of this project from both financial and technical perspectives. The estimates revealed the potential to achieve an attractive return on investment of approximately 20.6%, against a total investment of around 52 million US dollars.

These positive results served as a strategic incentive that propelled the company to proceed with implementing the project, with a daily operational capacity of 450 metric tons of carbon dioxide. The project was completed with high efficiency and remarkable professionalism, thanks to the efforts of Bahraini national talents. It was finalized ahead of schedule and within the allocated budget—an achievement that embodies the spirit of commitment and institutional excellence.

The benefits of the carbon dioxide recovery process can be summarized in the following points:

Reducing Carbon Emissions:

• Critical Environmental Importance: Carbon dioxide is one of the primary greenhouse gases responsible for global warming. Its recovery and recycling directly contribute to reducing the plant's carbon footprint.

• Compliance with Environmental Standards: It helps factories comply with local and international environmental regulations aimed at emission reduction.

Improving Resource Efficiency:

• Instead of releasing CO□ into the atmosphere, it is reused as an input in other production processes, such as in the manufacture of urea or other chemicals, which enhances resource efficiency and saves raw materials.

Achieving Additional Economic Returns:

• Reducing Operating Costs: Recycling carbon dioxide can eliminate the need to purchase certain raw materials.

• Increasing Production: In some cases, using recycled CO□ contributes to improving the productivity of products such as urea and methanol.

• Enhancing the Plant's Image: Environmental projects boost the reputation of companies and earn the trust of markets and investors.

Innovation and Industrial Leadership:

• Factories that adopt carbon capture technologies are at the forefront of innovation, giving them a competitive advantage—especially amid the global transition toward a low-carbon economy.

Supporting Efforts to Transition to a Green Economy:

• These initiatives contribute to achieving sustainable development goals, such as Goal 13 (Climate Action) and Goal 12 (Responsible Consumption and Production).

• They also support national visions like "Bahrain Economic Vision 2030" by promoting sustainability and innovation in the industrial sector.

Bahrain Society of Engineers Award

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 four award-winning projects.

1 Architecture

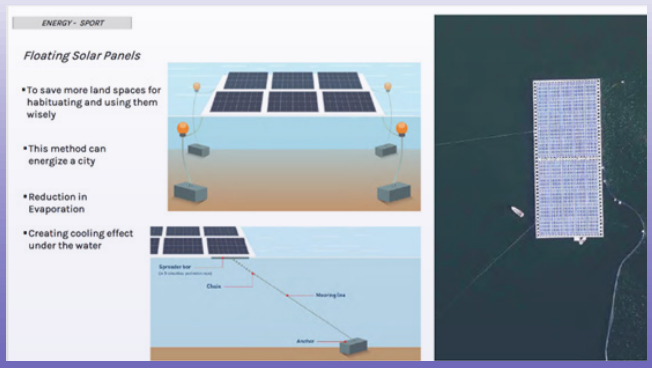
The "Revive Hub" is a sport medicine and fitness complex

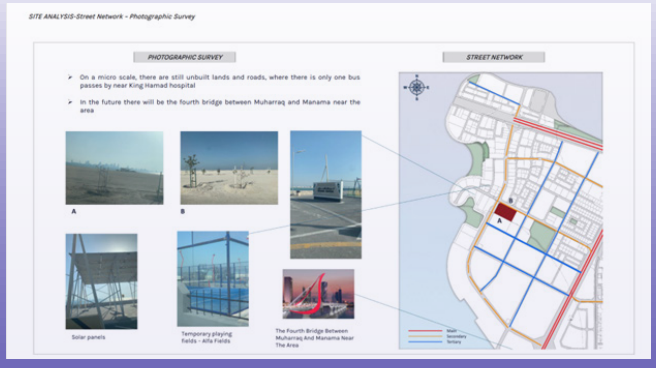
Student: Aysha Abdul Aziz Al-soreti

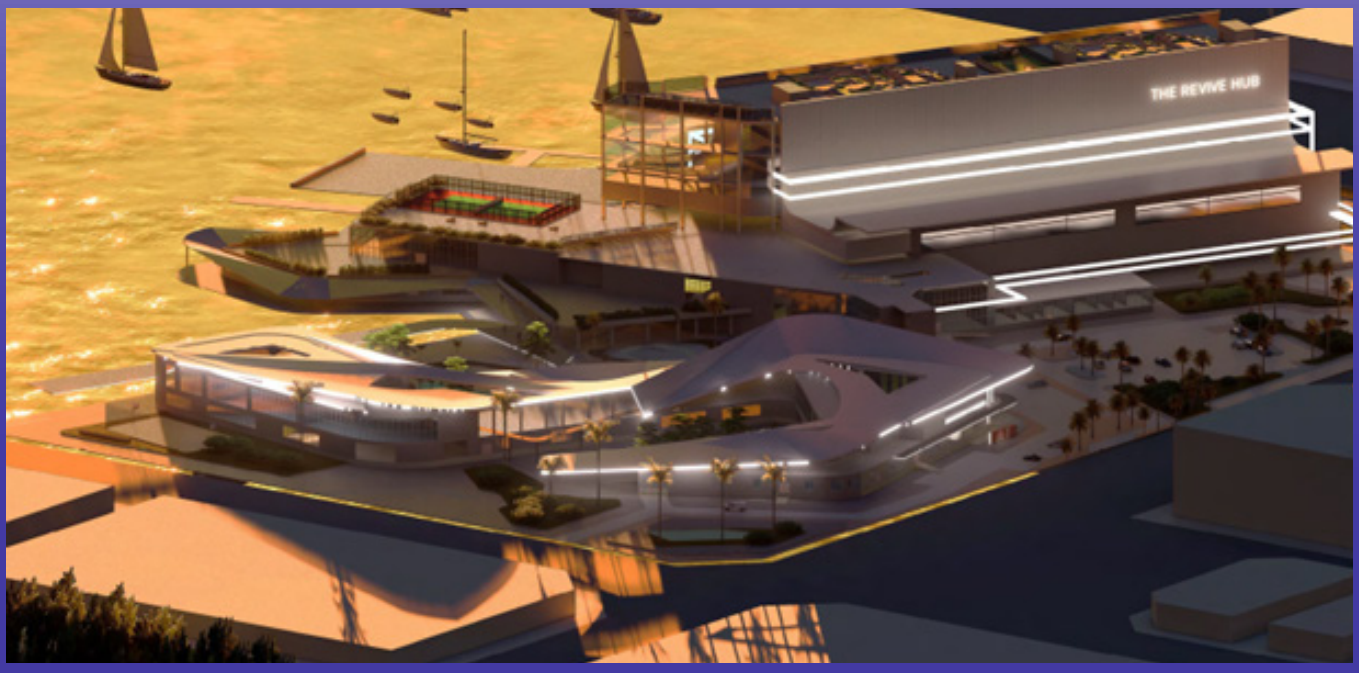
Supervisor: Dr. Wafa Al Ghatam

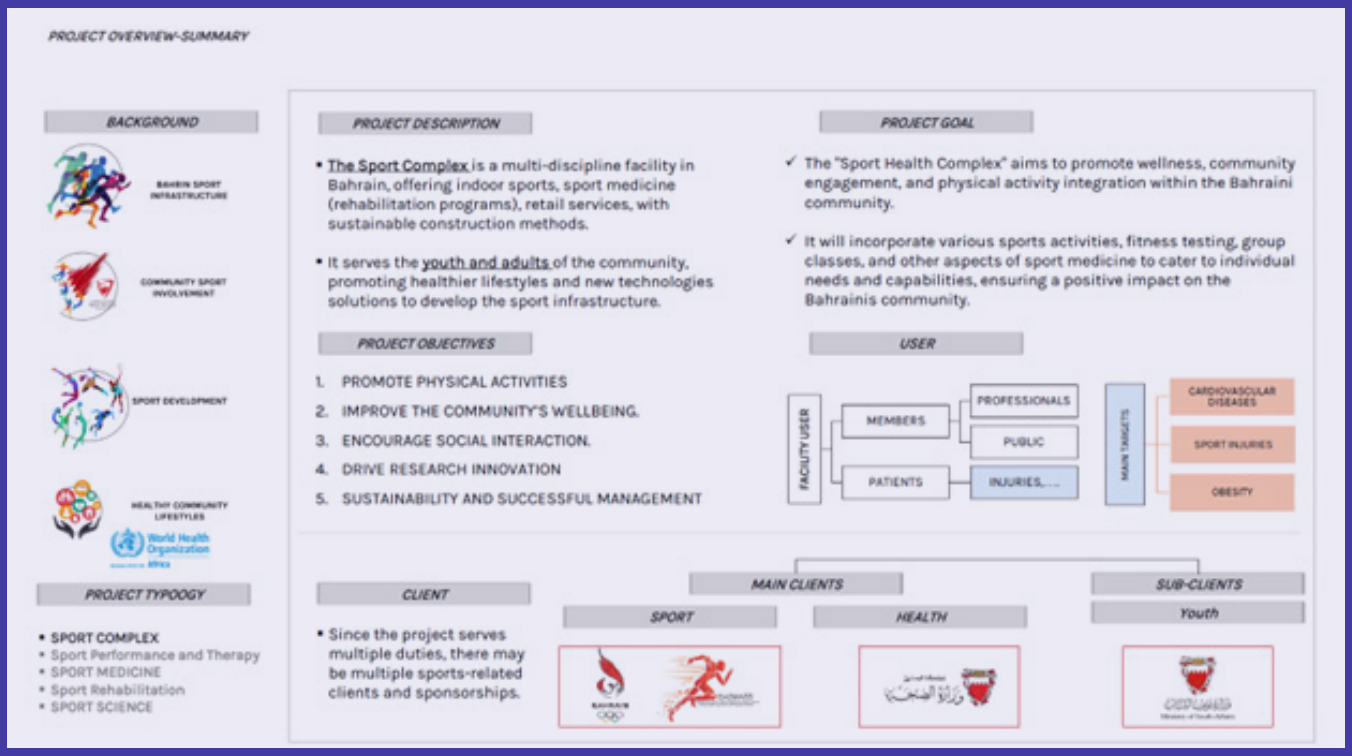
offering indoor sports and sport medicine (rehabilitation programs) with high technologies to develop the sport infrastructure in the kingdom of Bahrain.

The project consists of several programs to gain recovery, health, and fitness for patients (diabetes, hypertension, cardiovascular diseases), injuries, and whoever is seeking a healthier lifestyle or sports enthusiasm.


