جامعة الشارقة
UNIVERSITY OF SHARJAH

كلية الهندسة
COLLEGE OF ENGINEERING

# College of Engineering

# Selected:Students Senior Design Projects Exhibition Catalog

May 2023

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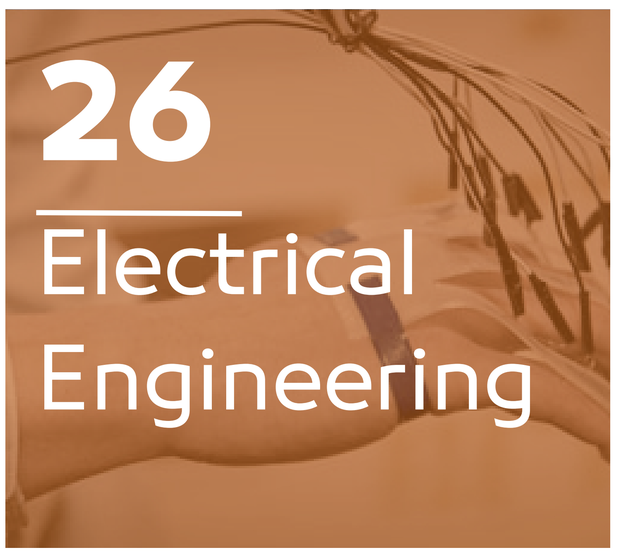



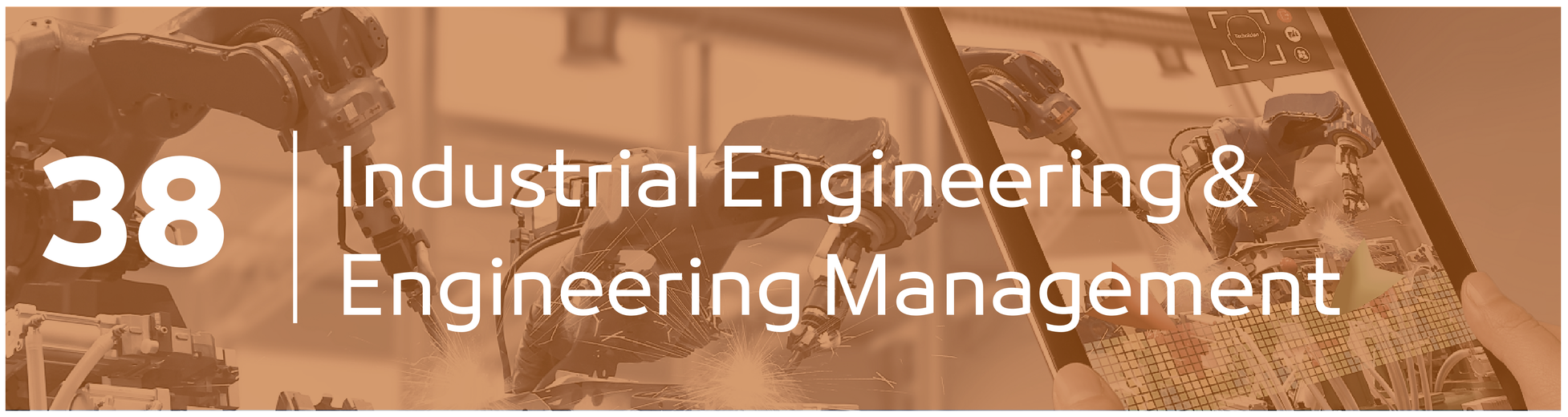



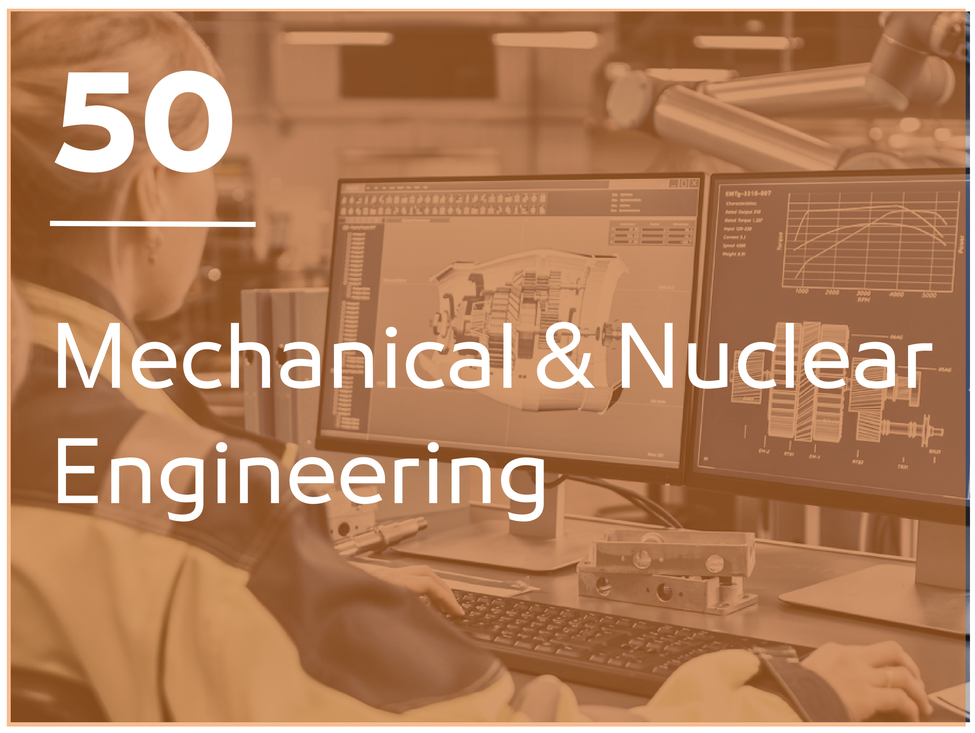



# Dean's Message

Welcome to the College of Engineering, The University of Sharjah! The College was established in 1997 and has become one of the largest Colleges in the university. UoS is a comprehensive institution of higher education that offers a distinctive learning style and a global vision. At the College of Engineering (CoE) we have six departments consisting of Architectural Engineering (AE), Civil and Environmental Engineering (CEE), Electrical Engineering (EE), Industrial Engineering & Engineering Management (IEEM), Sustainable & Renewable Energy Engineering (SREE), and Mechanical & Nuclear Engineering (MNE). Mechanical & Nuclear Engineering also hosts the newest program offered by UoS namely Chemical and Water Desalination Engineering program. Please explore each of the department website in order to know more about the details of each program being offered.

All of our programs are accredited by the UAE Ministry of Higher Education and Scientific Research. The undergraduate engineering programs are also accredited internationally by the Accreditation Board for Engineering and Technology (ABET).

All programs have been designed, and are continuously updated, to provide factual, conceptual, procedural and metacognitive knowledge. The learning objectives and the expected outcomes of our courses have been carefully developed to improve skills in application, analysis, synthesis, evaluation and innovation. The main aims of every program is to produce outstanding engineers who will be able to make significant contribution as engineers in industry, government, research or academic institutions.

Our graduates are also expected to contribute to society in a responsible manner through engagement in professional societies and/or community services. To achieve these aims, each program has been carefully developed with the advice from important stakeholders from the industries and ministries.

To provide a conducive learning environment, the University has invested significantly in the infrastructure and facilities for students. The University's rich library, information systems and broadband infrastructure, across campuses, provide an excellent and modern learning environment. The university will continue to leverage the latest technology-enabled framework to enhance the overall teaching and learning experience of its faculty members and students.

I wish you all the best and I hope that you will enjoy your time in UoS and aspire to become the engineers that will shape the future of the world.

**Prof.Abdul Wahab Bin Mohammad**
Dean of the College of Engineering

# Organizing Committee Members

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Committee Chair
Industrial Engineering & Engineering Management

**Dr. Mamun Rashid**
Co- Chair
Architectural Engineering

**Prof. Ghazi Al-Khateeb**
Civil & Environmental Engineering

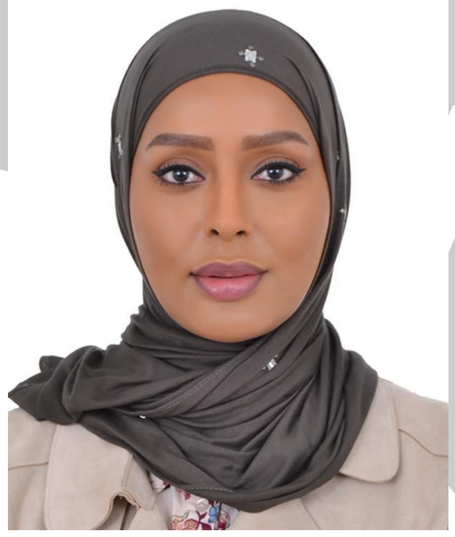
**Dr. Sohaib Majzoub**
Electrical Engineering

**Dr. Basharia Yousef**
Sustainable & Renewable Energy Engineering

**Dr. Mohammad Al Shabi**
Mechanical & Nuclear Energy Engineering

**Eng. Rola Abu Farha**
Dean's Office

**Eng. Farah Alani**
Architectural Engineering



**Eng. Lamees Hamid**
Architectural Engineering

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Electrical Engineering

**Prof. Hamdi Bashir**
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Engineering Management

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Engineering

**Dr. Salem Buhashima**
Architectural Engineering

**Dr. Saleh Abu Dabous**
Civil & Environmental
Engineering

**Dr. Ihsanullah Obaidullah**
Mechanical & Nuclear Energy
Engineering

# Architectural Engineering

# Table of Content

# HaramaIn-between Spiritual and Civilizational Consortium

Students: Joud Al Saht | Hanan Al Sahin

Advised by Dr. Ahmad Sukkar


Introduction:

Every year, millions of Muslims flock to the hubs of the Islamic world, Mecca, and Medina to encounter a spiritual journey, and recently, visits were opened to all people from across the globe to come and discover the k The proposed Spiritual and Civilizational Hub will provide an immersive spiritual experience to visitors, including non-Muslims, and educational facilities to learn about Islam. The project

seeks to revive the historic Hijrah and pilgrimage path, enhance the journey of pilgrims between the cities, and offer a place for diverse people to gather and interact. The study utilized mixed methods, including qualitative and quantitative research, to design the building, select a suitable location, and identify missing elements and design strategies. The project aspires to fill gaps in the field of Islamic architecture, improve the pilgrimage experience, and promote dialogue between civilizations.

# HaramaIn-Between

## A Spiritual and Civilizational Consortium

Students: Hanan Al Sahin, Joud Alsaht

*Supervisor: Dr. Ahmad Sukkar*

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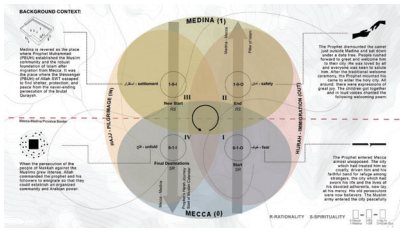
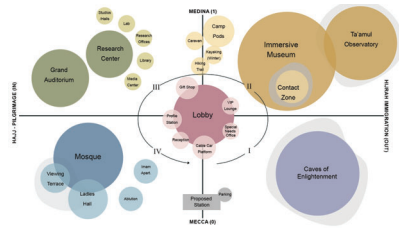
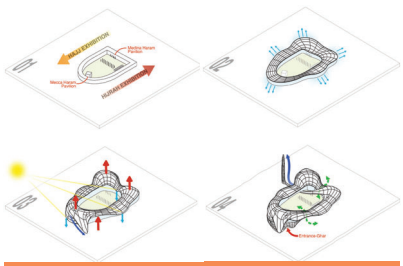
## SITE LOCATION