ENERGY - SPORT
Floating Solar Panels
•To save more land spaces for habituating and using them wisely
•This method can energize a city
•Reduction in Evaporation
•Creating cooling effect under the water


SITE ANALYSIS-Street Network - Photographic Survey
PHOTOGRAPHIC SURVEY
STREET NETWORK


THE REVIVE HUB


PROJECT OVERVIEW-SUMMARY
BACKGROUND
BAHRIN SPORT INFRASTRUCTURE
COMMUNITY SPORT INVOLVEMENT
SPORT DEVELOPMENT
HEALTHY COMMUNITY LIFESTYLES
World Health Organization
PROJECT TYPOOGY
• SPORT COMPLEX
• Sport Performance and Therapy
• SPORT MEDICINE
• Sport Rehabilitation
• SPORT SCIENCE
PROJECT DESCRIPTION
• The Sport Complex is a multi-discipline facility in Bahrain, offering indoor sports, sport medicine (rehabilitation programs), retail services, with sustainable construction methods.
• It serves the youth and adults of the community, promoting healthier lifestyles and new technologies solutions to develop the sport infrastructure.
PROJECT OBJECTIVES
1. PROMOTE PHYSICAL ACTIVITIES
2. IMPROVE THE COMMUNITY'S WELLBEING.
3. ENCOURAGE SOCIAL INTERACTION.
4. DRIVE RESEARCH INNOVATION
5. SUSTAINABILITY AND SUCCESSFUL MANAGEMENT
PROJECT GOAL
✓ The "Sport Health Complex" aims to promote wellness, community engagement, and physical activity integration within the Bahraini community.
✓ It will incorporate various sports activities, fitness testing, group classes, and other aspects of sport medicine to cater to individual needs and capabilities, ensuring a positive impact on the Bahrainis community.
USER
FACILITY USER
MEMBERS
PROFESSIONALS
PUBLIC
PATIENTS
INJURIES,...
MAIN TARGETS
CARDIOVASCULAR DISEASES
SPORT INJURIES
OBESITY
CLIENT
• Since the project serves multiple duties, there may be multiple sports-related clients and sponsorships.
MAIN CLIENTS
SPORT
HEALTH
SUB-CLIENTS
Youth

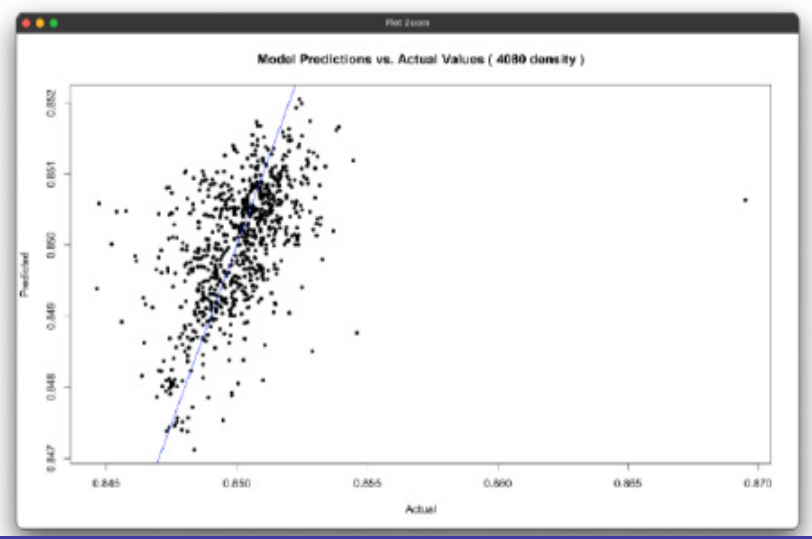
2 Chemical Engineering

Building a Soft Sensor Model to Predict Lube Base Oil Properties Using Various Industrial and Laboratory Data

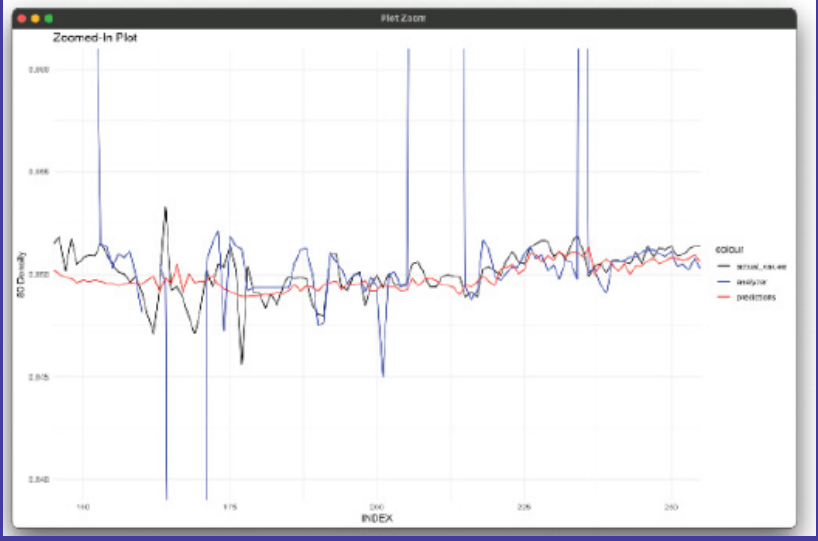
Student(s):
Ahmed Elwathig Osman Elyass
Husain Ali Husain Abdulnabi
Mohamed Abdulredha Ali Amralla Hasan
Supervisor:
Dr. Raed Aljowder
University and department:
University of Bahrain, Department of Chemical Engineering

Summary:
This research project focuses on the development of an advanced artificial intelligence model designed to measure and predict the physical properties of lubricating base oil. Leveraging a blend of process and laboratory data, the study aims to overcome the challenges associated with the direct measurement of certain properties in industrial processes using conventional solid-state sensors. The cornerstone of this research is a machine learning model capable of intelligent monitoring, which facilitates real-time prediction and measurement of lubricant oil properties. By harnessing industrial and laboratory data, the model significantly enhances monitoring processes, enabling swift identification of issues, and reducing dependency on expensive, condition-resistant sensors. This approach not only minimizes costs but also lessens the need for human intervention. The research methodology involved several critical steps to ensure optimal model performance. It began with careful data selection from various processes, followed by extensive data exploration and preprocessing, including data cleaning, normalization, and standardization. The project explored multiple modeling techniques, starting with Multiple Linear Regression (MLR), which faced challenges with collinearity. Subsequent models like Principal Component Regression (PCR) and Partial Least Squares (PLS) were developed; PCR aimed to address collinearity issues in MLR but showed limited improvements. PLS, while managing collinearity effectively, only modestly improved the capture of variations in laboratory values compared to an industrial model.

The final phase involved implementing Neural Networks (NNs), specifically the Multilayer Perceptron (MLP), to handle the complex nonlinear relationships between variables. A hybrid model that combines Principal Component Analysis (PCA) and MLP has emerged as a superior predictor of quality variables, surpassing the industrial PLS model. This hybrid model not only predicts with remarkable accuracy but also captures nuanced laboratory values, yielding low Root Mean Square Error (RMSE) values: 0.00151768 Kg/L for WAXY43 density, 0.0012863 Kg/L for WAXY80 density, 0.005063 centistokes (cSt) for WAXY43 KV100, and 0.24866 centistokes (cSt) for WAXY80 KV100. This comprehensive approach demonstrated superior predictive performance and accuracy, surpassing traditional singular modeling techniques.



PLS model prediction's 45°-line scatter plot for Waxy80 Density



PLS model's prediction's time series representation for Waxy80 Density: Prediction (-), Actual (-), Industrial (-)

3 Civil Engineering

Design of Metro Station Using Virtual Reality

Students:

Lubna Omar Ebrahim Almahmood

Nawra Hasan Husain Ali

Supervisor:

Dr. Uneb Gazder

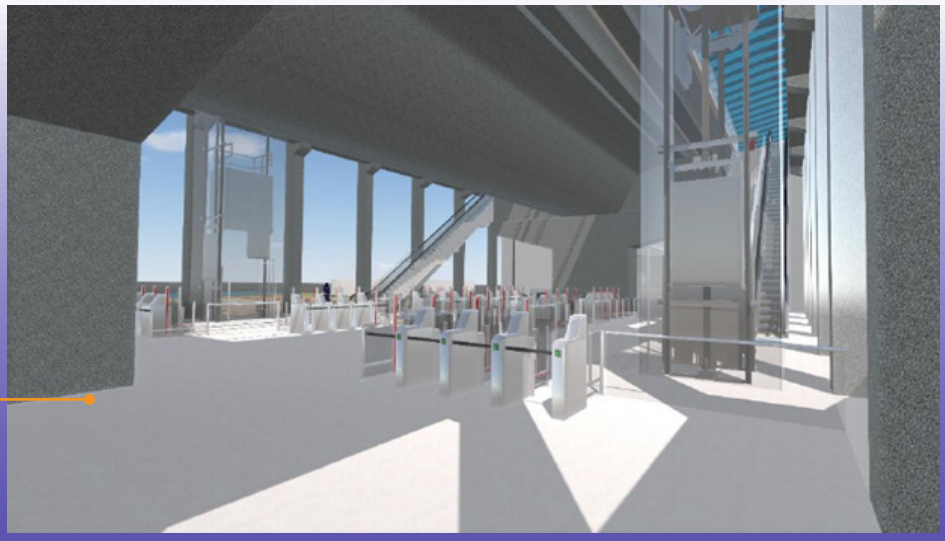
University and Department:

University of Bahrain, Department of Civil Engineering

This senior design project report presents a completed process of designing a metro station with developing a 3D model and implementing virtual reality concept. It starts with a brief background about the metro transportation system and metro stations' history around the world, an elucidation about virtual reality technology and its' usages, Metro Bahrain project, and pedestrians' facilities. Then moves to the design process, which begins with choosing a location after studying the conditions around the site, design an integration and accessibility system, and going through the architectural and structural design of the station building. The architectural design section justifies the logic behind selecting the specified design as per Dubai Building Code, Neufert Architects' Data Standard, and International Building Code, and also shows the stations' plans, elevations, and one section. While the structural design section clarifies the manual calculations of roof beams, platform slabs, I-girders, corbels, inner columns, mezzanine slabs, mezzanine beams, mezzanine girders, hammerhead pier cap, and pier column, as per American Society of Civil Engineering, American Concrete Institute, and American Association State Highways and Transport Official. Then, it presents the 3D model and demonstrates the Virtual Reality usage in this project. In addition, station capacity, train speed, train stoppage time, train safe time interval, and a sight distance study are discussed. The report concludes with a, a summary of the results, and recommendations.

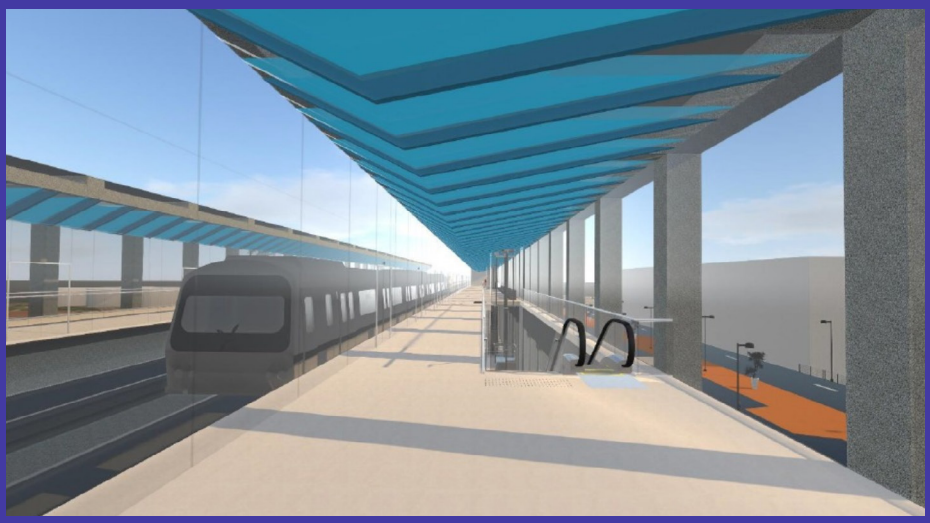
We used different software such as AutoCAD for architectural and structural design, ETABS for designing the columns and continuous beams, and Revit for developing the 3D model.

To apply virtual reality, we have used Prospect by Iris VR and Steam VR. It is important to



Mezzanine Level in Virtual Reality

Mezzanine Level in Virtual Reality



mention that we have done the structural design manually with the help of Microsoft Excel software. Moreover, the report is supported with figures, tables, Videos (as QR codes), and appendices in order to convey the work done in a simple manner.