## CORE CONCEPT

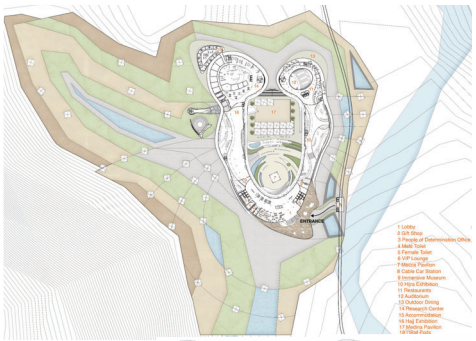


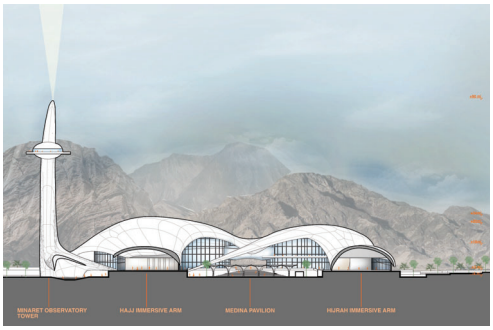



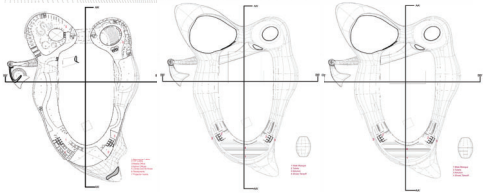

## FORM DEVELOPMENT



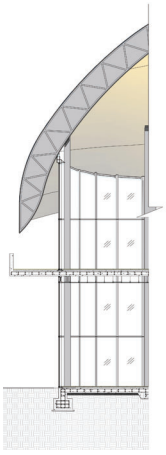
## DESIGN RESULTS

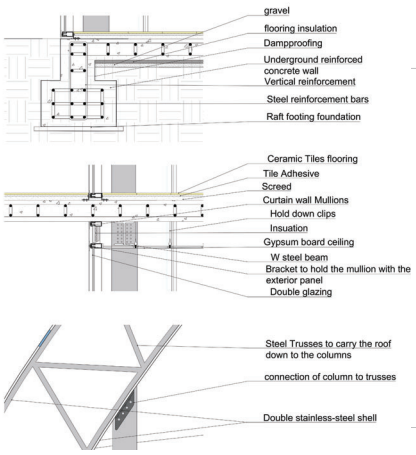




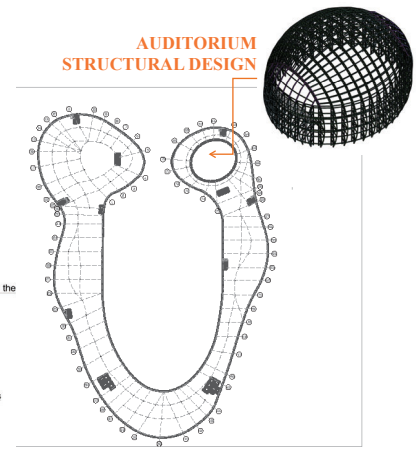



## ENGINEERING SOLUTIONS AND IMPLEMENTATION






AUDITORIUM STRUCTURAL DESIGN



Freeform Column Grid

## ACKNOWLEDGEMENT

First and foremost, we are deeply grateful to my project supervisor, Dr. Ahmad Sukkar, for his guidance, support, and encouragement throughout this project. His expertise and valuable feedback have been instrumental in shaping the direction of our research and helping us overcome any challenges that arose. I would like to thank our family and friends for their unwavering support and encouragement throughout our academic journey. Their love and encouragement have sustained us through both the challenges and triumphs of this project.

# Transgate
# Transportation Oasis

Students: Haya Ibrahim Alhariri | Tabarek Fawzi Yousif | Tasneam Ashraf

Supervisor: Moohammed Wasim Yahia

Introduction:

The rapid urbanization and development in the United Arab Emirates have created a growing need for efficient transportation systems that can keep pace with the increasing demand for mobility that resulted in a traffic congestion in the region. To address this issue, this thesis project explores the concept of a multi-modal transportation hub in the UAE.
A transportation hub is a strategic location where different modes of transportation intersect, providing a convenient transfer point for travellers. Where they can switch between modes of transportation, such as metros, buses, and taxis to reach their destinations efficiently.
Aim:
develop architectural & urban design strategies on how future transportation hub contribute to solve problems of Efficiency, Accessibility, Sustainability, Safety and Functionality in Sharjah.
Objectives:

- improve mobility and reduce traffic to promote seamless travel experience.
- Promoting social interactions
- encourage economic growth.
- Utilize eco-friendly transportation practices and promote a green environment.

# Transgate
## Transportation Oasis

Students: Haya Alhariri, Tabarak F. Allami, Tasneam Ashraf
*Supervisors: Dr. Moohammed Wasim, Dr. Ahmad Sukkar*

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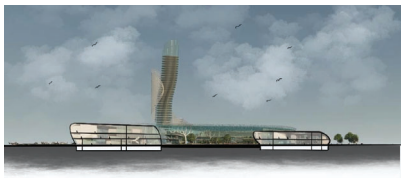
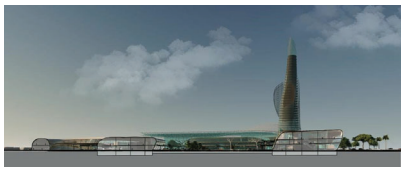




## CONCLUSION

Transportation hubs are a necessary step towards ensuring continued growth and development in a country that is a global hub for trade and commerce. By integrating different modes of transportation and promoting sustainable development, transportation hubs can help to address the challenges of urbanization and create a more liveable and prosperous future for all.

## SITE SELECTION – ALMALHA, SHARJAH

site selection criteria:

- Accessibility
- Land availability
- Compatibility with local land use
- Future expansion potential
- proximity to the Sharjah's airport and Etihad railway station should be considered to provide convenient transfer points for travellers and can attract economic development to the surrounding area.

## Concept Development

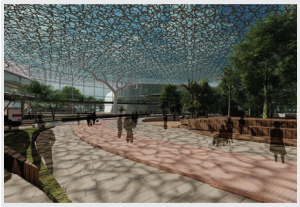
1-Urban growth direction in Sharjah

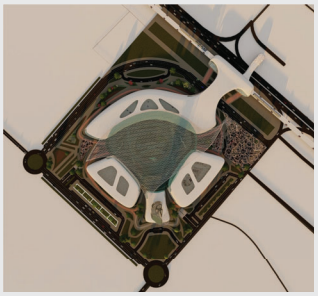
2-Proposed metro line direction connecting Sharjah's airport with Etihad railway metro station

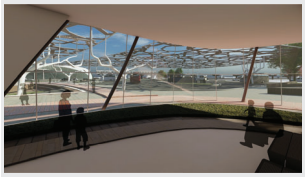
3-land use surrounding our site influenced the distribution of the building masses.

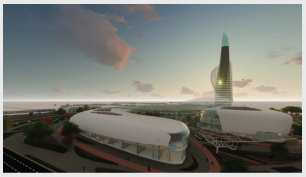
4-defining the pedestrian walkways that are connecting the surrounding to our site and grouping them to one center point that will be a multi-functional plaza.

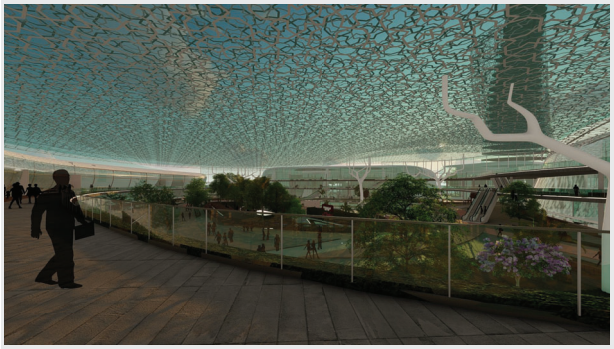
## RESULTS





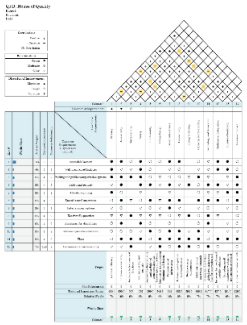


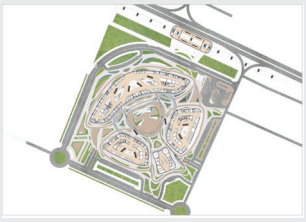


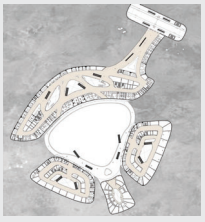


## DISCUSSIONS

This research used various methods to collect and analyze data. The primary methods were literature review and semi-structured interviews. The focus group discussion was conducted to gather input on how a transportation hub can be aligned with the social, efficiency, and safety and sustainability factors. 461 questionnaires were collected from members of the public to gather their perspectives and insights. The output of the focus group discussion will be compared with the outcomes of questionaries via Quality Function Deployment (QFD)to translate customer requirements into specific product or service features







## ACKNOWLEDGEMENT & REFERENCES

We would like to thank our supervisors Dr. Moohammed Wasim, Dr. Ahmad Sukkar for supporting this project throughout the whole year

# Space elevator station

Students: Malak Majed | Ragd alharbat

Supervisors: Dr. Aseel Ali Hussien

Introduction:

The space elevator, as its name implies, is fundamentally a transport system that consists of an extremely long ribbon-like cable, anchored to the Earth and extending into space. Creating a physical connection from the surface of the Earth to a Geostationary Earth orbit (GEO) 36,000 km away from earth. So the Space Elevator is considered to be a connection of both terrestriall and space architecture. The suggested design optimization framework is demonstrated the Earth Station of the Space Elevator, located at the Galapagos Island. To show how it may produce actionable design information and promote more performance-informed design in the planning stages of building construction.

# The space elevator.

**Utilization of computational design techniques to optimize, improve, and validate the optimal space elevator architectural form and design process with multiple objectives.**

Students : Malak Majed, Ragd AlHarbat
*Supervisor : Dr.Aseel Hussein*

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## INTRODUCTION

**The space elevator , as its name implies, is fundamentally a transport system that consists of an extremely long ribbon-like cable, anchored to the Earth and extending into space. Creating a physical connection from the surface of the Earth to a Geostationary Earth orbit (GEO) 36,000 km away from earth. So the Space Elevator is considered to be a connection of both terrestrial and space architecture. The suggested design optimization framework is demonstrated the Earth Station of the Space Elevator, located at the Galapagos Island. To show how it may produce actionable design information and promote more performance-informed design in the planning stages of building construction.**

## BACKGROUND

**The space elevator consists manly of 4 main part which are :**
**The Earth station.**
**The tether (cable).**
**The climber.**
**And The GEO station .**
**Where each one of these parts has its own guidelines, specification and details to make sure that it is working correctly without any issues.**
**<u>The Earth station:</u> a station serves as an anchor pinning the tether to the Earth at the equator. Centered with a port for climbers which is a point of arrival and departure from and to earth .**
**<u>Cable :</u> Carbon nanotube material with 150 Gpa capbiliy, was proposed to be as a major material of the tether.**
**<u>Climber:</u> is like a conventional elevator carriage. A chamber that works its way up and down the tether.**
**<u>The Orbital station (GEO station)</u> : A space Station at the top holds up the tether, launching point for all missions from the space . The longitudinal modular structure of the Geostationary Orbit Station allows for the arbitrary combination of the units to be assembled and varied according to their function**

## CONCLUSION

The space elevator can be constructed by the materials and technologies that we have today, by using Carbon nanotube for the tether, solar panels and leaser beam to power the whole system, adding to this the location should be at the equator to make sure that the weather condition is mild and calm in our case study we have it at Galapagos islands .

## METHODS

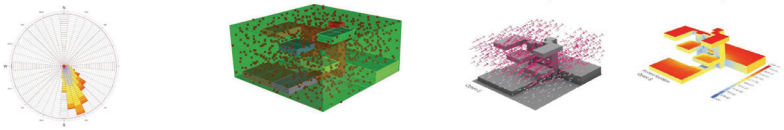
Our method divided into 3 main section where we used the computational design to reach to our final result , stating by the Form Generation, then the Form selection and lastly the Architectural design.

### Form Generation

the Input parameters that includes departments name, areas, connections between spaces, entrance location, In addition to the type of space

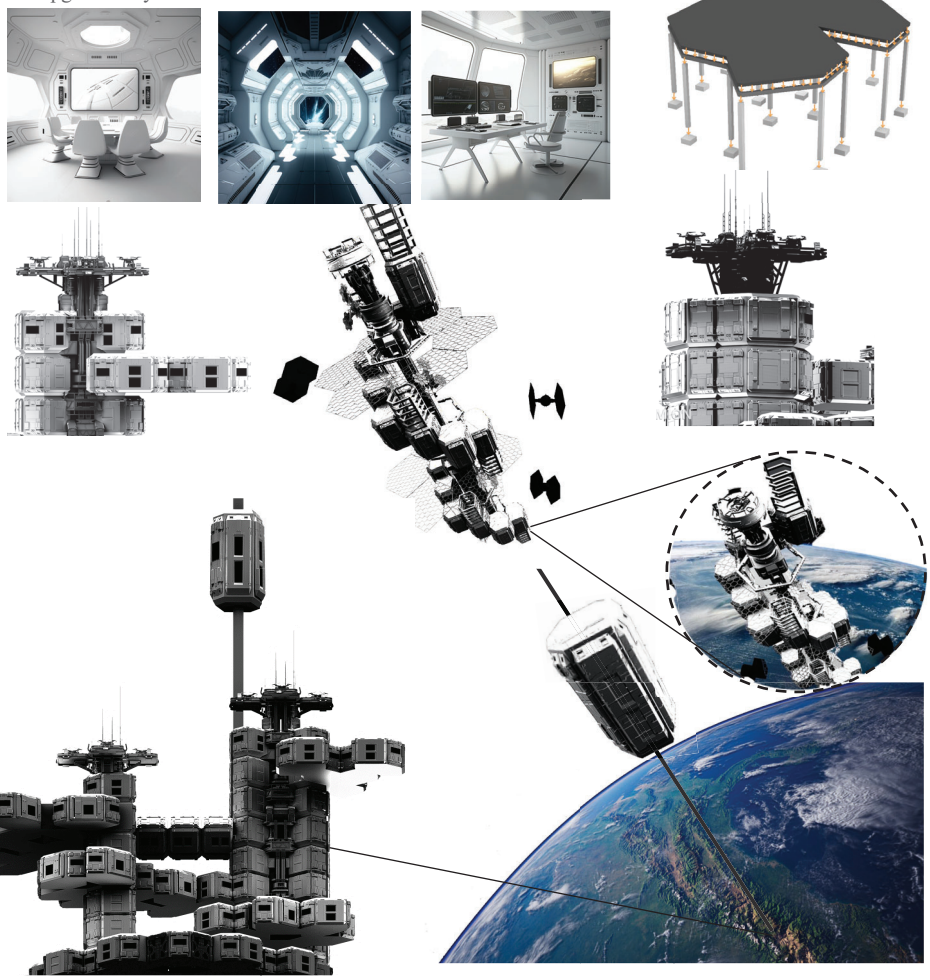
### Form Selection

The input data were the maximum wind speed which equals to 10.2 m/s and the direction of the wind which is SEE




### Architectural Design

Modular design is one of the significant design methods used in the space industry which is characterized by various construction stages. It proved its capability to perform in both space and terrestrial projects. Due to this, this method is mainly used in projects that need flexibility, growth ability, and upgradability



# Stroke Rehabilitation Center

Students: Ameera Abdulla Anas | Salma Essam Eldin Anwar | Muna Mohamed Elsadig

Supervisor: Ahmed Abdeen Saleem

Introduction:

Theory:
Having clear and unique spaces will give the Stroke survivors their personal control over the social and interpersonal experience by treating these spaces as landmarks within the center. Hence, improving their way finding will support their choice, flexibility, and social activity. Choosing to subtract masses to create semi-open courtyards not only was to engage the Stroke survivor with the community and the real world, but also to give them the opportunity to connect to nature, active, positive, and stimulating environment. Furthermore, having semi-open courtyards will help improve the sightlines of the survivors to see key spaces inside the center.

Concept:
To both reduce the confusion caused from repetition and to give the Stroke survivors their personal control over the space, A ramp was designed to take the stroke survivors from the inpatient unit from the first floor to the outpatient /rehabilitation unit in the underground level. Having one clear path will allow Stroke survivors and their families to easily circulate and move from one space to another. A structure revolving around the mass was added to amplify the curves and to be used to direct daylight in an indirect way to different spaces within the center. The structure is treated with perforations to add to the dynamic effect of shadows caused by daylight.

# REINVIGORATE CENTER PROJECT

## NEXT GENERATION OF STROKE REHABILITATION CENTRES

Done by: Ameera Abdulla Moussa, Muna Mohamed Elsadig, Salma Essam Eldin Abbas.
*Supervised by: Ahmed Abdeen Saleem*

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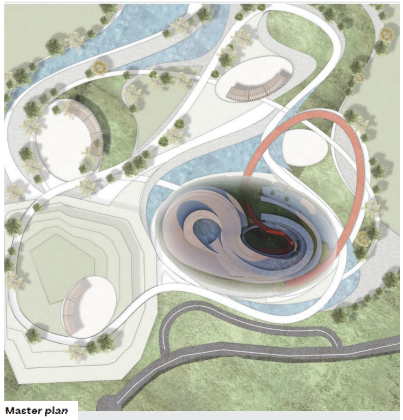
## INTRODUCTION



Master plan
Scale: 1:1000

## THEORY

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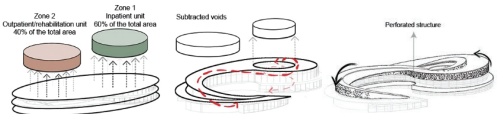
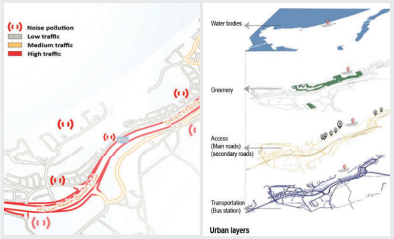


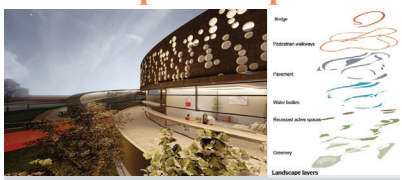

A structure revolving around the mass was added to amplify the curves and to be used to direct daylight in an indirect way to different spaces within the center. The structure is treated with perforations to add to the dynamic effect of shadows caused by daylight.

## SITE SELECTION

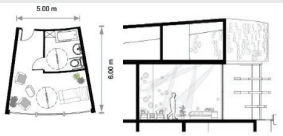




**The motivation behind choosing a site in Abu Dhabi relates to its vision in 2030, where it aims to position Abu Dhabi as an international destination for medical tourism. Furthermore, the unique nature of the site and the surrounding that includes the gulf sea and a golf yard helps in constantly connecting the stroke survivor to the nature.**

## Landscape concept



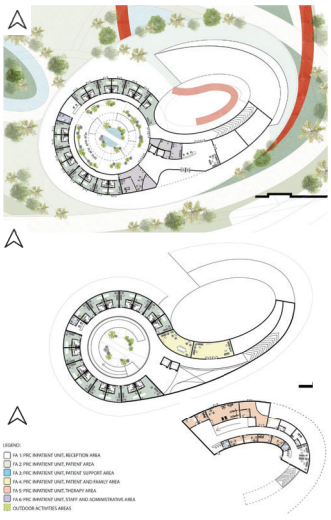

**The garden consists of different levels and elements (bridges, walkways, and recessed activity spaces) to stimulate the survivor's psychical and psychological healing.**



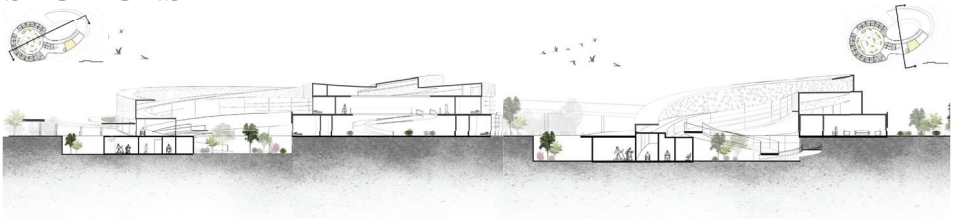

**Deciding to choose a single room layout for the Stroke Survivors was to mainly achieve high levels of privacy, but to accommodate for the drawbacks such as decreased level of physical activity, a therapeutic garden was designed to encourage the Stroke Survivors to engage in psychical movement.**

## DISCUSSIONS

**The concept behind the design was based on several parameters that consider and integrates the physical and psychological aspects in design to help in the Stroke survivor's healing progress. Choosing a curvilinear form was based on several research outcomes, one was meant to ease the Stroke survivor's wayfinding inside the space, this is by deriving away from typical healthcare rectilinear designs. One major step in designing the rehabilitation center took into consideration several NOVELL Redesign core concepts. And the step was subtracting voids to create central nodes within the space.**



## SECTIONS



# Civil & Environmental Engineering

# Table of Content

# Investigating the Rheological Properties of Coloured Asphalt Binder for Cooler

Students: Moza S. Ibrahim Almadhloum Alsuwaidi | Ghaya M. Mubarak Hamad Alsulaiti | Meera A. Eisa Hassan Aljasmi | Rzan A. Abdulwadood Alqaysi

Supervisor: Dr. Waleed Zeiada | Prof. Ghazi Al-Khateeb


## Introduction:

Rheological properties of colored binder

The dark color of conventional road pavements that are widely distributed in urban and rural areas significantly contribute to the quality of the environment. Therefore, the attention is rising to implement environmentally friendly materials in road construction, (i.e., colored pavements). Having an aesthetic landscape, promoting safety and most importantly, mitigate the heat distribution that is caused by the conventional of asphalt. The colored pavement works by self-reflection to reduce the heat of the pavement.

# Investigating The Rheological Properties Of Colored Asphalt Binder

Moza Al Suwaidi, Ghaya Alsulaiti, Meera Aljasmi and Rzan A. Al-Qaysi
Supervised by: *Dr. Waleed Zeiada, Prof. Ghazi Al-Khateeb and Prof. Rami Al-Ruzouq*

## INTRODUCTION

***Rheological properties of colored binde***r

The dark color of conventional road pavements that are widely distributed in urban and rural areas significantly contribute to the quality of the environment. Therefore, the attention is rising to implement environmentally friendly materials in road construction, (i.e., colored pavements). Having an aesthetic landscape, promoting safety and most importantly, mitigate the heat distribution that is caused by the conventional of asphalt. The colored pavement works by self-reflection to reduce the heat of the pavement.

## BACKGROUND

Asphalt road pavements are vulnerable to permanent deformation as a result of the high temperature and low temperatures, and traffic conditions. The effects of pavement high temperatures, especially in urban cities, are beyond a person's expectation since they greatly contribute to global warming. As this issue continues to face the environment, the need of an alternative or additives to the pavement is required. One technology is the cooling of pavement technology which is still under research and development. More specifically the switch from black asphalt to a clear binder that is mixed with pigmented powder, surprisingly was found to work in cooling the pavement temperature. In this study, the focus will be on mixing clear asphalt along with iron oxide pigments in the colors of 4% green, 4% red, 4% orange and 4% yellow, carrying the conventional tests along with the Superpave tests while comparing the indicated results with the usual black asphalt characteristics and the clear binder.

## CONCLUSION

The field of asphalt mix is very broad and there might be many reasons why the colored binder did not show any significant cooling temperature when mixed with aggregates. This can include the heat conductivity of iron oxide, using lighter aggregates such limestone, using brighter iron oxide powder, reducing the temperature at which the aggregates are heated at and many more could be furthered explored. Overall, it was clear from the results obtained above that the colored binder had significantly better rheological properties than of the conventional binder.

## THEORY / METHODS

From 1 to 5% of the binder weight must be made up of pigment. This suggests that the characteristics of pigment powder differ from supplier to supplier.When combined with the clear binder, the orange iron oxide pigment produced a vivid orange hue by increasing to 3g of pigment (6% of clear binder weight).It was tested to see how the clear binder would interact with the yellow iron oxide; the result was a darker shade of yellow. The yellow pigment blended easily and performed with more color intensity than the the blue pigment.

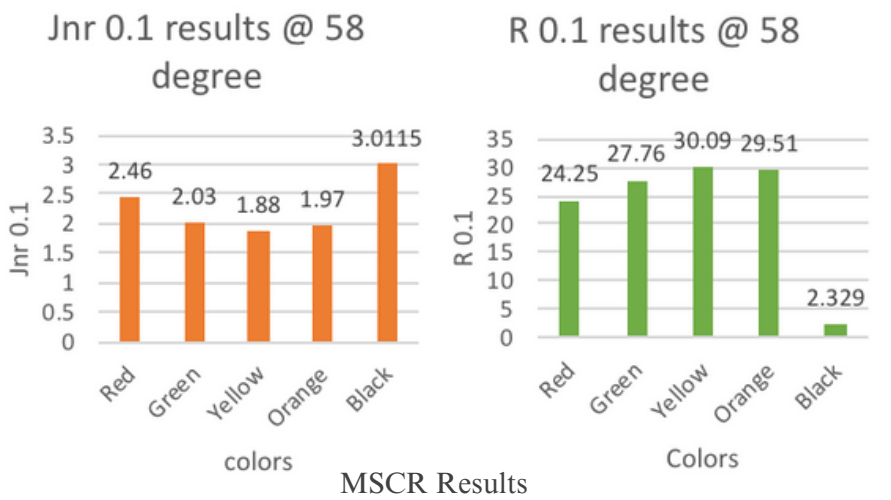
## SETUP, EXPERIMENTAL

Conventional Tests: Softening Point , Rotational Viscosity , Penetration test
Superpave Tests: Bending Beam Rheometer , Multiple Creep Stress Recovery , Dynamic Shear Rheometer.
Aging conditions: Rolling Thin-Film Oven and Pressure Aging Vessel.