4 Electrical and Electronic Engineering

Ultrawideband Antenna for Monitoring Radio Spectrum

Students:

Ebrahim Almalki

Mohamed Ghazi

Supervisor:

Dr. Ali Harmouch

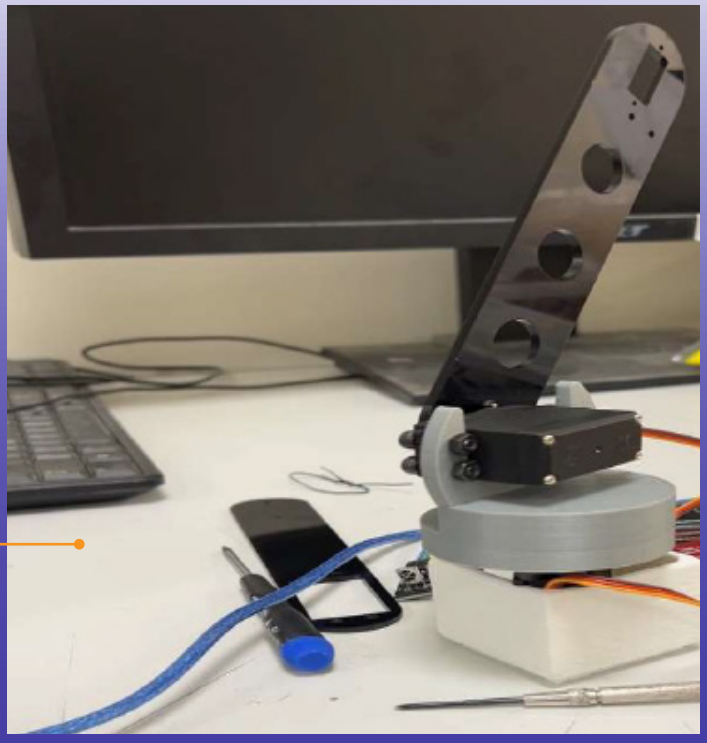
University and Department:

Ahlia University, Department of Telecommunication Engineering

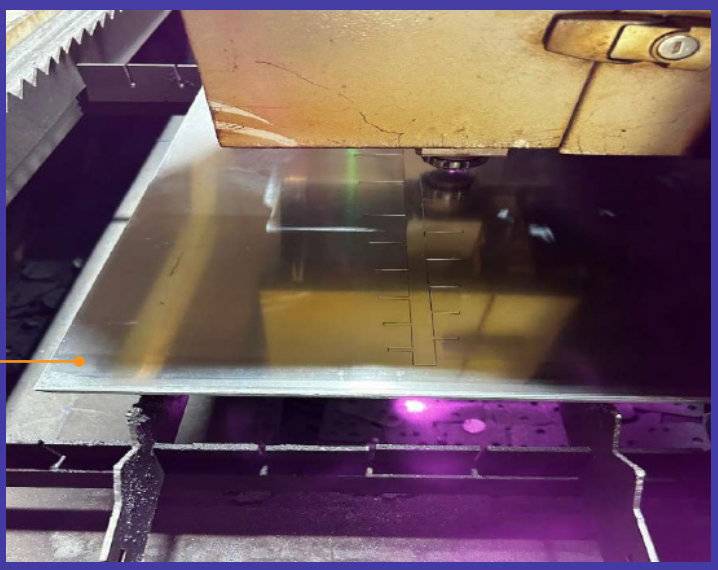
Summary:

This research project involves the design and analysis of an integrated high-gain log-periodic antenna system, specifically designed for advanced real-time ultra-wideband spectrum monitoring within the UHF band, covering frequencies from 250 MHz to 3 GHz. Utilizing a laptop equipped with Dragon OS for its superior processing capabilities, the system is further enhanced by precise 360-degree horizontal, and 180-degree vertical adjustments controlled by an Arduino UNO, allowing the Antenna to operate with double polarization states.

The design process involved calculating the antenna elements and their spacing through MATLAB, where a simulation of the designed antenna was made using CST Microwave Studio. This theoretical model was accurately transferred into a physical model by creating a DXF file used to cut a 6mm aluminum sheet with a CNC machine, ensuring exact dimensionality. The antenna achieved initial gains ranging from 4.89 dBi for the first to the fourth element, increasing to 11 dBi from the fourth to the thirtieth element. Field tests confirmed the antenna's efficacy in capturing the entire UHF band from 250 MHz to 3 GHz, demonstrating the success of our design, simulation, and manufacturing processes in meeting the project's objectives.



Controlling Device for Antenna Rotation



Cutting Device for Antenna Manufacturing

Testing the designed antenna in outdoor environment

Articles

Dr. Fawzi ALJawder
Senior IEEE Member
Certified Renewable Energy Consultant Expert by (ERI), UK

Hybrid Renewable Power Generation

Hybrid renewable power generation, as the name suggested, combines two or more renewable power generation stations to minimize intermittency and to further improve efficiency, reliability, and resiliency. This article explains the components, merits and demerits, and prospects of hybrid renewable power generation.

1.Main components

Hybrid renewable power generation integrates multiple (two or more) renewable power sources to produce a more stable, efficient, and resilient power supply. The most common hybrid combinations include [1]:

1-Photovoltaic (PV)-Wind hybrid power generation.

2- Photovoltaic (PV)- Battery Energy Storage System hybrid power generation.

3- Photovoltaic (PV)- Wind-Battery Energy Storage System hybrid power generation

4-Photovoltaic (PV)-Hydro hybrid power generation.

5-Photovoltaic (PV)-Battery Energy Storage System (BESS)-Biomass hybrid power generation.

6-Wind-Biomass hybrid power generation.

The six main components of the hybrid renewable power generation stations are given as:

1-The renewable power generation source (PV arrays, wind turbines, hydro turbine-generator, biomass generator).

2-DC-to-AC converters or Inverters to convert the DC power to AC power and DC-to-DC converters which are used as Maximum Power Point Trackers for PV arrays.

3- Battery Energy Storage Systems (BESS) like

Batteries (lithium-ion, lead-acid)

4-Control and Power management Systems: to control and optimize power production management between sources and storage.

5-Protection systems: to protect the hybrid renewable power generation station (Fuses, isolation switches).

6- Diesel generators (optional) provide additional reliability in off-grid power systems.

2. Coupling Topologies of Hybrid Renewable Power Generation

There are three topologies for coupling Hybrid Renewable Power Generation: (1) DC bus coupling, (2) AC bus coupling and (3) Dual DC-AC Bus coupling. Fig.1 and Fig.2 show, respectively, the DC bus coupling and AC bus coupling. In DC bus coupling, the Wind Turbine Generator (WTG), Hydro generator and Biomass generator are connected to the DC bus through an AC-to-DC converter, while the PV array is coupled to the DC bus using a DC-to-DC converter (Maximum Power Point Tracker). The battery energy storage system (BESS) is connected to the DC bus using a bi-directional DC-to-DC converter to permit charging or discharging of BESS. A common DC-to-AC converter (Inverter) is required to transfer the power produced by the Hybrid renewable power generation station and collected by the DC bus to the grid as depicted in Fig.1. This topology eliminates the challenges associated with synchronization. However, the losses involved with the power conversion systems, particularly the losses associated with converting the AC powers of WTG, Hydro generator and Biomass generator to DC and then back to AC, which is approximately 10% of the transferred power [1].

In AC Bus coupling, the PV array is coupled to an AC bus using a DC-to-AC converter (inverter) which acts as MPPT and, simultaneously, converts DC power to AC power. On the other hand, the WTG is connected to the AC bus through an AC-to-AC converter. The hydro and biomass generators are directly connected to the AC bus and the BESS is coupled to the AC bus by a bi-directional DC-to-DC converter and an

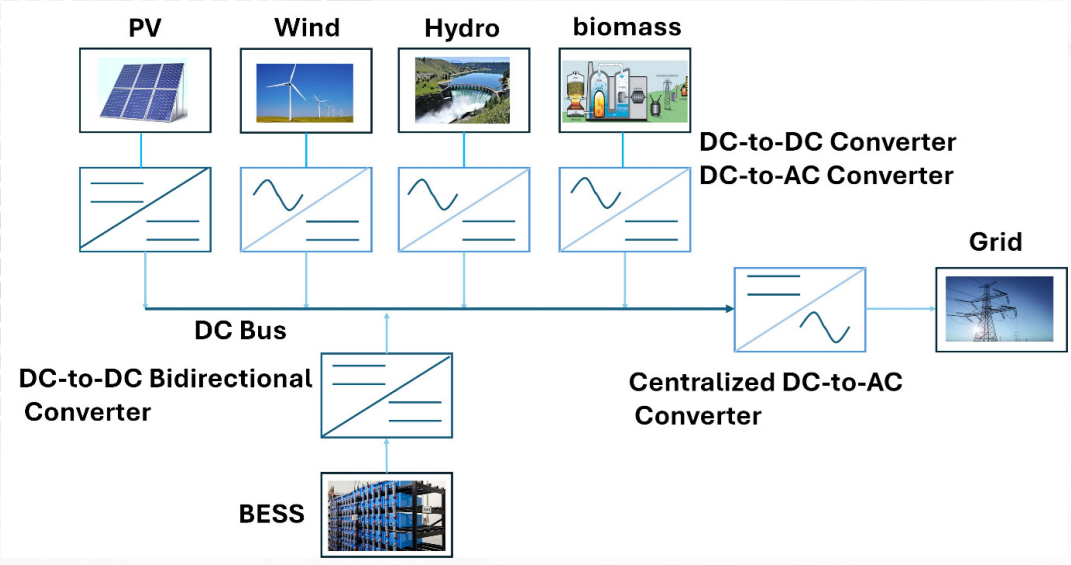


Fig.1 DC Bus coupling for Hybrid Renewable Power Generation.

inverter. In this configuration, PV array and WTG are connected to the AC bus through a separate converter which allows them to produce power even if one of them is disconnected (no common DC-to-AC converter is needed). This improves the system's reliability [1]. In addition, less power converters are needed in this topology which reduces the power loss of the Hybrid Renewable Power Generation Station.

Fig.3 illustrates the topology of the dual DC-AC Bus coupling for Hybrid Renewable Power Generation where both DC and AC buses are used. The renewable power resources with DC output power are connected to the DC Bus and the resources with AC output power are connected to the AC bus. Therefore, the hydro generator and Biomass generators are connected to the AC Bus. The WTG is coupled to the AC bus through AC-to-AC converters (Back-to-Back converters). On the other hand, the PV array is connected to the DC bus through a common DC-to-AC converter (inverter).

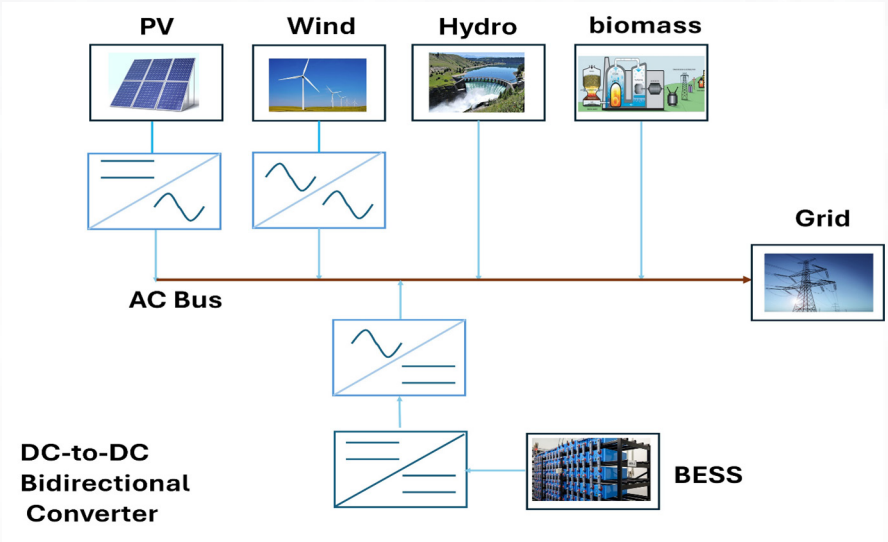


Fig.2 AC Bus coupling for Hybrid Renewable Power Generation.