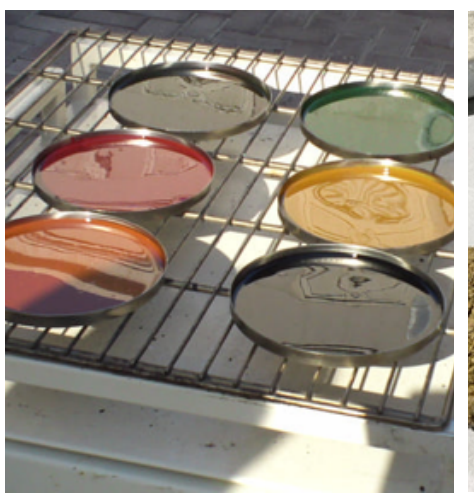
In addition to the measurement of heat absorbed, *thermal camera* was used for both colored binder and asphalt mix.

## RESULTS

- Colored Binder 7° C cooler than the conventional binder.
- slight stiffness increase and higher rutting resistance in colored binders.
- The most elastic and least viscous colored binders were the Yellow and Orange, followed by Green and Red.
- Colored binders have a higher resistance to permanent deformation under repeated load.
- The red colored asphalt performed best by reaching lowest temperature (-18°C) to resist thermal cracking comparing it with the other colors and the black.
- the temperatures of the colored mix asphalt was similar to the black asphalt mix, which made the results to be not reliable.



MSCR Results


Colored Asphalt Binders


Colored Asphalt Mix

## DISCUSSIONS

The idea of this research study was obtained from the fact that the color black of the conventional bitumen, is what will absorb the most heat. In this current research project, the main focus was on studying the rheological properties of mixing clear asphalt binder with bright colored iron oxide powders. Yellow, orange, green, red, clear and conventional (black binder), were tested at the pavement lab. Conventional tests and Superpave tests, were carried out on the six binder samples. However, to fully characterize the binder, further advanced tests were carried out. This included aging the binder to both short and long term aging for the superpave tests to be carried out. The MSCR and BBR, were carried out on the controlled binder, as well as the colored binders. To further investigate whether the colored binders have positively showed an effect in reducing the amount of heat absorbed, the binders were exposed under sunlight and a thermal camera measured the binder temperatures. Taking a step forward, the colored asphalt mixes were prepared, and their temperatures were also measured by a thermal camera.

## ACKNOWLEDGEMENT & REFERENCES

Dr Waleed Zeiada, Prof. Ghazi G. Al-Khateeb and Prof. Rami Al-Ruzouq
Al Shabib trading centre
Eng. Anas Cherkaoui
Eng. Helal Ezzat

# Design of a Multi-story Building

Students: Ameed F. Hafez Kayal | M. Moheddin A. Alhaj Hussein | Mohammed H. Mustafa Al-Hamed | Saleh A. Salem Omer Ba Jabaa

Supervisor: Prof. Salah Altoubat

Introduction:

Earthquakes are a natural phenomenon that can strike at any time, causing significant damage to buildings, infrastructure, and the lives of people. While they can be devastating, earthquakes also play an important role in the safety of people. By understanding the science behind earthquakes and the risks they pose, people can take measures to protect themselves and their communities. Preparedness and response plans, building codes, and early warning systems are all essential tools in reducing the impact of earthquakes.

# Design & Analysis of Multistory Building


M. Moheddin Alhaj Hussein U19100512
Ameed Fadi Hafez Kayal U19100632
Mohammed Hani Al Hamed U19101633
Saleh Ali Salem U19102774

***Supervised by: Professor Salah Al-Toubat***


## INTRODUCTION

Earthquakes are a natural phenomenon that can strike at any time, causing significant damage to buildings, infrastructure, and the lives of people. While they can be devastating, earthquakes also play an important role in the safety of people. By understanding the science behind earthquakes and the risks they pose, people can take measures to protect themselves and their communities. Preparedness and response plans, building codes, and early warning systems are all essential tools in reducing the impact of earthquakes.

## BACKGROUND

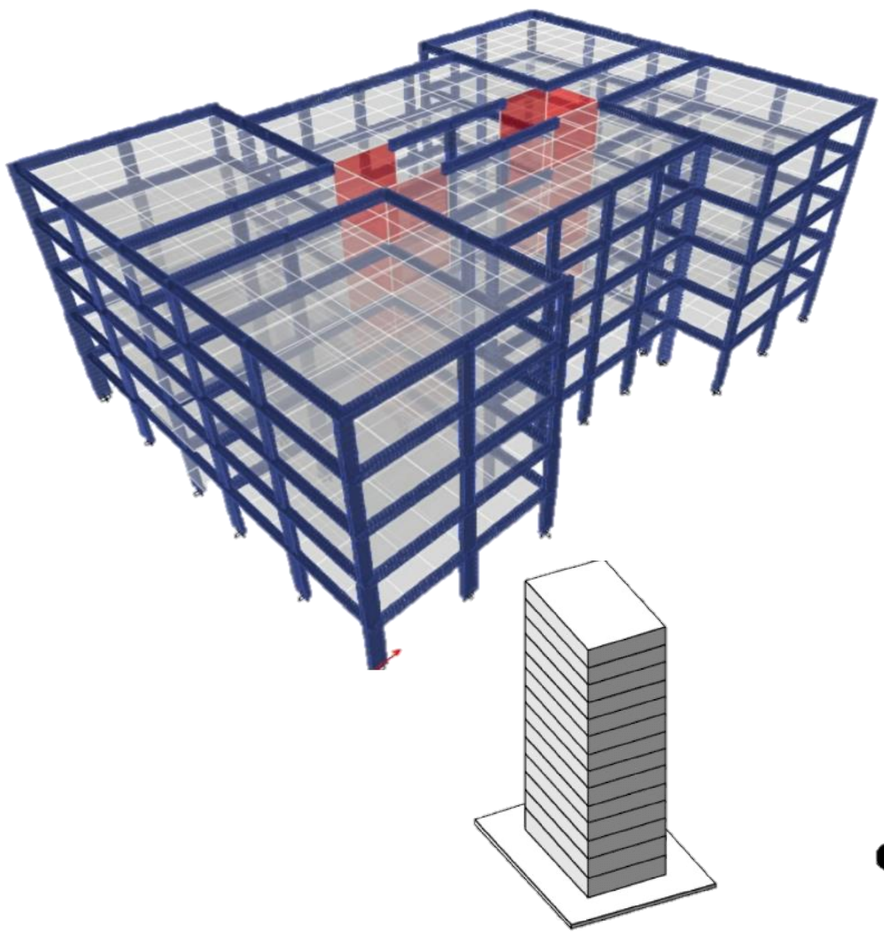
Studying earthquakes can lead to a better understanding of the Earth's structure and how it changes over time, which can help improve our ability to predict and prepare for future events. Ultimately, recognizing the importance of earthquakes in safety can help us build more resilient communities and prevent loss of life and property in the face of natural disasters.

To ensure the safety of a structure during an earthquake, there are several simple steps that can be taken. Firstly, it is important to design and construct buildings to meet seismic standards and codes. This includes using appropriate building materials, reinforcing critical structural components, and ensuring proper foundation design. Secondly, regular maintenance and inspections should be conducted to identify and address any potential weaknesses in the building's structure or foundation. Thirdly, during an earthquake, occupants should take cover under sturdy furniture and away from windows and objects that may fall or break. It is also important to evacuate the building if instructed to do so by emergency authorities.

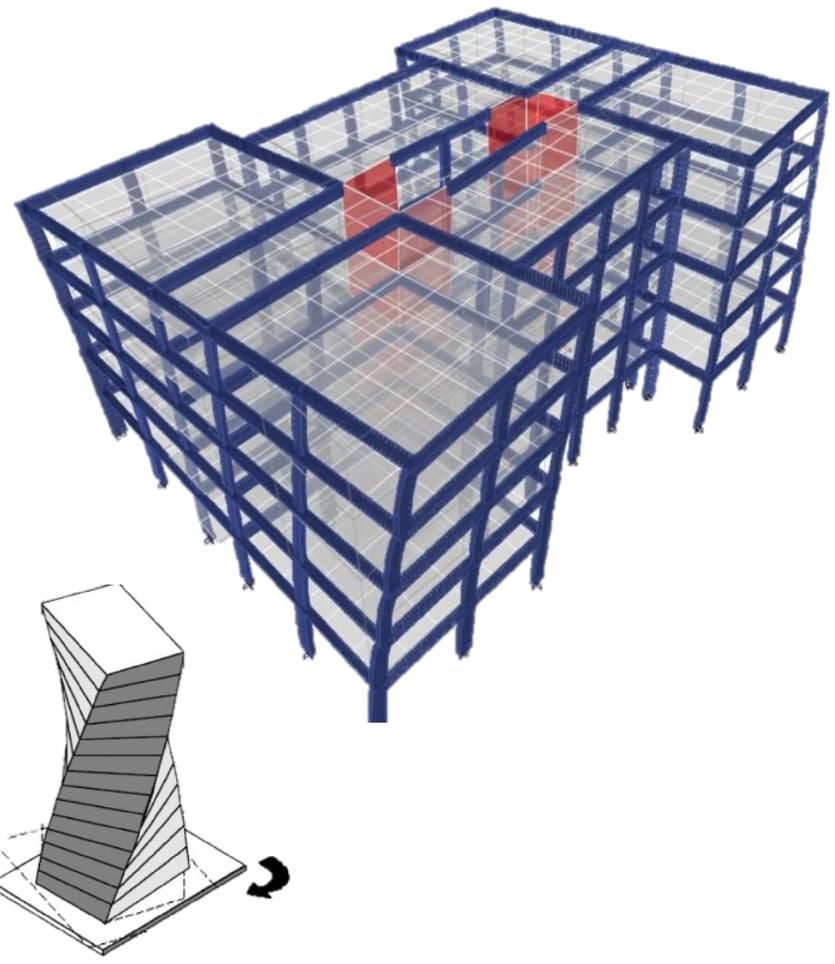
## CONCLUSION

In conclusion, ensuring the safety of buildings is a critical component of disaster preparedness and risk reduction. Building safety measures such as earthquake-resistant designs, materials, and construction techniques can significantly reduce the risk of damage and loss of life during seismic activity. Strict building codes and regulations, proper foundation design, and retrofitting of existing buildings with seismic-resistant technologies are also crucial factors in ensuring building safety.

## 3D Model

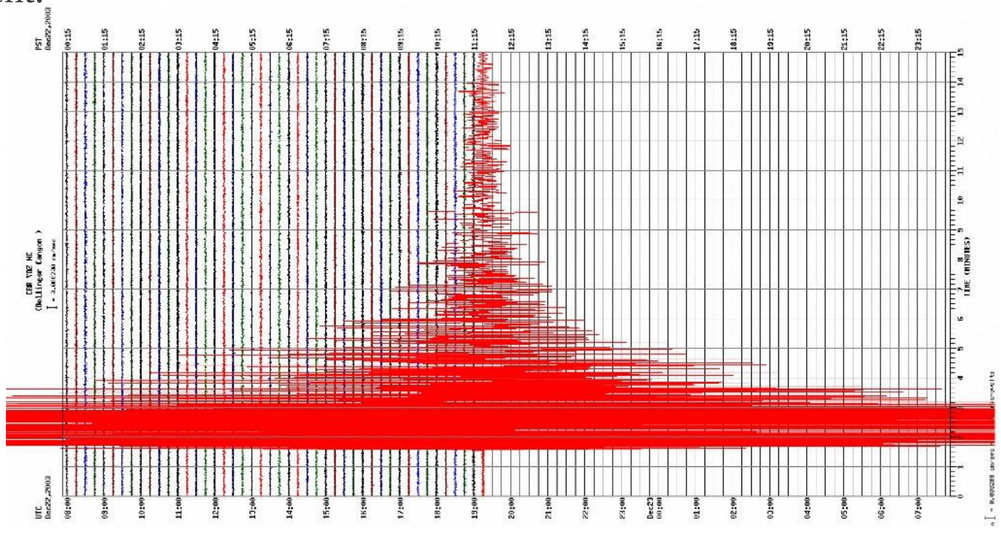


## Twisting behavior



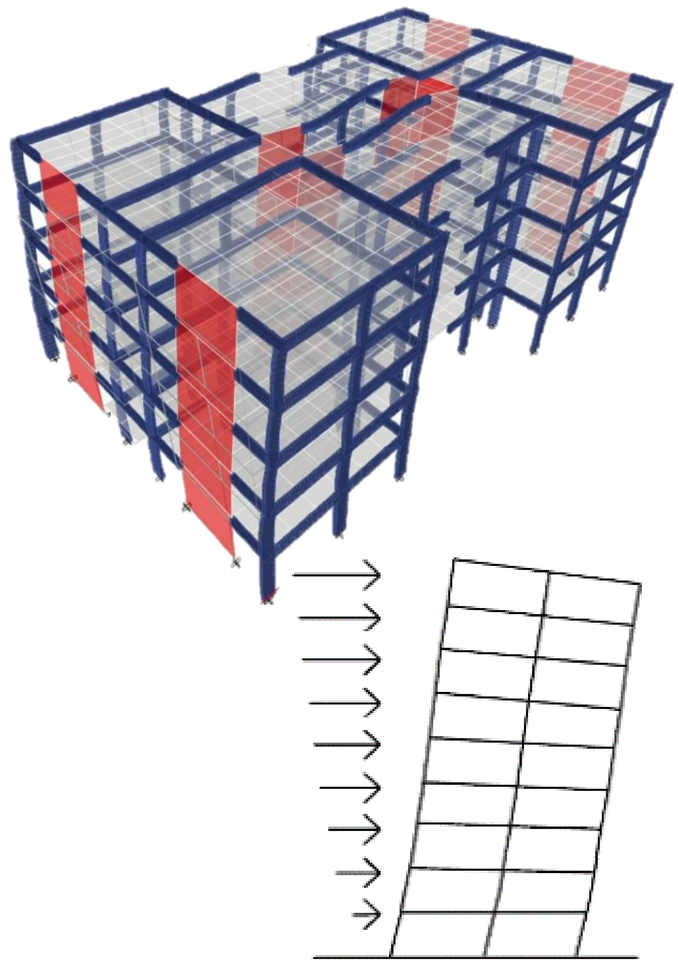
## RESULTS

Increasing the stiffness of the structure, adequately designing connections, and providing the needed confinement reinforcement are all steps that have to be taken to ensure the safety of the structure and people to avoid what happened during the latest earthquake event.




## DISCUSSIONS

Seismic activity refers to the occurrence of earthquakes, which are caused by the movement of tectonic plates beneath the Earth's surface. These plates are constantly shifting and interacting with one another, creating stress and pressure that can build up over time and eventually release in the form of seismic waves. Seismic activity is measured using seismometers, which detect and record the vibrations created by earthquakes. The magnitude of an earthquake is determined by the amount of energy released by the seismic waves, as measured on the Richter scale, which ranges from 1 to 10. A magnitude 1 earthquake is very weak and may not be felt, while a magnitude 10 earthquake is extremely rare and would likely cause catastrophic damage.



# Structural Design of G+5 Villa

Students: Hanin I. Abdulaziz Goodarzi | Afra M. Rashid Alsaleh Alteneiji | Roa'a A. Mohamad Masadeh | Aniqa Tabassum Mohamed Abul Hossain

Supervisor: Prof. Samer Barakat

Introduction:

This project explores the structural design of a G+5 Villa based in Dubai, UAE. It includes the design of various structural elements such as slabs, beams, columns, and foundations. The design considers dead loads, live loads, wind loads, and seismic loads, and ensures the building's stability and
economic design using hand calculations and software design. The objectives of the design are as follows:

- Design columns, beams, slabs, and foundations for gravity and lateral loading conditions.
- Obtain economical design using iterative processes.
- Ensure the design is satisfying the local authority regulations and international codes which include ACI 318M-19, ASCE 7-16, IBC, and Dubai Building Code (DBC-2021).

# STRUCTURAL DESIGN OF G+5 VILLA

*Aniqa Tabassum (U19104144), Roa'a Masadeh (U19100430), Hanin Ibrahim (U1900794), and Afra Mohammed (U19100475).*
*Supervisor(s): Prof. Samer Barakat*

## PROJECT CONCEPT

This project explores the structural design of a G+5 Villa based in Dubai, UAE. It includes the design of various structural elements such as slabs, beams, columns, and foundations. The design considers dead loads, live loads, wind loads, and seismic loads, and ensures the building's stability and economic design using hand calculations and software design.

The objectives of the design are as follows:

- Design columns, beams, slabs, and foundation for gravity and lateral loading conditions.
- Obtain economical design using iterative processes.
- Ensure the design is satisfying the local authority regulations and international codes which include ACI 318M-19, ASCE 7-16, IBC, and Dubai Building Code (DBC-2021).

## LOCATION

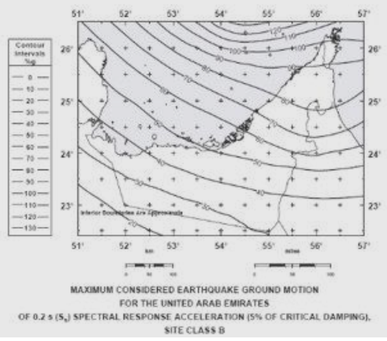
Geographical Location of Plot 1010.

## MATERIALS PROPERTY

The materials used in the designing of the villa are:

1. Concrete with a strength of 40 MPa
2. Steel with a strength of 420 MPa
3. Soil with a bearing capacity of 140 $kN/m^2$

## LOADING CRITERIA



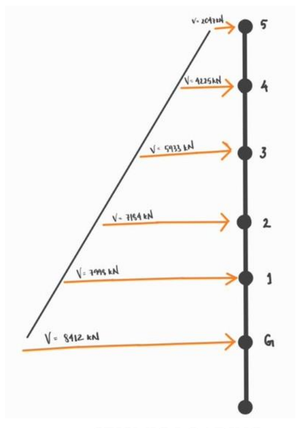

Mapped Seismic Accelerations of UAE (ADIBC 2013).

WIND LOAD

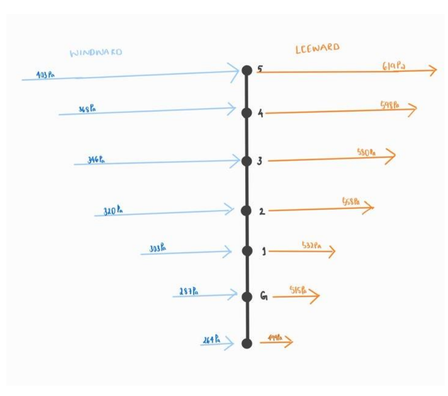
| Loads | Roof Height | Exposure Category | Wind Velocity | $K_d$ | I | $K_z$ | $K_{zt}$ |
|---|---|---|---|---|---|---|---|
| Wind Load | 21.5m | C | 38.0 m/s | 0.85 | 1.00 | 0.92 | 1.00 |

SEISMIC LOAD

| Loads | Element | Cs | Time Period |
|---|---|---|---|
| Seismic Load | Shear Wall | 0.096 | 0.75 s |
| | RC Frame | 0.064 | 0.50 s |
| | | | $T_L$=8.00 s |



SEISMIC LOADING

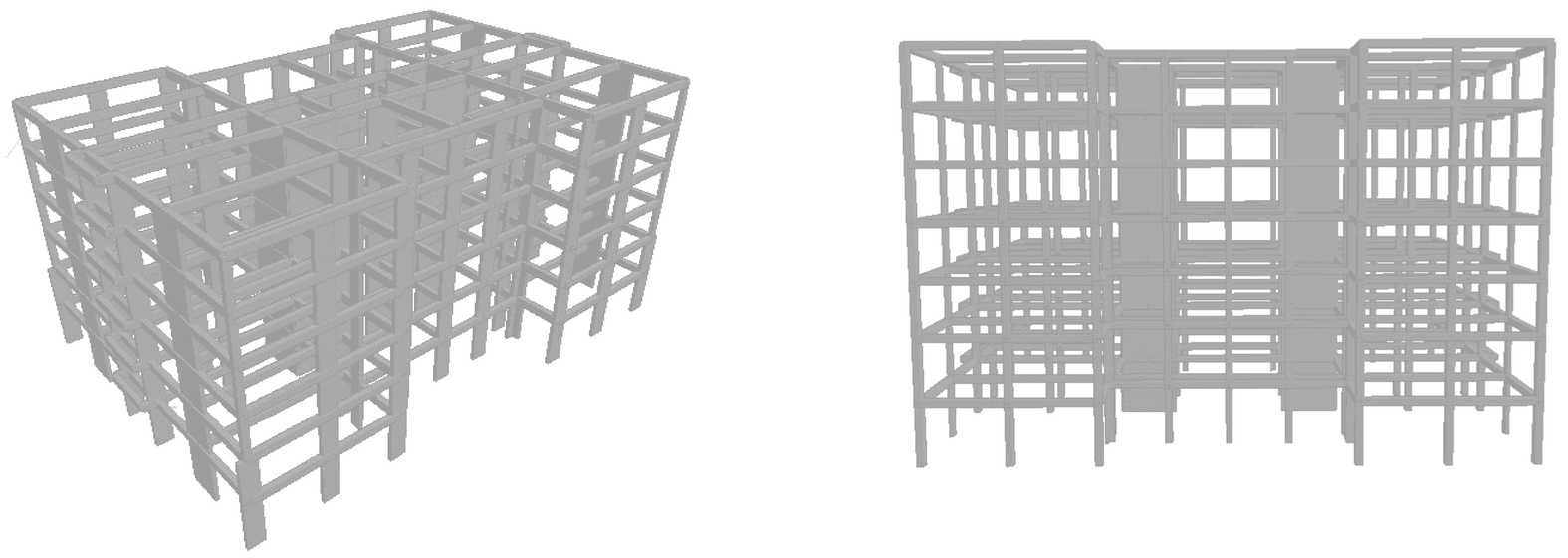



WIND LOADING

## CONCLUSION

International and local codes were used to design the structural elements of a G+5 building taking into consideration different loads applied such as the dead, live, wind, and seismic loads.

## MODEL

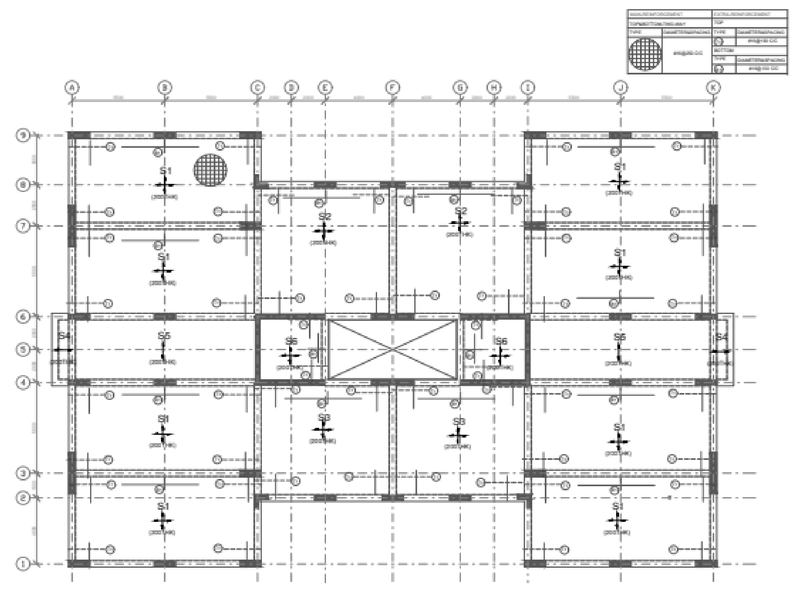


3D Models of the G+5 Villa on STAAD PRO

## SLAB DESIGN

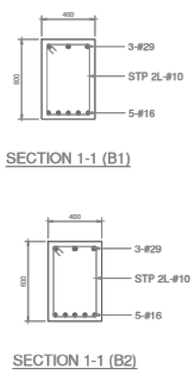
SLAB MAIN AND EXTRA REINFORCEMENT

| | |
|---|---|
| Main Reinforcement (Mesh T&B) | #16@250 c/c |
| Extra Reinforcement (at supports and midspan) | #16 @130 c/c |

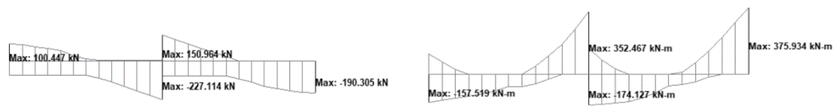


200 mm Thick Slab Reinforcement Layout

## BEAM DESIGN

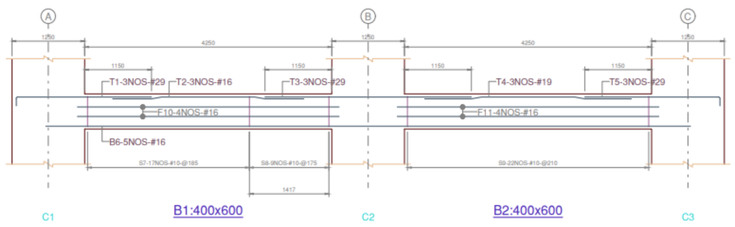



Beam Cross Section Samples




Shear Diagram

Bending Moment Diagram




Beam Elevation Samples

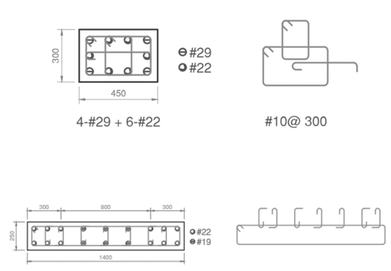
## COLUMN DESIGN

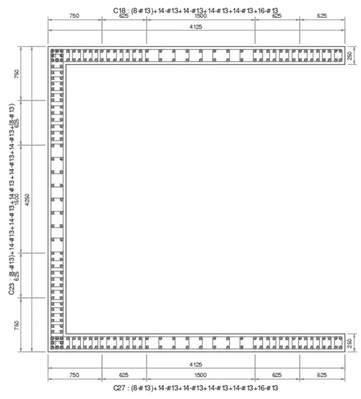
Design Assumptions & Basis:

- The column-beam connections are assumed to be rigid connections.
- The columns are assumed to carry both moments & axial loading.
- Tied Columns were designed.
- Cover= 40mm

COLUMN REINFORCEMENT COMPARISON

| | Design Summary |
|---|---|
| Section | $300\ mm \times 450\ mm$ |
| Main Reinforcement | $4\#29 + 6\#22$ $(A_s = 4902\ mm^2)$ |
| Tie Bars | $\#10@300mm$ |



Sample Column & Shear Wall Cross-Sections

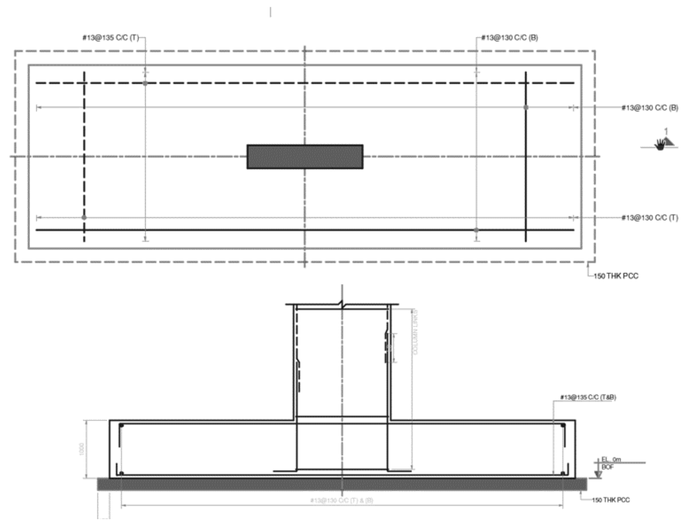
## FOUNDATION DESIGN

Design Assumptions & Basis

- Raft foundation was chosen for this plot.
- Punching shear is critical in determining the depth of the foundation.
- The cover chosen was 75mm with a F.O.S=3 for design process.

FOUNDATION REINFORCEMENT

| Parameter | Design Results |
|---|---|
| Depth | 1000 mm |
| Reinforcement (Mesh) | #13mm@130mm c/c $A_s$ = 992 $mm^2/m$ |




Foundation Sample Cross-Section

# Traffic Study of University of Sharjah

Students: Omar S. Ali Elkhouly | Saqar M. Ali Mohamed Almheiri | Mohammed O. Dawood Dawood | Fadi E. Hussein Abdelgadir | Marwan H. Khalil Almutawa | Abdalla S. Bashir Abdellatif Ahmed | Elawady M. Elmorsy Elawady

Supervisor: Prof. Khaled Hamad | Dr. Muamer Abuzwidah

Introduction:

University of Sharjah. Which is considered one of the best universities locally, which holds more than 14,000 students. As a result of the high number of students in the university, a traffic congestion occurs during the peak hours. We provided possible solutions to reduce/ eliminate all the possible negative impacts. We are continuing what we started in Senior I by designing new roundabouts and a new parking lot. After we conducted the traffic count and the required simulations, We designed Exterior and interior roundabouts and a parking lot.

# Title: Traffic study of UOS

**Mohammed omar Dawood U19100135,**
**Marwan Hesham AL mutawa U19100165**
**Omar Sabry Elkhouly U19101459**
**Saqar Mohamed Al Mheiri U19100912**
**Fadi Elmubarak U19101715**
*Supervisor(s): DR. Khalid Hamad*

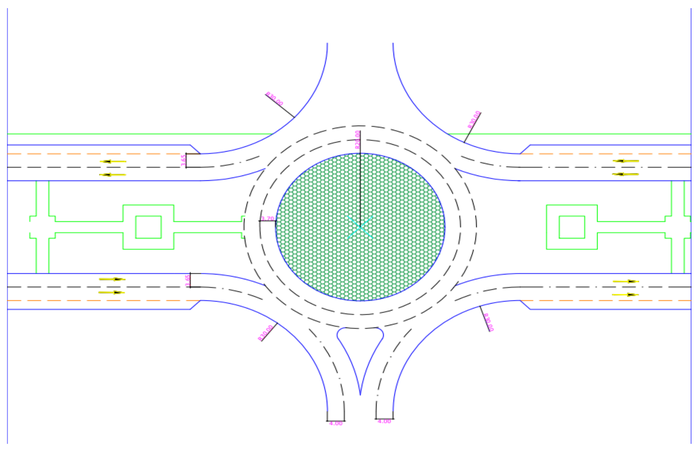
جامعة الشارقة
UNIVERSITY OF SHARJAH
كلية الهندسة
COLLEGE OF ENGINEERING

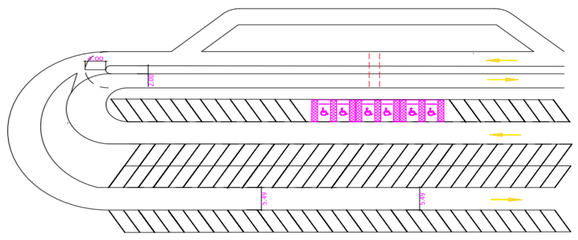
## INTRODUCTION

**University of Sharjah. Which is considered one of the best universities locally, which holds more than 14,000 students. As a result of the high number of students in the university, a traffic congestion occurs during the peak hours .We provided possible solutions to reduce/eliminate all the possible negative impacts. We are continuing what we started in Senior I by designing new roundabouts and a new parking lot. After we conducted the traffic count and the required simulations, We designed Exterior and interior roundabouts and a parking lot.**

## BACKGROUND

On the 8th of November in 2022, a traffic count survey was conducted to update the university's previous data that was collected way back in 2019. The aim of this survey was to capture the current traffic levels by utilizing traffic counters, cameras, and manual calculations. In this project, Vissim was used as an analytical tool to analyze different scenarios. These scenarios included the existing conditions in 2022, which were roundabouts, intersections, and available parking spaces. The future condition in 2027 was also analyzed as the population growth is expected to increase traffic. A future forecasting was carried out using the growth equation which states F=P(1+i%)^n. Since the future volumes were unknown, discussions were held with our supervisor, Dr. Khaled, and it was decided to choose an annual growth rate between 1% to 3%, with 2% being chosen. In addition, a few traffic volume reduction scenarios will be deployed and analyzed, with traffic reduction of 5%, 10%, and 15% being used to understand how the network will respond to changes. The purpose of this is to promote sustainability and reduce carbon emissions and air pollution. The proposed solutions included shifting parking away from the road and turning it into a parking lot, converting U-turns in front of the campus gates into roundabouts, or a combination of both proposed solutions (U-Turn + Parking).





| | Green Area | | percentages of loss | Parking lots | | percentages of increase |
|---|---|---|---|---|---|---|
| | Existing | Proposed | | Existing | Proposed | |
| In Front of M2 | 33065.7 | 25757.9 | 22.10079546 | 206 | 210 | 1.904761905 |
| In Front of M8 | 4448.6 | 2924.9 | 34.25062899 | 111 | 277 | 59.92779783 |
| In Front of W2 | 33065.7 | 25757.9 | 22.10079546 | 206 | 210 | 1.904761905 |
| In Front of W8 | 4448.6 | 2924.9 | 34.25062899 | 111 | 277 | 59.92779783 |

## CONCLUSION

In conclusion, based on the simulations and analysis of various solutions, it is recommended to implement a combination of parking and roundabout solutions, which has shown significant improvements in reducing traffic delay, emissions, and fuel consumption. Specifically, the optimal solution includes the installation of three roundabouts and improvements to internal roads and parking facilities.

## THEORY / METHODS

The scenarios where then applied and simulated to find the results and compare, Vissim was used to analyse this scenario. After that AutoCAD was used to design these supposed solutions. The designing details where of course according to a detailed standard, the Dubai geometry manual was used as the main source of detailing/designing the round abouts.

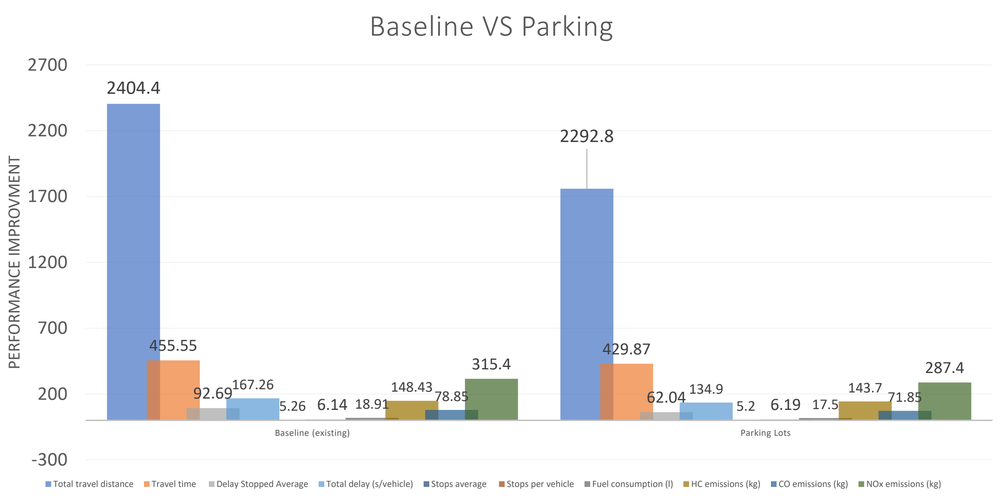
## SETUP, EXPERIMENTAL

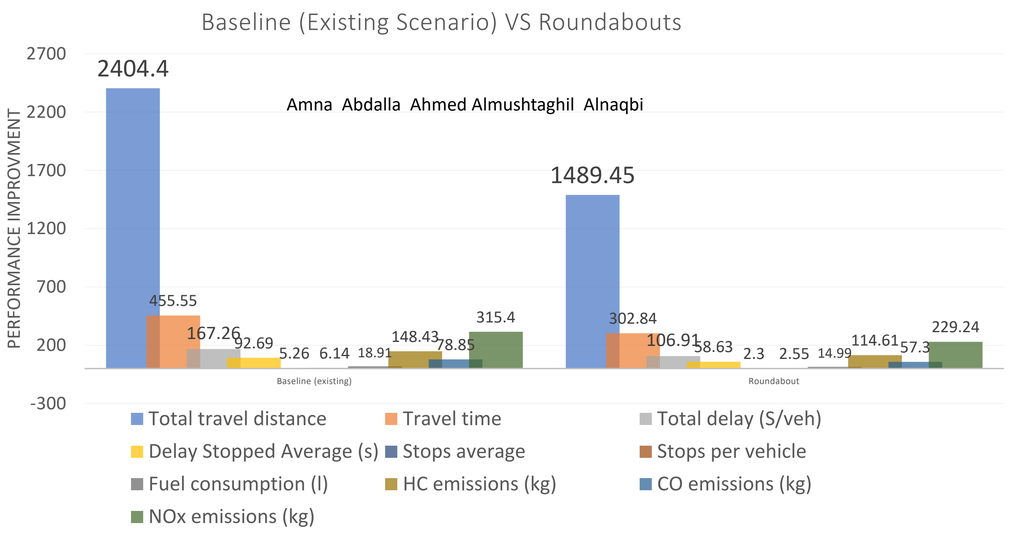
For the traffic count, we used both traffic counters and a cameras in order to conduct the traffic count. Before the traffic count by 1 day, we placed the instruments.