The BESS is coupled to the DC bus through a bi-directional DC-to-DC converter and the common inverter. With this topology, the power losses are limited, and the efficiency is improved by reducing the number of converters [2]. This configuration is the most widely implemented due to its resiliency to combine renewable power sources and DC/AC load irrespective of features [3].

3.Merits and Demerits

Table 1 summarizes the merits and demerits of the Hybrid Renewable Power Generation. The demerits or the challenges can be overcome by Government subsidies, Artificial Intelligent-based controller and considering Floating PV arrays and offshore WTGs.

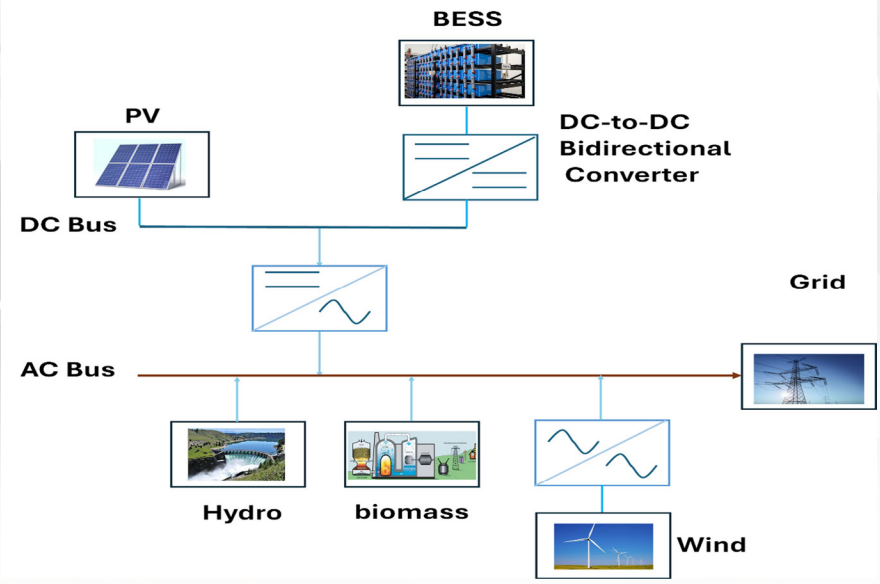


Fig.3 Dual DC-AC Bus coupling for Hybrid Renewable Power Generation.

Table 1. Merits and demerits of the Hybrid Renewable Power Generation

No.	Merits	Demerits
1	Reduce intermittency, improve reliability and reduce power fluctuations due to weather-dependent renewable power sources.	Require a large space (land) to install different types of renewable power sources
2	Suitable for remote and off-grid (isolated or remote-located) power systems and less dependance on centralized power grids.	Require complex control and protection systems design to regulate and balance the power generated by each source.
3	Improves grid stability and peak load management by supplying power during peak demand which reduces pressure on the grid.	High initial cost due to integration of different renewable power source technologies.
4	Reduce dependency on a single power source and lower operational costs since all sources are installed at the same location.	

4.Practical Installations and Prospective

Table 2 provides a list of some of the worldwide practical installations of Hybrid Renewable Power Generation. Hybrid Renewable Power Generation offers a transformative solution for sustainable power by providing a reliable, efficient, and environmentally friendly alternative to conventional power generation stations. As technology progresses and the costs of renewable power sources continue to fall, Hybrid systems will become more affordable and accessible. It is anticipated that Artificial intelligence (AI) will play a crucial role in controlling, managing, and optimizing the operation of Hybrid Renewable Power Generation. In addition, public sector, private sector and researchers will continue investing in this technology to build a cleaner and more resilient energy future.

Table2. some of the practical installations of Hybrid Renewable Power Generation worldwide.

No.	Practical Installation	PV	WTGs	BESS	Hydro	Biomass
1	Kennedy Energy Park–Hughenden, Queensland, Australia.	20MW	30MW	2MW	_____	_____
2	Wheatridge Renewable Energy Facility – Morrow County, Oregon, USA.	50MW	300MW	120MWh	_____	_____
3	Punjab Biomass-Wind Hybrid in India.	_____	5MW	_____	_____	10MW
4	Banja PV-Hydro in Albania.	12.9MW	_____	_____	64MW	_____

References:

1- A. M. Eltamaly and A. A. Al-Shamma'a, "Optimal configuration for isolated hybrid renewable energy systems," J. Renewable Sustain. Energy, vol. 8, no. 4, 2016, Art. no. 045502.

2- M. H. Nehrir et al., "A review of hybrid renewable/alternative energy systems for electric power generation: Configurations, control, and applications," IEEE Trans. Sustain. Energy, vol. 2, no. 4, pp. 392–403, Oct. 2011. [24]

3- K. Anoune, M. Bouya, A. Astito, and A. B. Abdellah, "Sizing methods and optimization techniques for PV-Wind based hybrid renewable energy system: A review," Renewable Sustain. Energy Rev., vol. 93, pp. 652–673, 2018.

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University of Bahrain

The Impact of Climate Change on Civil Engineering Structures: Current & Future Challenges

Abstract

Climate change is creating serious challenges for buildings and infrastructure. This article looks at how extreme weather, higher temperatures, rising sea levels, and unstable soil affect structures. It also discusses ways engineers can adapt, such as using better materials, smarter designs, and updated construction methods. The goal is to create awareness among civil engineers prepare about these challenges and recommend strategies to build safer, longer-lasting structures.

1.Introduction

Climate change refers to significant and lasting changes in the Earth's temperatures and weather patterns. These changes can be from natural causes (such as large volcanic activity) or from human activities. Since the Industrial Revolution in the 1800s, humans have been the main driver of climate change, primarily due to the burning of fossil fuels like coal, oil, and gas.

The negative impact of climate changes on civil engineering structures is apparent. The primary effects as extreme weather effects as well as secondary effects as deterioration and corrosion, the changes in type of load at structures induced by rising sea level or variation of temperature through cross section. Therefore, it is necessary for civil engineers to adapt to ongoing changes and start to consider these problems.

2. Trends of Climate Change

2.1 Extreme Weather Events

Extreme weather events induced by climate change in particular, and environmental factors in general have a significant effect on the performance of shallow ground behavior and geo-infrastructures placed in this zone. The impact of climate change on infrastructure is multi-dimensional. In regions where an increased precipitation is expected, more infrastructure damage and soil erosion are likely. Increased ambient and ground temperatures will accelerate evaporation and lead to crack formation.

One of the most visceral effects of climate change is the increasing intensity of weather events. From hurricanes Katrina and Rita to recent tornadoes in the American South and Midwest–these weather events wreak billions

of dollars in damages to residential areas, commercial buildings, and critical infrastructure in over short spans of time.

2.2 Rising Temperatures

Climate change is also altering temperature patterns, with more frequent heatwaves and extreme cold events, as shown in Figure 2. These temperature fluctuations can have a significant impact on the structural integrity of buildings, bridges, and other infrastructure. Civil engineers are now incorporating climate data into their designs to ensure that structures can withstand these temperature variations.

Additionally, engineers are exploring innovative materials and construction techniques that can better adapt to changing temperature patterns. This includes the use of heat-resistant materials, improved insulation, and smart building technologies that can regulate internal temperatures efficiently.

2.3 Rising Sea Levels

One of the most visible impacts of climate change is the rising sea levels. As the polar ice caps melt and ocean temperatures rise, coastal areas are increasingly prone to flooding and erosion, as shown in Figure 2. This poses a significant challenge for civil engineers involved in the design and construction of coastal infrastructure such as ports, harbors, and sea walls. To address this issue, engineers are incorporating climate change projections into their designs, considering the potential rise in sea levels over the project's lifespan. This involves raising the elevation of structures, implementing flood-resistant materials, and employing innovative design techniques to ensure the long-term resilience of coastal infrastructure.

2.4 Soil Stability

Climate change has a profound impact on soil erosion, exacerbating the loss of topsoil and leading to environmental degradation. Some of these impacts are summarized in Figure 3. The increased frequency and intensity of rainfall events due to climate change results in greater runoff, which carries away sediments and erodes the soil. This process not only reduces soil fertility but also contributes to the sedimentation of rivers and streams, impacting ecosystems and water quality. Moreover, changes in temperature patterns can alter the freeze-thaw cycles, further destabilize the soil and increase erosion risks. Therefore, understanding and addressing the effect of climate change on soil erosion is crucial in developing effective strategies for sustainable land management and geotechnical engineering practices.

3. Impacts of Climate Change on Civil Engineering

Extreme Weather Events: Future challenges include designing infrastructure to handle increased uncertainty, as climate models predict a greater frequency and severity of events like hurricanes, floods, and storms. Engineers must create robust yet flexible systems capable of withstanding unpredictable forces. Repeated exposure to extreme weather will shorten the lifespan of bridges, roads, and buildings, leading

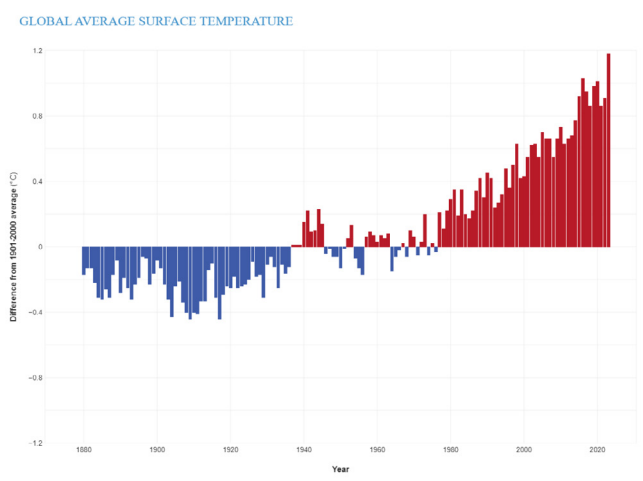

Figure 1. Yearly surface temperature from 1880–2023 compared to the 20th-century average (1901-2000). Blue bars indicate cooler-than-average years; red bars show warmer-than-average years. NOAA Climate.gov graph, based on data from the National Centers for Environmental Information.

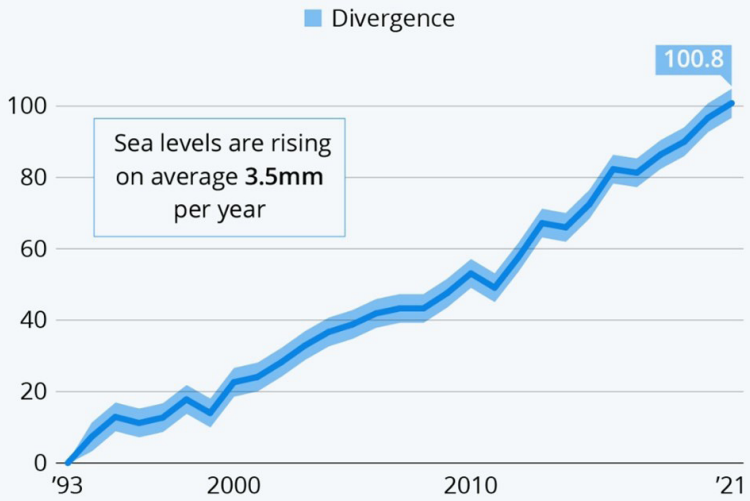

Figure 2. Rise in Sea Levels (https://www.weforum.org/stories/2022/08/rising-sea-levels-global-adaptation/)

to the need for more frequent maintenance and retrofitting. Urban areas will require integrated emergency management systems, including smart grids, drainage systems, and disaster shelters, to facilitate rapid recovery.

Rising Temperatures: Higher temperatures will accelerate the degradation of materials like asphalt, concrete, and steel, impacting the durability of roads, pavements, and structures. Energy demands for cooling buildings and cities will rise, straining electrical grids and exacerbating the urban heat island effect. Construction worker safety will also be a concern, necessitating improved protective gear and adjustments to working hours in extreme heat conditions.