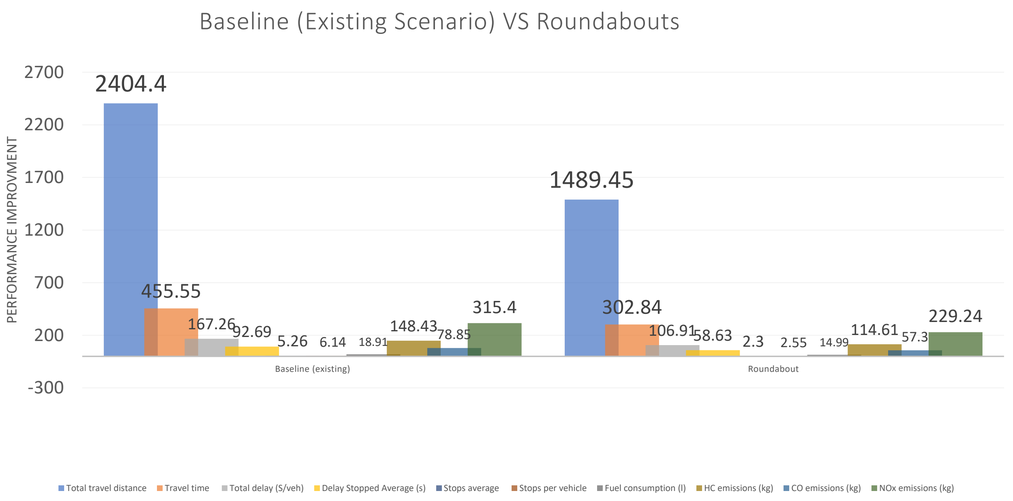
After we finished the traffic count, we added our numbers in VISSIM (the simulation program) in order to compare the current traffic situation with possible solutions.

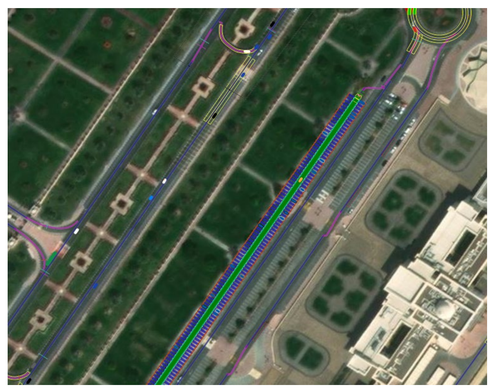
## RESULTS

Based on our simulations, the optimal solution is to install three roundabouts at the entrances of the men's, women's, and medical campuses, as well as make some enhancements to the internal roads and construct a new parking lot.



## DISCUSSIONS

- **solution one was to shift the parking from the main internal roads. As we can see there are improvements in the overall performance after adding the parking lot in VISSIM. For example, we can see the difference in the Total delay, which is one of the most crucial performance metrics to consider while doing an analysis. Looking at the table (Table 7) , summarizing the results before adding the parking lot, the total delay was 167.26, after adding the proposed solution it dropped to 134.9. In addition, we also can see the improvements in the emissions. As we can see there is huge drop in CO emissions which was 78.85 and dropped to 71.85 with 8.9% drop in emissions.**

- **For the second solution, we opted for a conversion of the U-Turns into roundabouts and shifting them to be adjacent to the Higher Colleges of Technology (HCT) gates, that way it eases the traffic coming in and out of the campus gates. As we can see in Table 8 (Shown Below), There is a significant difference between the baseline scenario and the proposed roundabout solution. For example, the total stops decreased a tremendous 59.7% going from 54804 stops to 22096, throughout the whole network. Which indicates that the problem with UOS campuses was entering and exiting the campuses and wasn't the actual internal network of the campuses.**

- **the overall performance of the two solutions combined is better than the baseline. As we can see the total delay in the baseline was 167.26, but after implementing the two solutions it dropped to 82.31 with a 50.78% reduction. Another important parameter to see how eco-friendly our solution is to compare toxic gases emissions with the solution implemented with the baseline. In our case, we will compare HC, CO, and NOx emissions. As we can see, HC emissions dropped from 148.43 to 124.12, CO emissions also dropped from 78.85 to 62.06, same also happened to the NOx dropped from 315.40 to 248.23. Another important parameter is fuel consumption, we can notice a decline in fuel consumption which dropped from 18.91 to 14.12. All these improvements in overall performance indicate that solution 3 should be considered seriously.**

## ACKNOWLEDGEMENT & REFERENCES

Bakar, N. A. A., Adi, A. F. N., Majid, M. A., Adam, K., Younis, Y. M., & Fakhreldin, M. (2018). The Simulation on Vehicular Traffic Congestion Using Discrete Event Simulation (DES): A Case Study. 2018 International Conference on Innovation and Intelligence for Informatics, Computing, and Technologies (3ICT). https://doi.org/10.1109/3ict.2018.8855781

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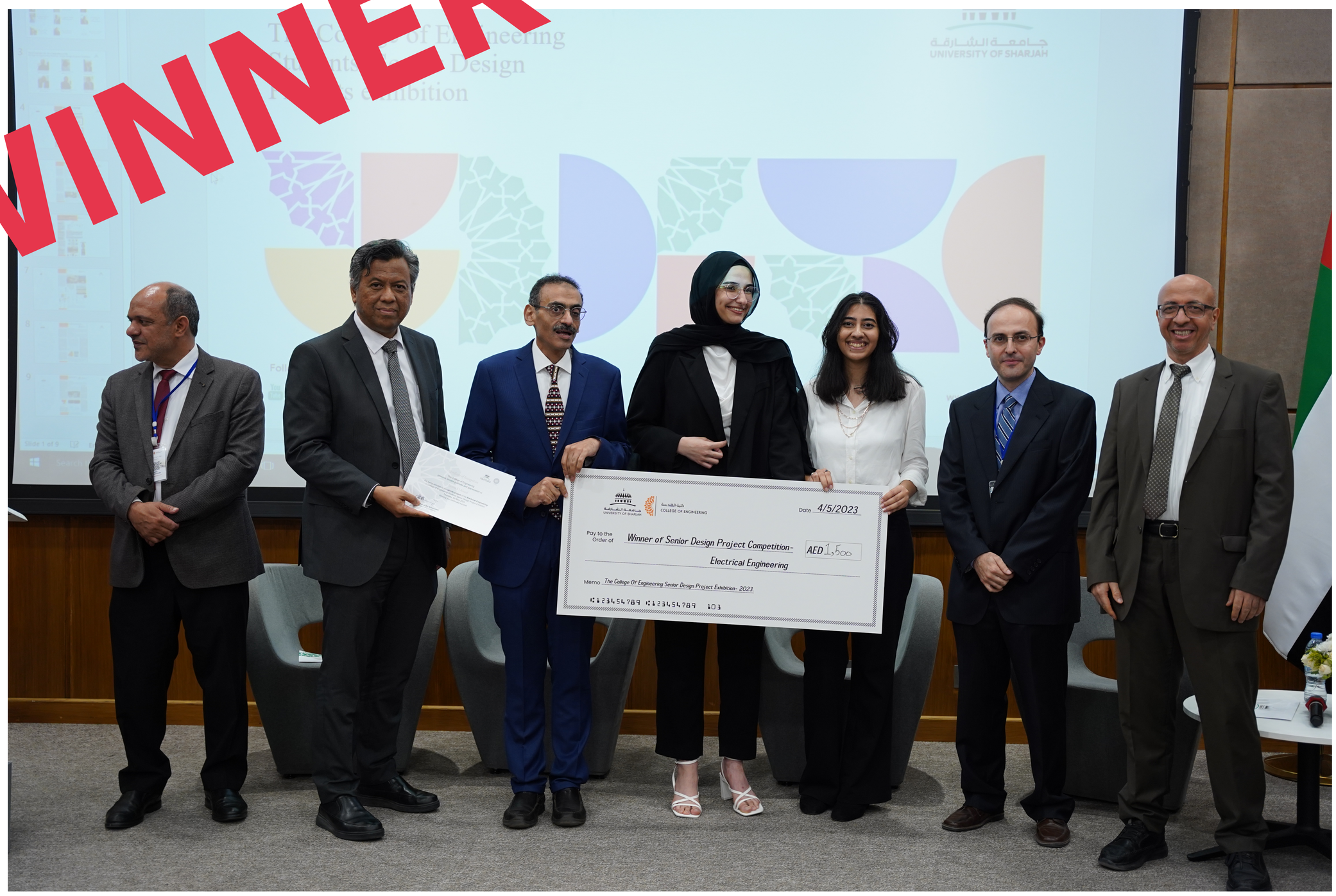
# Electrical Engineering

# Table of Content

# Electrical Impedance Tomography for Breast Cancer Detection

Students: Basma S I Alsaid | Tracy Emad Saroufil | Romaissa Berrim
Supervisor: Dr. Sohaib Majzoub




## Problem Statement:

Breast cancer is a serious health issue that affects millions of women worldwide. Traditional diagnostic techniques, however, like mammography and biopsies, can be intrusive, expensive, and time-consuming. The objective of this project is to create and put into use a non-invasive diagnostic tool that can help with breast cancer early detection and diagnosis. A two-dimensional image of the breast can be created by tracking the electrical impedance on it in order to spot any cancers or anomalies. This technique may offer a less intrusive and more effective way to identify breast cancer.

# Electrical Impedance Tomography for Breast Cancer Detection

Senior Design Group: Romaissa Berrim, Basma Alsaid, Tracy Saroufil
Supervisor: Dr. Sohaib Majzoub, Mentor: Eng. Sol Andrew C. Domingo
Examination Committee: Prof. Abir Jaafar Hussain, Prof. Soliman Awad Mahmoud
*College of Engineering, Department of Electrical Engineering.*

## Problem Statement

Breast cancer is a serious health issue that affects millions of women worldwide. Traditional diagnostic techniques, however, like mammography and biopsies, can be intrusive, expensive, and time-consuming. The objective of this project is to create and put into use a non-invasive diagnostic tool that can help with breast cancer early detection and diagnosis. A two-dimensional image of the breast can be created by tracking the electrical impedance on it in order to spot any cancers or anomalies. This technique may offer a less intrusive and more effective way to identify breast cancer.

## Technical Background

Electrical Impedance tomography is a noninvasive imaging technique. The purpose of utilizing this method is to provide an inexpensive and radiation-free imaging device. The EIT system consists of a function generator and an oscilloscope, in which current will be applied on an object and voltage will be measured to calculate the impedance within a selected region of the object. Using those measurements, a tomographic image with information about the spatial distribution of resistivity can be formed. After reconstructing an image, a machine learning algorithm will be used to find patterns and make predictions according to the data given.

## Future Developments

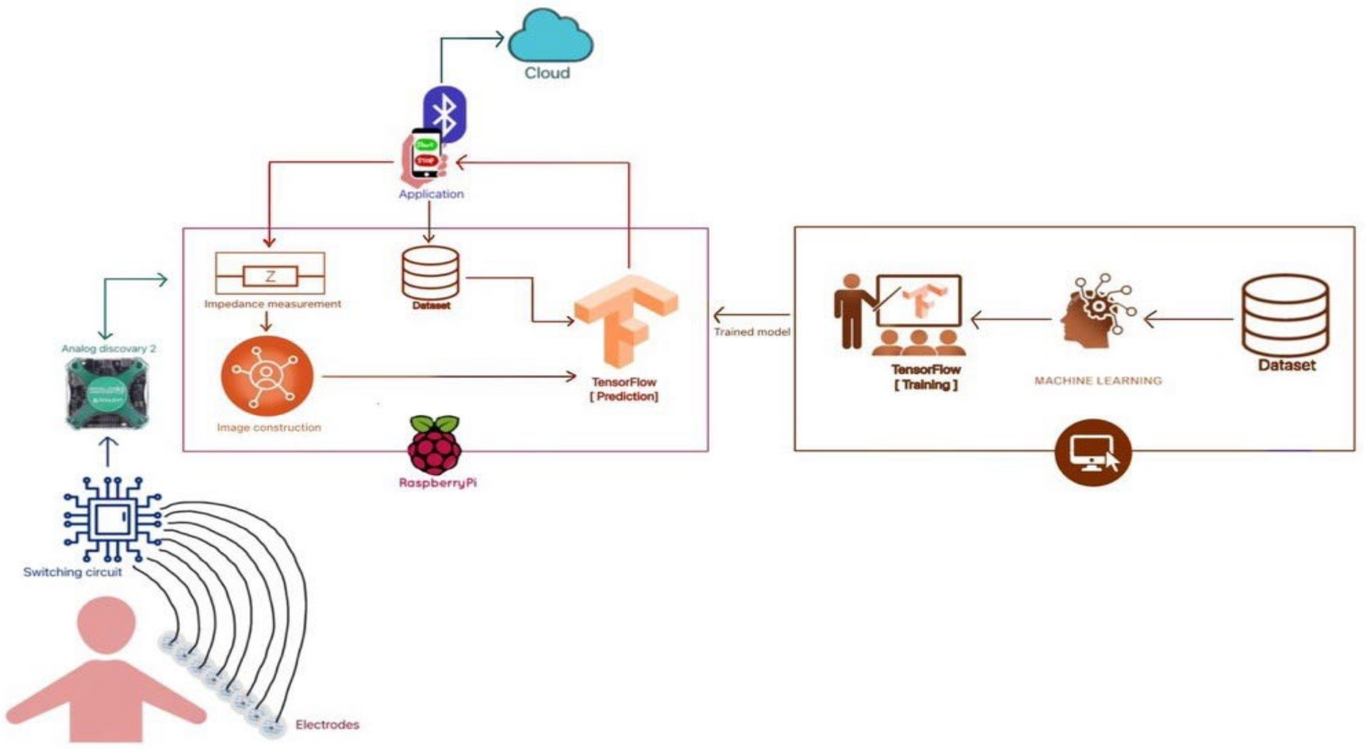
Since this project has a great deal of potential, it needs to be upgraded in many aspects to improve its accuracy and make it more beneficial.