Rising Sea Levels: Coastal infrastructure, such as ports, bridges, and roads, will face heightened flood risks. Saltwater intrusion due to rising sea levels will corrode steel reinforcements in concrete and disrupt freshwater supplies. Relocation of populations from vulnerable coastal areas will require civil engineers to design sustainable urban developments for displaced communities.

Soil Stability: Increased rainfall and flooding will lead to greater soil erosion, jeopardizing the stability of roads, railways, and building foundations. Subsidence caused by groundwater extraction and soil drying due to rising temperatures will pose additional risks to urban infrastructure. In cold regions, thawing permafrost will weaken the foundations of buildings and roads, causing deformation or collapse.

4. Solutions and Adaptation Techniques

4.1 Design Changes for Extreme Weather Events

Extreme Weather Events require improved design standards to enhance the resilience of structures against high winds, heavy rainfall, and storm surges. Building codes should be updated to address these challenges, ensuring that infrastructure can endure extreme conditions. In high-risk areas, flood-resistant infrastructure, such as permeable pavements, elevated foundations, and flood barriers, is essential. Additionally, urban areas must be equipped with advanced emergency management systems, including early warning mechanisms and rapid response capabilities. Practical adaptation measures include retrofitting existing buildings with stronger materials and waterproofing, as well as implementing multipurpose flood retention systems like wetlands or reservoirs.

4.2 Solutions for Rising Temperatures

Rising Temperatures necessitate innovative solutions to mitigate their effects on infrastructure and urban environments. Heat-resistant materials, such as high-reflectivity coatings, can be utilized to reduce structural

damage and counteract the urban heat island effect. Passive cooling designs, including green roofs, enhanced ventilation systems, and reflective facades, should be integrated into urban planning. Roads can be constructed with deformation-resistant asphalt to withstand heat-induced damage. Key adaptation examples include installing shading structures over public spaces and roads to reduce heat exposure and retrofitting air conditioning systems in critical infrastructure to ensure functionality during extreme heat.

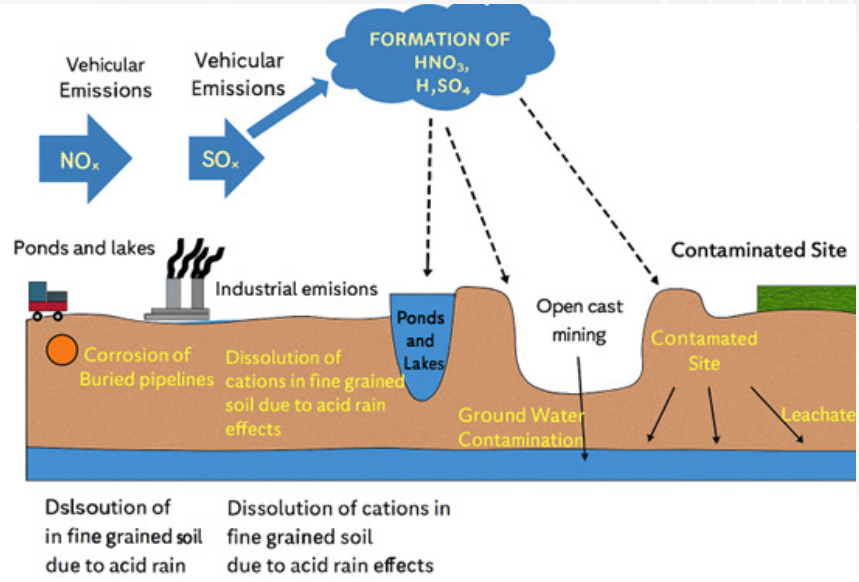

Figure 3. (https://link.springer.com/article/10.1007/s11356-022-24788-7)

4.3 Response to Rising Sea Levels

Rising Sea Levels pose significant risks to coastal regions, demanding robust strategies to protect critical infrastructure. Coastal defenses, such as sea walls, levees, and storm surge barriers, are crucial for mitigating the impact of rising water levels. Managed retreat strategies involve relocating infrastructure and communities from high-risk areas, while innovative solutions like floating or amphibious buildings can adapt to fluctuating water levels. Additionally, restoring natural defenses, such as mangroves, coral reefs, and wetlands, can provide a sustainable barrier against storm surges and erosion. Notable examples of adaptation include the Netherlands' extensive dike systems and storm surge barriers, as well as coastal realignment projects that enable the development of natural defenses like salt marshes.

4.4 Addressing Soil Stability

Soil Stability is increasingly at risk due to changing climate conditions, making it essential to adopt measures to strengthen and protect the soil. Techniques like soil nailing, geosynthetics, and ground improvement methods, including deep soil mixing and compaction, can enhance soil stability. Efficient drainage systems are critical to prevent waterlogging and reduce soil erosion. Planting vegetation on slopes and embankments can further stabilize these areas and mitigate the risk of erosion and landslides. Comprehensive geotechnical assessments are necessary to account for changes in soil conditions caused by climate change. Examples of effective adaptation include stabilizing foundations in areas affected by expansive clays or sandy soils impacted by water table fluctuations and utilizing bioengineering methods, such as planting vetiver grass, to stabilize slopes.

5. Conclusion

Climate change has a big impact on buildings and infrastructure, causing damage through extreme weather, heat, flooding, and soil problems. To tackle these issues, engineers need to use new materials, follow improved construction rules, and design buildings that can handle these challenges.

This article provides a brief of the possible strategies which can be used to handle the above-mentioned issues mitigating their impact. In the future, it will be important to include climate change in all stages of construction planning, design and execution. Only by doing this, it will be possible to create stronger, safer, and more sustainable structures for everyone.

Projects

Student Names:
1.Ali Abdulameer Abdulla
2.Ahmed Yusuf Ashoor
3. Sayed Ali Majed Yusuf Majed

Supervisor:
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Chairman of Electrical & Electronics Engineering Department
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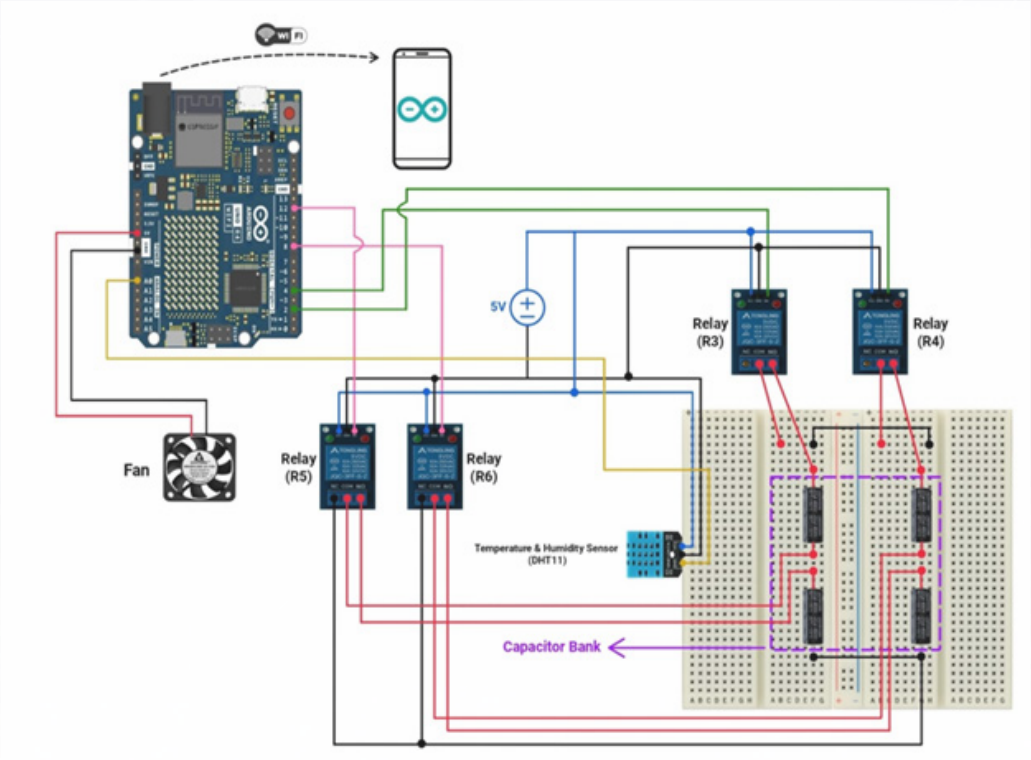
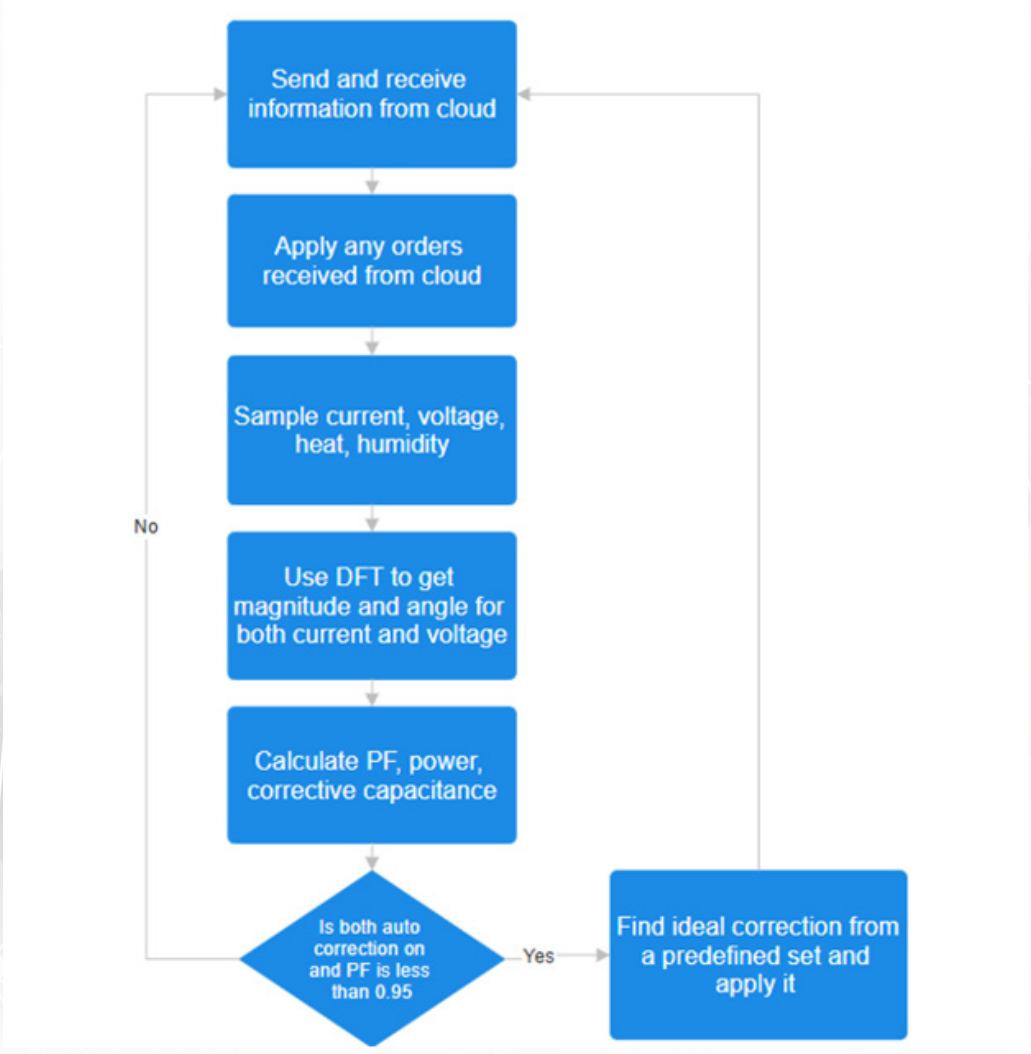
IOT-Enabled Substation Monitoring, Control and Management

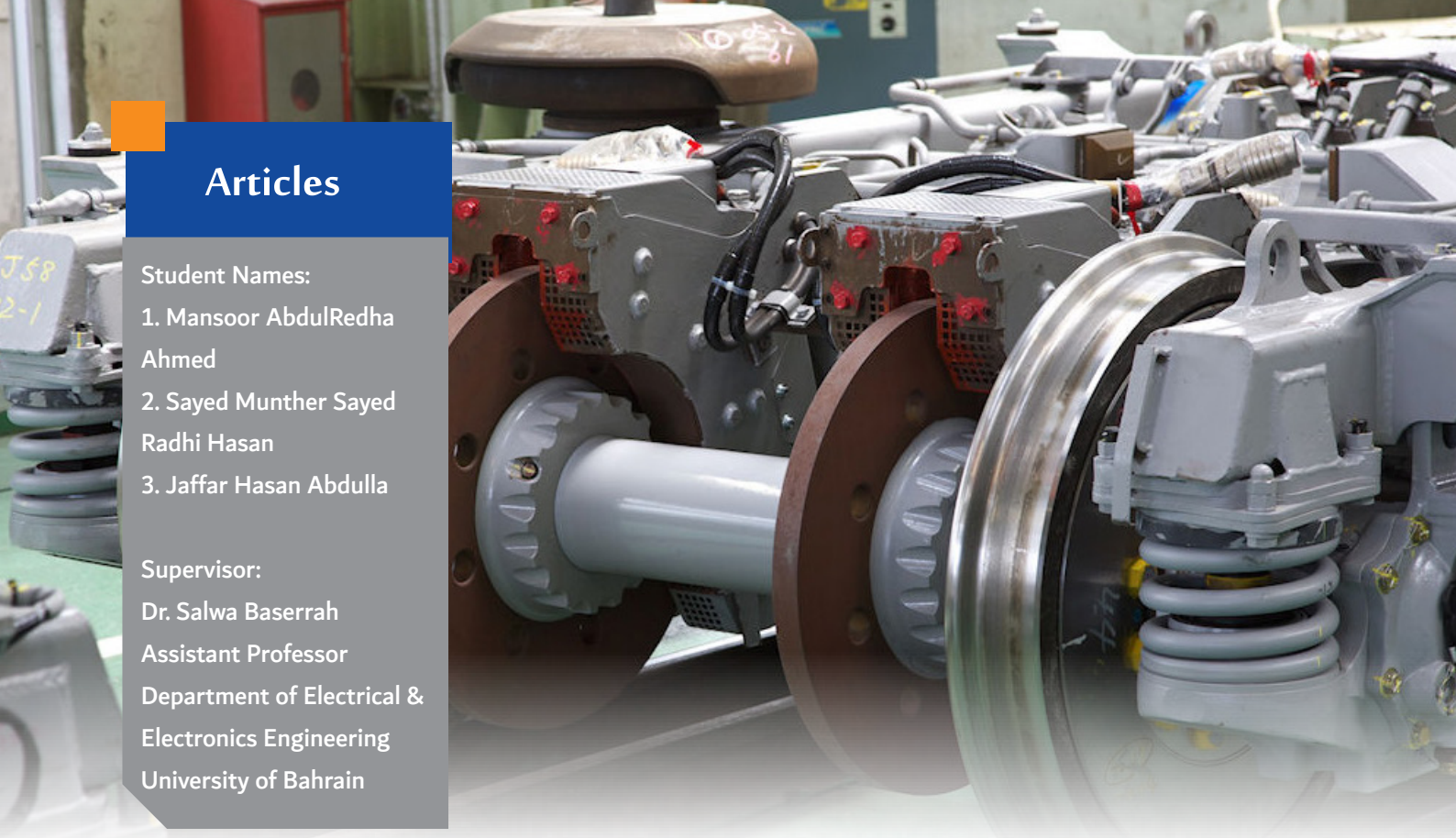
This project aims at facilitating efficient Electrical Substation monitoring, control, and management through the integration of smart technologies including IoT. The monitoring system accurately monitors essential parameters such as currents, voltages, real and reactive power, power factor, energy consumption, temperature, and humidity to provide important information for system analysis and decision-making. The control system facilitates precise management through selecting input sources, managing capacitor bank switching, and regulating fan operation. Capacitor bank switching is provided with manual or automatic modes based on user choice, and the fan receives input from the temperature and humidity sensors to provide optimal operating points. The capacitor bank employs arrays of series-parallel-connected capacitors with switches between the sets, dynamically varying to maintain the power factor close to 1 in response to dynamically changing load demands. This project is accomplished by two complementary implementations. A miniature prototype, driven by an Arduino microcontroller, containing a transformer, circuit breakers, resistors, inductors, switching relays, temperature sensor, humidity sensor, and a fan. This miniature model demonstrates the system operation in a small analogical environment, enabling manual testing and adjustments. In addition, a simulation built using RSCAD software simulates a three-phase circuit, giving a real-world demonstration of the project's functioning in a larger and more complex system with real-time monitoring through IoT, smart control, and an adaptive capacitor bank. The initial results of this work have successfully demonstrated a robust solution for a smart and efficient substation operation and management.



The full design of substation



Flow Chart of the main loop of the code



Articles

Student Names:
1. Mansoor AbdulRedha Ahmed
2. Sayed Munther Sayed Radhi Hasan
3. Jaffar Hasan Abdulla

Supervisor:
Dr. Salwa Baserrah
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Department of Electrical & Electronics Engineering
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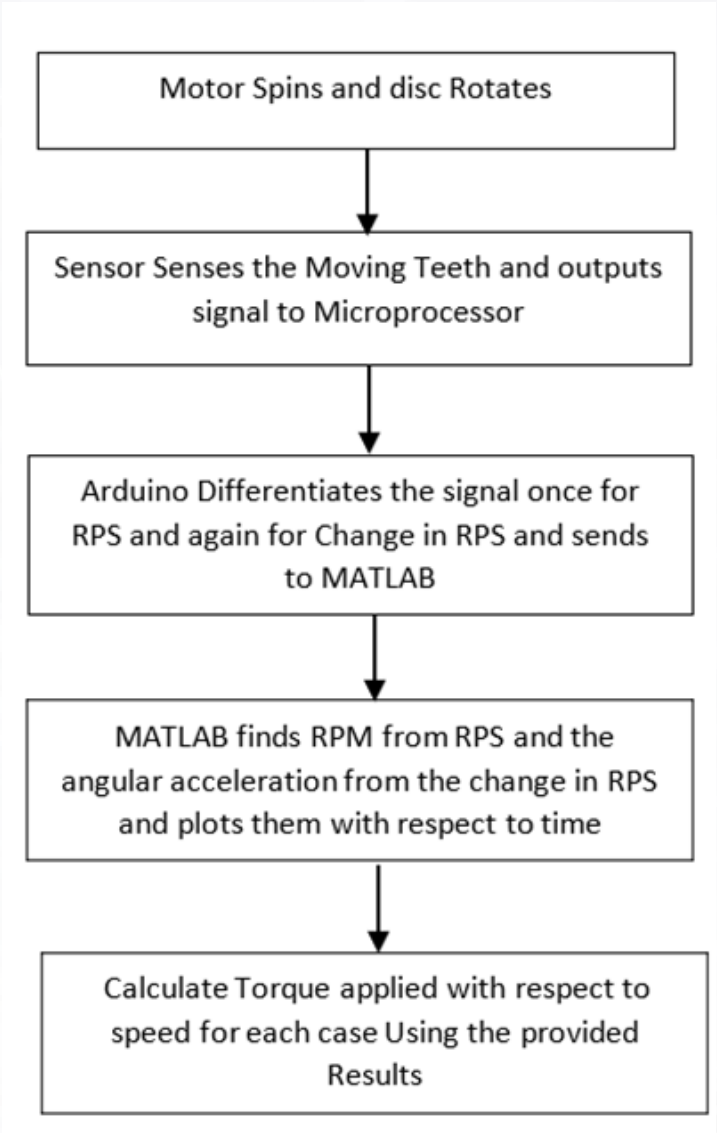
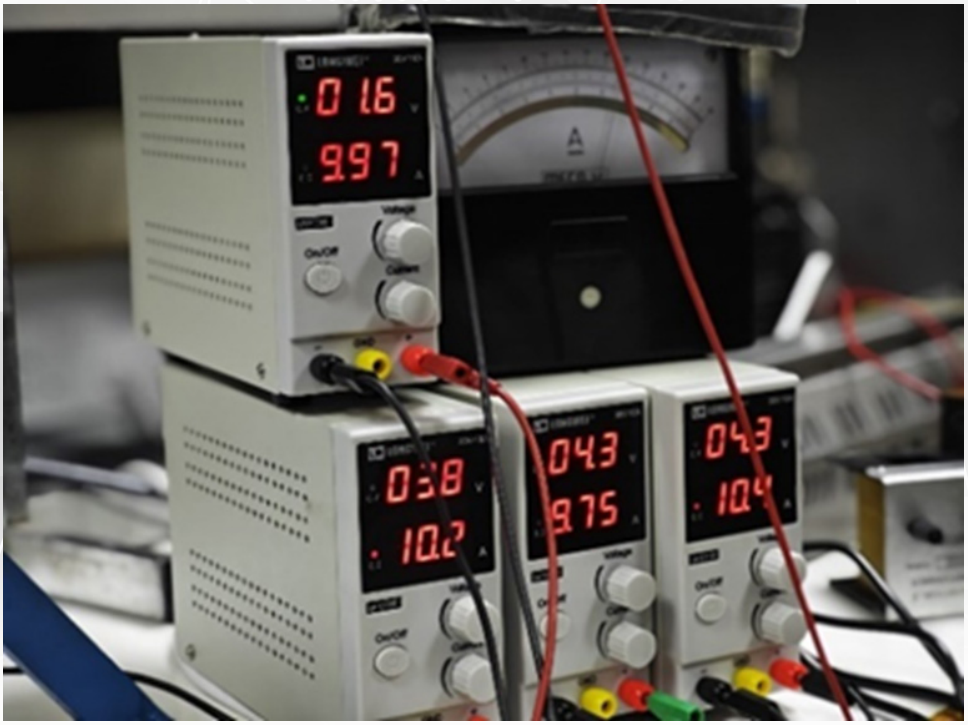
A Validation Study of the Decelerative Capabilities of Eddy Currents in an Electromagnetic Braking System

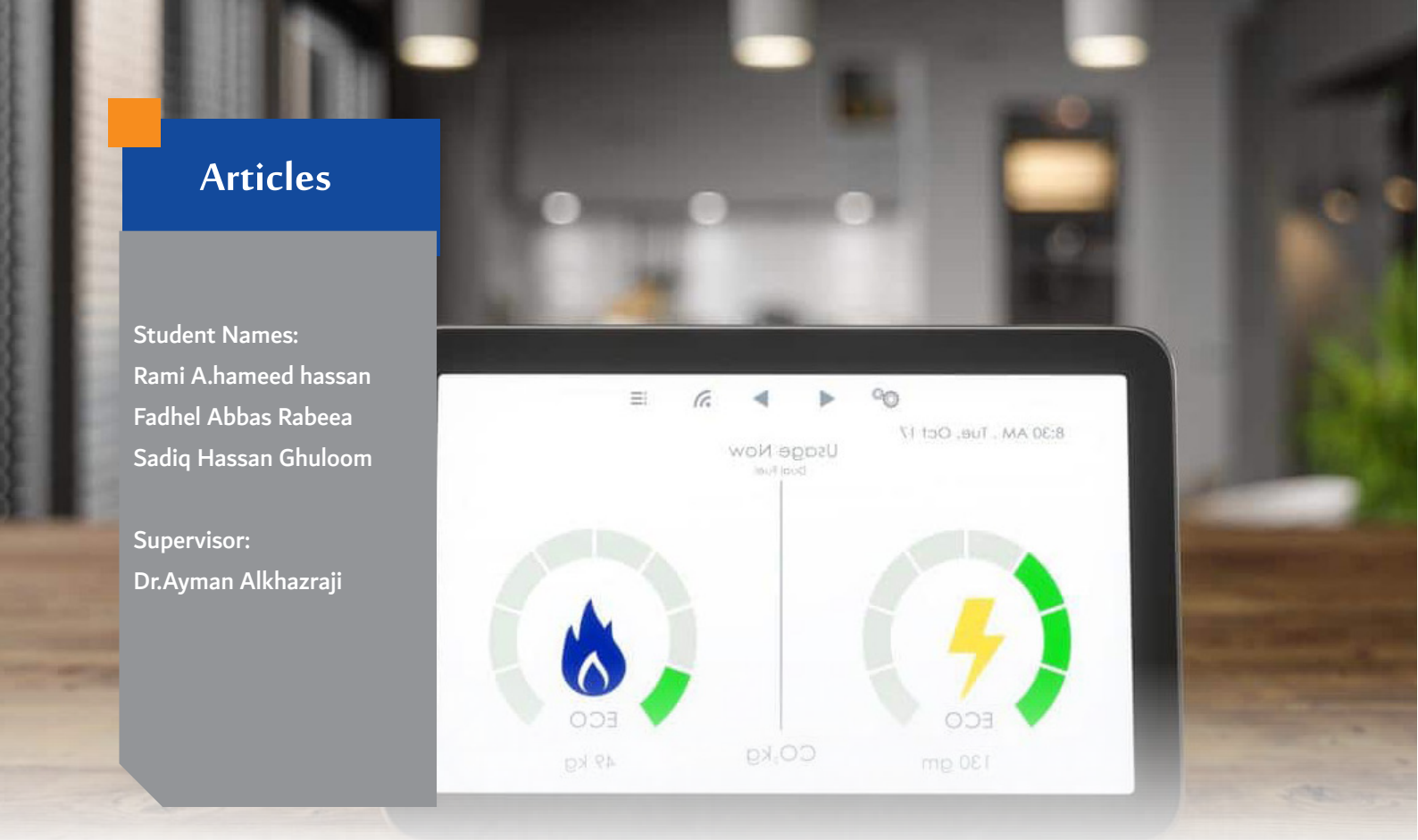
Eddy current braking is a method of electromagnetic braking that uses the eddy current to produce a resistive force without any direct mechanical contact. Our setup produces a magnetic brake that uses an electromagnet to produce a magnetic field which penetrates a rotating brake disc, generating eddy currents in that very disc, which push against the rotating motion without physical contact. By eliminating friction, this process reduces maintenance demands and enhances the longevity of halting systems. We have examined the effect of eddy current on different materials. The prototype was designed, developed, and assessed under IEEE, IEC, and ASME standards and guidelines to analyze the braking torque. The experiment clearly illustrated the system's capability to complement and supplement the current traditional deceleration mechanism, especially in high-speed applications, where the system would perform most effectively. This experimental research highly assists the current trend in the vehicular industry to adopt sustainable, economical, affordable, and efficient braking solutions, boosting non-contact braking, and contributing to integrating this highly effective technology into modern vehicles, while complying with engineering safety and performance standards.



Flowchart of Data Collection



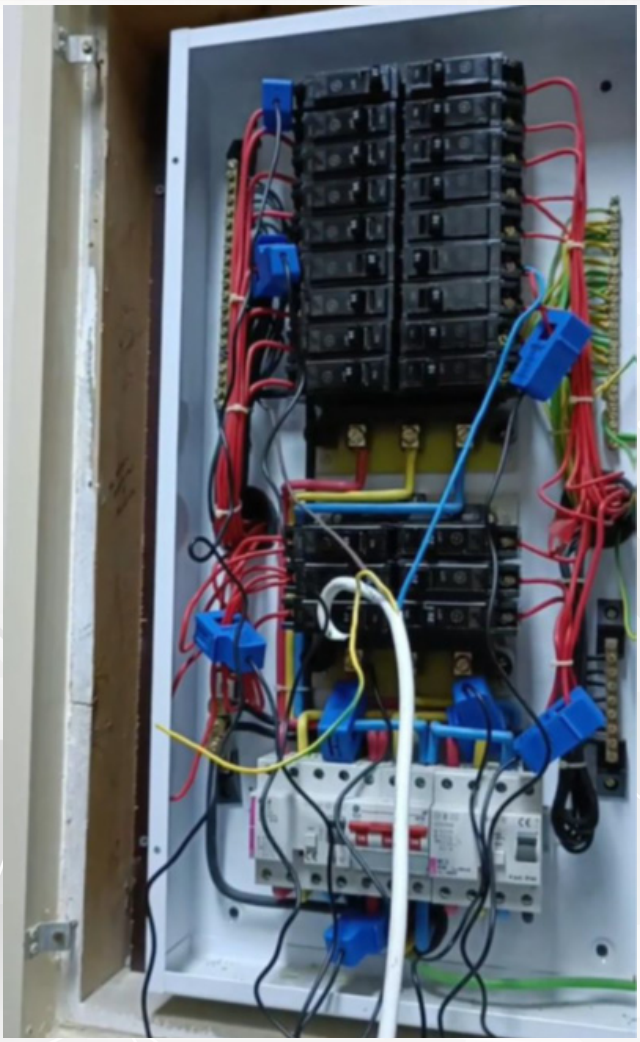
DC Supply Connecting to Winding



Articles

Student Names:
Rami A.hameed hassan
Fadhel Abbas Rabeea
Sadiq Hassan Ghuloom

Supervisor:
Dr.Ayman Alkhazraji

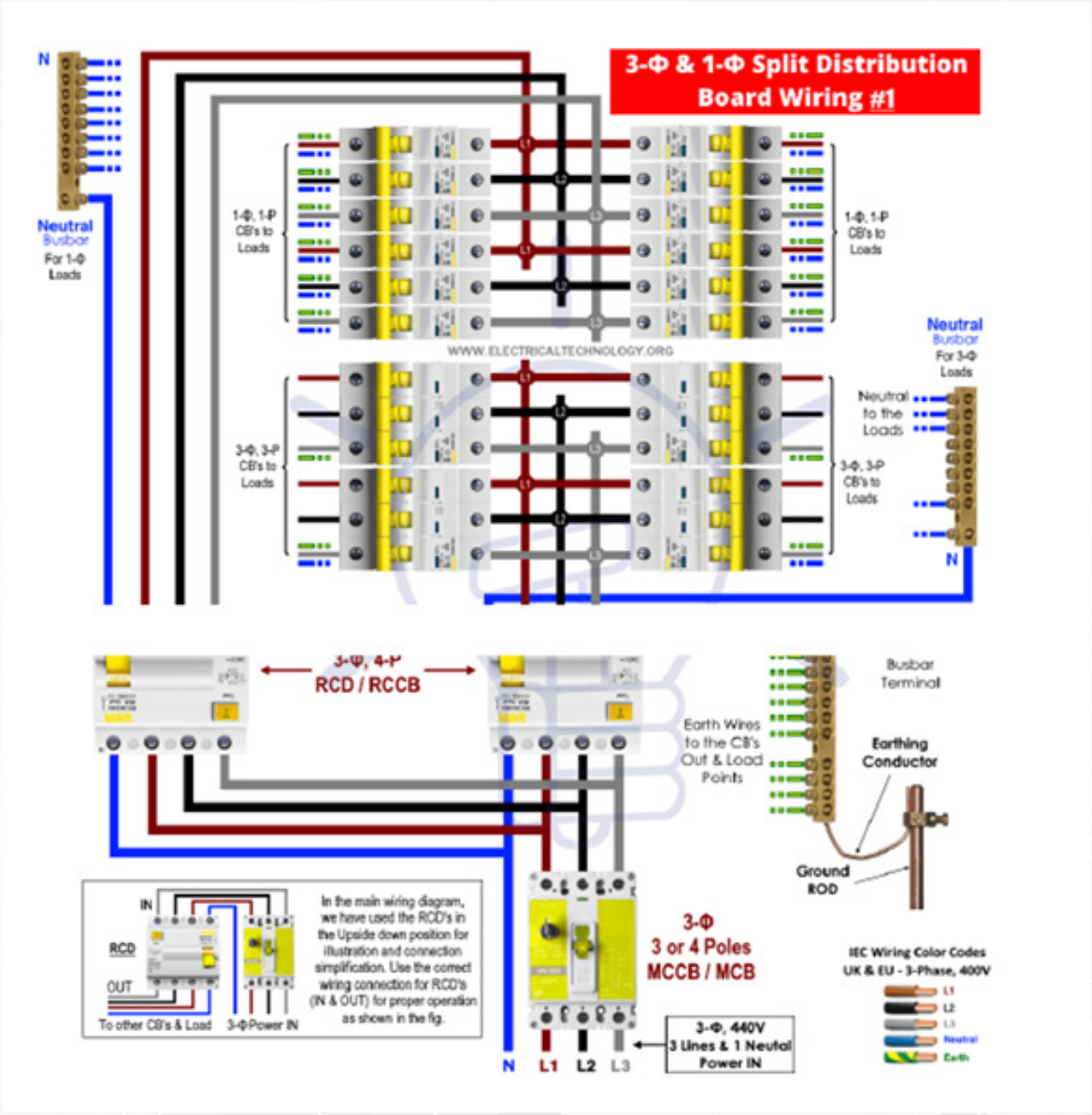


The circuit connected to the installation of the database system (DB)

Design and Implementation of Smart Monitoring for Household Electrical Usage and Indication

As the Technology continues to improve there are devices that monitor household electricity distribution. These devices tend to monitor the (voltage, current, and power) distributed within the house, however some of these cannot detect faults or overload when they exist.

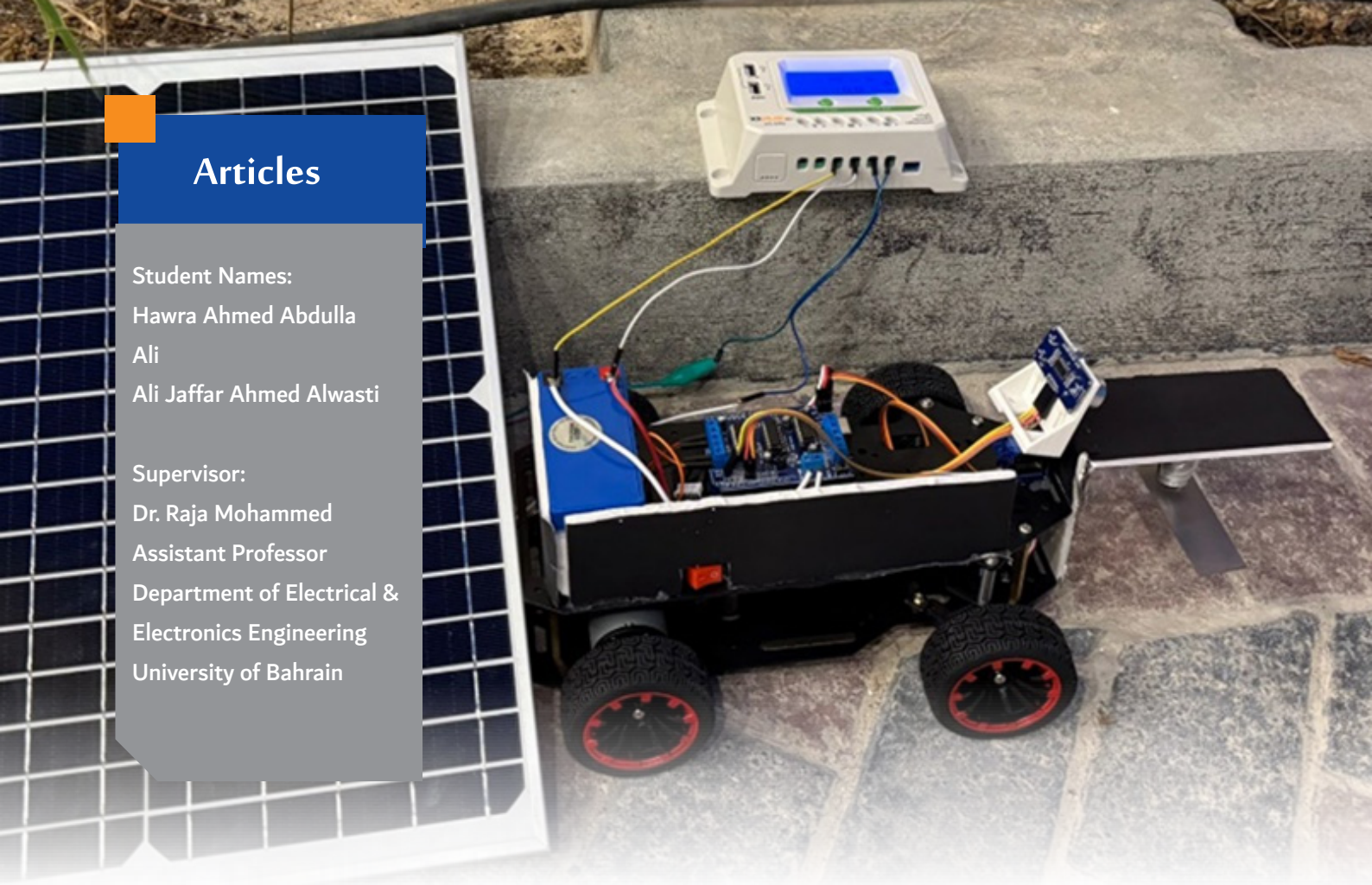
Overload is a revolutionary and worldwide problem in distribution boxes not just in houses but also in other establishments and overload means that the current in the circuit goes to exceed the rated current and that will lead to devastating consequences such as overheating, tripped circuit



Three-Phase and Single-Phase Distribution Board Wiring

breakers, equipment damage, and fire hazards. These consequences will lead to big losses in companies' revenue as they will stop the flow of production and to houses it could lead to a fire that will affect the family members, and we need to avoid that.

The proposed project is called a smart monitor for household electrical usage and indication, and it works on detecting these so-called overload faults, phase unbalances, and also it will be able to estimate the bill of electricity usage. And all this is to avoid the problems mentioned in the part before.



Articles

Student Names:
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Ali
Ali Jaffar Ahmed Alwasti

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Solar Powered Automatic Grass Cutting Robot

This project Presents the design and development of a robotic lawn mower powered by solar energy, aimed at delivering an environmentally friendly, economical, and effective solution for maintaining lawns. The system utilizes solar energy via photovoltaic panel, enabling it to be self-sustainable and decreasing reliance on other power sources. The robot features sensors for detecting obstacles and for navigation, allowing it to move automatically within a specified area while ensuring consistent cutting quality. It operates on a rechargeable battery that is charged using solar energy, guaranteeing continuous operation throughout daylight hours. This initiative not only helps minimize human effort and time but also advocates for the use of renewable energy in daily activities. The design focuses on simplicity, cost-effectiveness, and versatility, making it an appropriate solution for both home use and small-scale farming.

Wheel alignment

Engineering Excellence at ASU*

At Applied Science University (ASU), our Engineering programmes validated by London South Bank University (LSBU) are designed to prepare future-ready engineers who can solve real challenges in Bahrain and beyond. The programmes combine academic excellence with practical innovation, giving students the opportunity to gain dual Award through a degree validated by LSBU—one of the UK's leading universities, named Best University for Apprenticeships at the 2024 Apprenticeship Guide Awards and ranked 5th in the UK for Mechanical Engineering in the Guardian's 2026 rankings. These validations cover four programmes: Civil Engineering, Architectural Engineering, Electrical and Electronic Engineering, and Mechanical Engineering.

Students studying in these programmes can join the most prestigious professional bodies as student member such as Chartered Institute of Building (CIOB, UK), the Institute of Civil Engineers (ICE, UK) and the IEEE. ASU was the first university to be accredited by CIOB in Bahrain and currently hosts a student chapter for the ICE. Our students won the second position in the Global student competition by CIOB competing with engineering students from all over the world. In addition, engineering students get the opportunity to attend summer training with some of the top engineering companies in Bahrain every summer since they start enrolling on the programmes. They also have the opportunity to attend summer school in London to get an international experience with the home students who study the same programmes in the home campus in London south bank university. Engineering students at ASU have been regularly competing in the nation and regional competition in Bahrain and the UAE such as city scape and the inter college Environmental competition by the Emirates Environmental group in UAE. And most recently, a group representing all four programmes in the college of Engineering have successfully qualified to the semifinals in the COP30 Simulation organized by the British Universiy in Egypt under the UNDP and the Arab League.

Before they graduate, students work on projects that directly support Bahrain Vision 2030 and the UN Sustainable Development Goals (SDGs 6,11, 13) to develop sustainable solutions that make a difference to society, the economy, and the environment. Apply engineering knowledge to tackle urgent issues such as urban flooding, sustainable water use, and building safety.

* Paid editorial advertisement

ASU
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APPLIED SCIENCE UNIVERSITY

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Project Highlights

Reema Kameshki: 1st Prize (BSE 2023) & 3rd Prize (HH Shaikh Khalid Bin Hamad Award 2023)

Project: Stormwater Management — Design and Flood Modelling of Open Channels Including Road Culvert Design

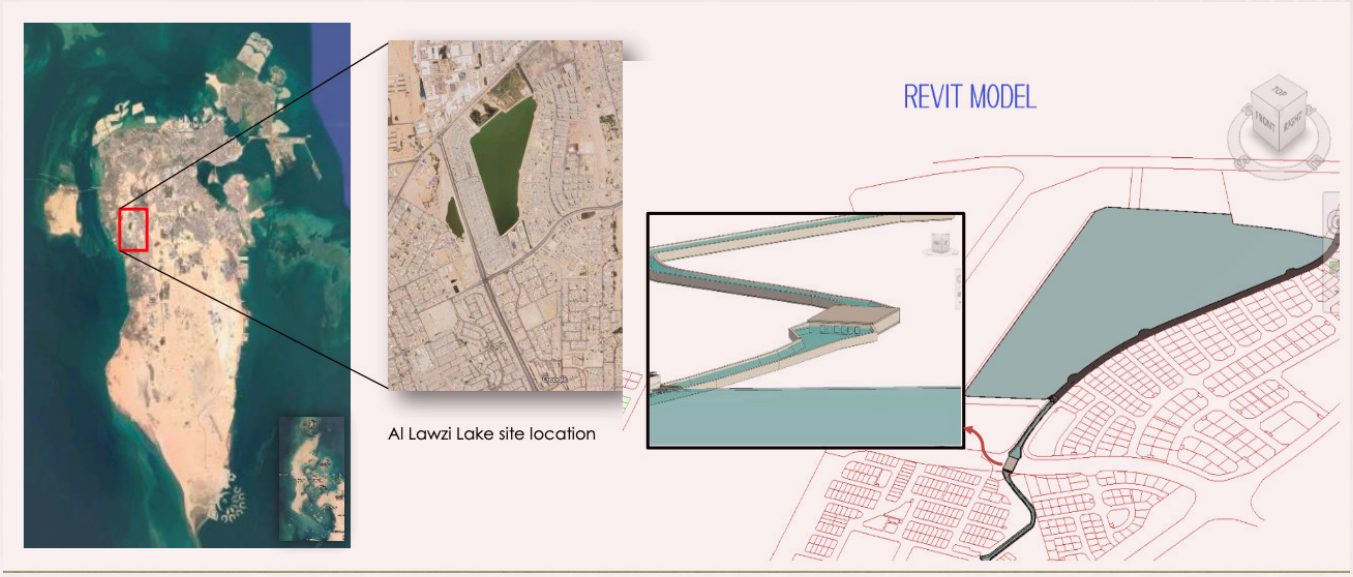
Supervisor: Dr. Rouya Hdeib

Reema's project addressed one of Bahrain's most pressing environmental challenges, urban flooding in the Al-Lawzi area, home to the Kingdom's only natural lake. Al-Lawzi Lake spans 150,000 m² with a storage capacity of 0.65 Mm³, but recorded multiple flood incidents in 2018, 2019, and 2020, caused by rainfall exceeding the 20-year return period.

Her work followed a five-step engineering design approach:

1. Assessing the current stormwater system in Al-Lawzi.

2. Studying hydrology and quantifying runoff estimates.



3. Linking hydrology and hydraulics to evaluate channel and culvert capacity.

4. Investigating flood events and their causes.

5. Proposing optimized upgrades to improve resilience.

The result was a comprehensive design of interconnected open channels and culverts to manage stormwater flow more efficiently, protect surrounding communities, and ensure climate resilience for Bahrain's urban landscape.

Reema's outstanding achievement was recognized nationally with two awards in 2023:

• 1st Place – Bahrain Society of Engineers Best Graduation Project (Civil Engineering)

• 3rd Place – HH Sheikh Khalid Bin Hamad Award for Graduation Projects (Engineering category)

Hala Alnameh: 2nd Prize (BSE 2023)

Project: Towards Sustainable Building Design — Rainwater and Greywater Harvesting Systems

Supervisor: Dr. Rouya Hdeib

Hala's project tackled one of the most critical sustainability goals for Bahrain — water conservation. With freshwater resources under increasing pressure, her work designed and optimized integrated rainwater and greywater harvesting systems for two major institutions: the Electricity and Water Authority (EWA) and Applied Science University (ASU).

Using rainfall-runoff modelling and formulas to estimate greywater production and reuse (for flushing and irrigation), Hala demonstrated how these systems can substantially reduce dependency on freshwater supplies. The project also assessed return on investment (ROI), proving the economic feasibility of adopting such systems in institutional, residential, and industrial settings.

Her design showed triple benefits:

• Environmental: reducing freshwater demand and mitigating flooding.

• Economic: lowering water bills through reuse systems.

• Social: conserving resources for future generations in line with Bahrain Vision 2030.

This innovative solution secured her the 2nd Place Award in the BSE Best Graduation Project competition (Civil Engineering category, 2023).

Dalal Bader Sayyar: 3rd Prize (BSE 2024)

Project: Retrofitting and Strengthening Concrete Columns in Residential Buildings Using FRP Composite Technology

Supervisor: Dr. Hamdy Alsayed

Dalal's project addressed a growing challenge in

Bahrain's residential buildings: weakened concrete columns due to steel reinforcement corrosion, concrete degradation, and higher axial loads from urban densification. Instead of costly reconstruction, she proposed the use of Carbon Fiber Reinforced Polymer (CFRP) wrapping as an innovative, sustainable, and cost-effective solution.

Her engineering design approach included:

• Reviewing literature and design codes for CFRP applications.

• Assessing slenderness, confinement pressure, and axial capacity of columns.

• Designing CFRP strengthening strategies for different scenarios:

o High axial loads.

o Reduced steel reinforcement.

o Concrete deterioration.

Dalal's analysis showed that CFRP wrapping significantly increases axial strength, reduces cracking, and slows deterioration, thereby extending the lifespan of residential structures. She also performed a cost analysis, demonstrating that CFRP is a practical alternative to reconstruction, improving safety, resilience, and sustainability in Bahrain's built environment.