- Data collection could be done in hospitals to acquire more accurate data from cancer patients to train the machine learning algorithm.
- Add more electrodes to increase accuracy of the Machine Learning algorithm and spatial resolution for images.

## Conclusion

Our contribution with this project is a fully automated, non-invasive, and non-ionizing Electrical Impedance Tomography device as an assistive tool for diagnosing breast cancer. The device is easy to use, safe, and cost-effective. this project represents a significant step forward in the development of more efficient and effective methods for diagnosing breast cancer, with the potential to improve patient outcomes and ultimately save lives.

## System Overview

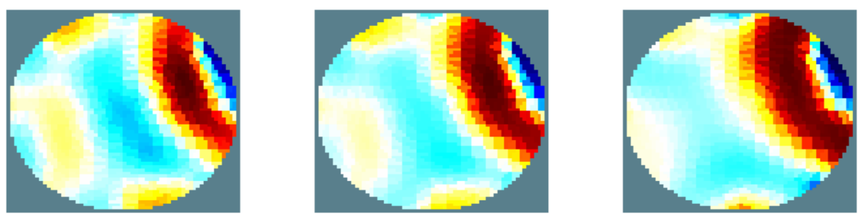



## Proposed Design

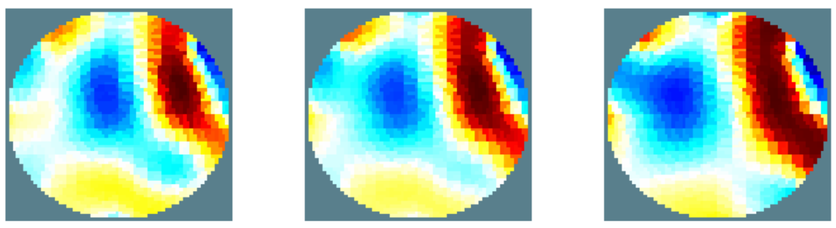
The purpose of the project is to create a fully automated Electrical Impedance Tomography device to assist in the diagnosis of breast cancer with the help of Machine Learning. There are two parts to this project: hardware and software. The hardware aspect contains an AD2, a Raspberry Pi, and 16-Channel Analog Multiplexers. The AD2 is used to apply voltage and measure the current across the object, which is the patient, being measured. The impedance is then calculated and sent to a MATLAB Toolbox to reconstruct an image from the measurements. The images are then fed into a trained Machine Learning algorithm to make a prediction, which is the diagnosis. The prediction will then be displayed, alongside the image, on the user interface in the Raspberry Pi.

## Results

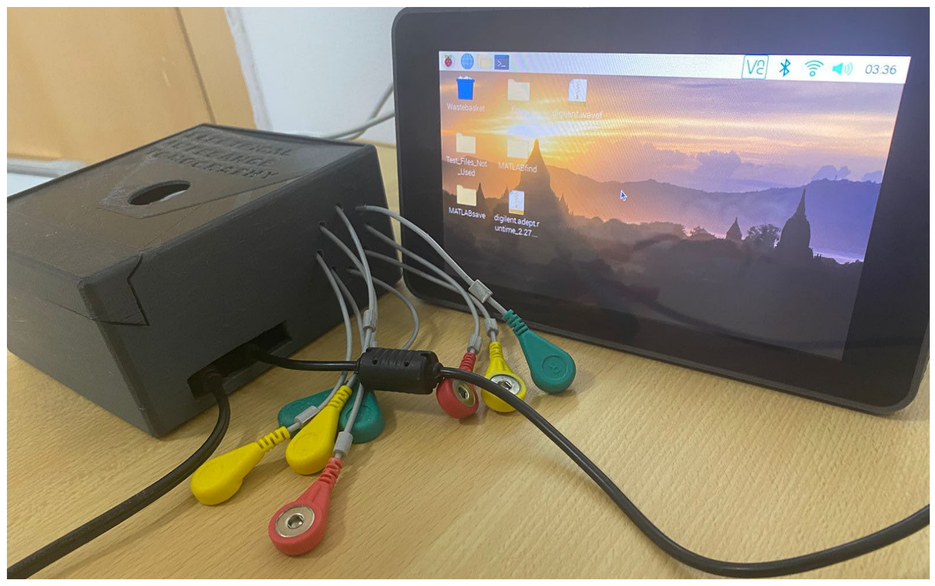
Using the MATLAB Toolbox, EIDORS, an accurate two-dimensional image of the chicken phantom was created from the impedance measurements acquired by the Analog Discovery 2 device. This image was then fed into a machine learning algorithm based on Convolutional Neural Networks (CNN), which predicted whether the images represented a cancerous tumor or not. The machine learning algorithm achieved an accuracy of 80%.



Non-cancerous

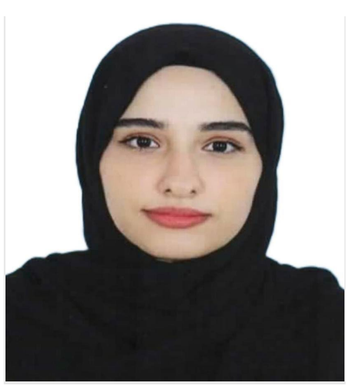


Cancerous



Full System

### Senior Design Group:



# Robot-Assisted Therapy and supervision for Children with Autism Spectrum Disorder

Students: Hassan Elhadi Idries | Waseem Mohamed Younis | Youssef Mohamed Fawzy

Supervisor: Dr. Raouf Fareh

Problem Statement:

According to the world health organization (WHO) autism spectrum disorder (ASD) affects one out of every 100 kids, studies have shown that in the United Arab Emirates, 4 per 10,000 (1 in 89) kids are diagnosed with autism in the early childhood years. Autism doesn’t only cause physical difficulties for the individual, it also causes difficulties in life such as social phobia, and obsessive-compulsive behavior. It also affects the people surrounding the person with autism since they all would have a tough lifestyle taking care of the person as they must consistently show affection. Autism is presently incurable, but their treatments can ameliorate the situation and issues of people with autism.

# Robot-Assisted Therapy and Inspection for Children with Autism Spectrum Disorder

**Hassan Elhadi U19100333 , Waseem Ayesh Younis U19103958, Youssef Mohamed Fawzy U19100603**

Supervisor: Dr. Raouf Fareh, Mentor: Eng. Alya Yousif Alhammadi

Examination Committee: Dr. Anwar Jarndal / Dr. Sofaine Khadraoui

*College of Engineering, Department of Electrical*

## Problem Statement

According to the world health organization (WHO) autism spectrum disorder (ASD) affects one out of every 100 kids, studies have shown that in the United Arab Emirates, 4 per 10,000 (1 in 89) kids are diagnosed with autism in the early childhood years. Autism doesn't only cause physical difficulties for the individual, it also causes difficulties in life such as social phobia, and obsessive-compulsive behavior. It also affects the people surrounding the person with autism since they all would have a tough lifestyle taking care of the person as they must consistently show affection. Autism is presently incurable, but their treatments can ameliorate the situation and issues of people with autism.

## Technical Background

Autism spectrum disorder (ASD) is a neurodevelopmental disorder that demotivates an individual's ability to interact and develop social skills with others. It is referred to be a "spectrum" disorder since each person will experience the symptoms and their intensity differently. In general, ASD is divided into three distinct levels based on the severity of the symptoms. According to research, children with autism like engaging with robots like most other kids. Robots are capable of repeatedly providing predictable replies. They are extremely crucial in assisting autistic children with learning since they act consistently. For therapeutic topics for children of all levels, NAO is the best robotic design. The Nao robot is a little humanoid robot made to communicate with people. It can walk, converse, and identify faces and objects. It also has sensors. NAO will be the robot we're implementing in this project, with additional features to support him like a Kinect camera and sensors.

## Future Developments

- Expand the targeted population and the learning material library.
- Increase the robot's interaction with children by incorporating elements like gesture recognition.
- Develop an application that sends an SMS message to the therapist if a child is under stress.

## Conclusion

The necessity for humanoid robots nowadays will eventually become increasingly apparent. The humanoid robot is being used to treat children with ASD, yet it is not meant to take the place of actual human therapists; rather, it is intended to support them. Our project consists of primarily three segments; demonstration, inspection, and progress tracking. This poster outlines our design process, all-around setup, and system output. The flowchart displays the order that the system operates. We were successful in designing the exercises for the robot to display after assembling an exercise library gathered through significant research.

## METHODOLOGY

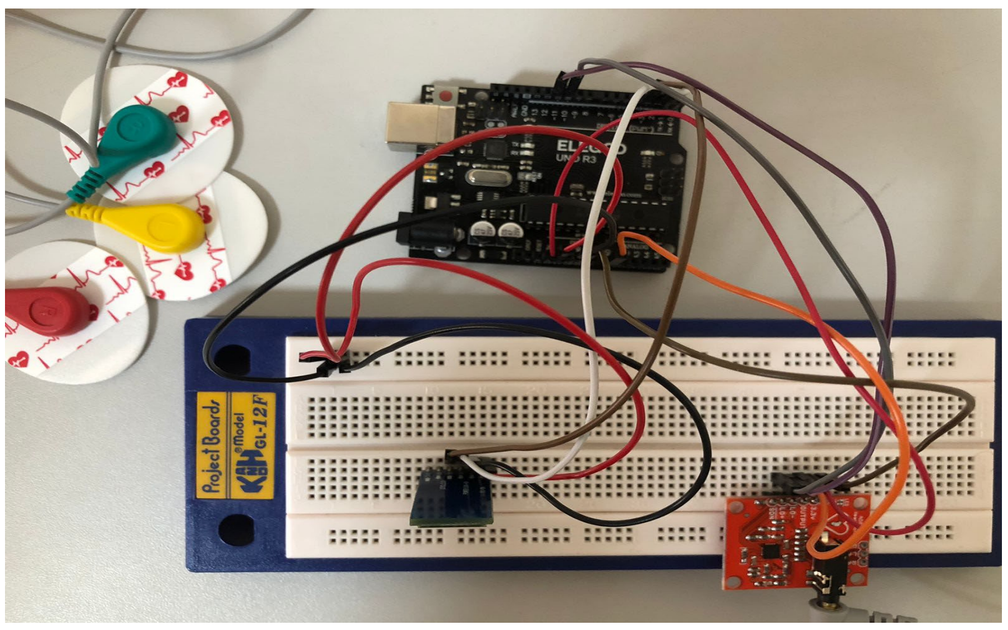
1- Collect learning material for children in the kindergarten age
2- Create a library for the NAO robot that includes the main social skills that would be needed in school.
3- Recognize the error made by the children when performing a social act (waving, raising the hand) through the Kinect-based inspection system.
4- Monitor the child's stress level through the heart rate monitoring sensor

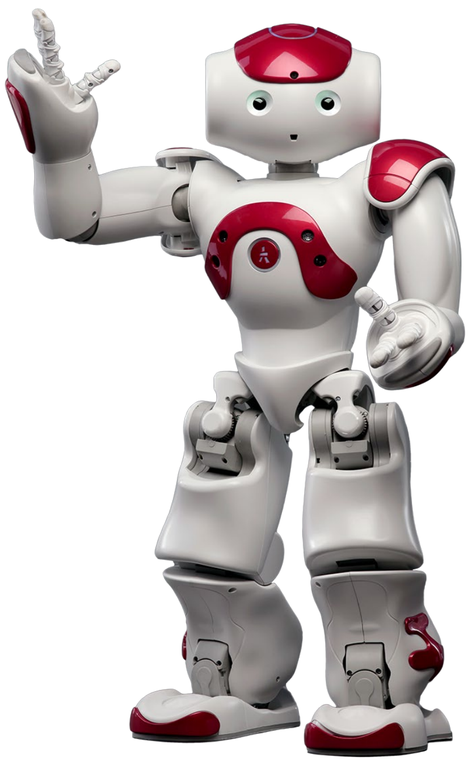
## EXPERIMENTAL SETUP

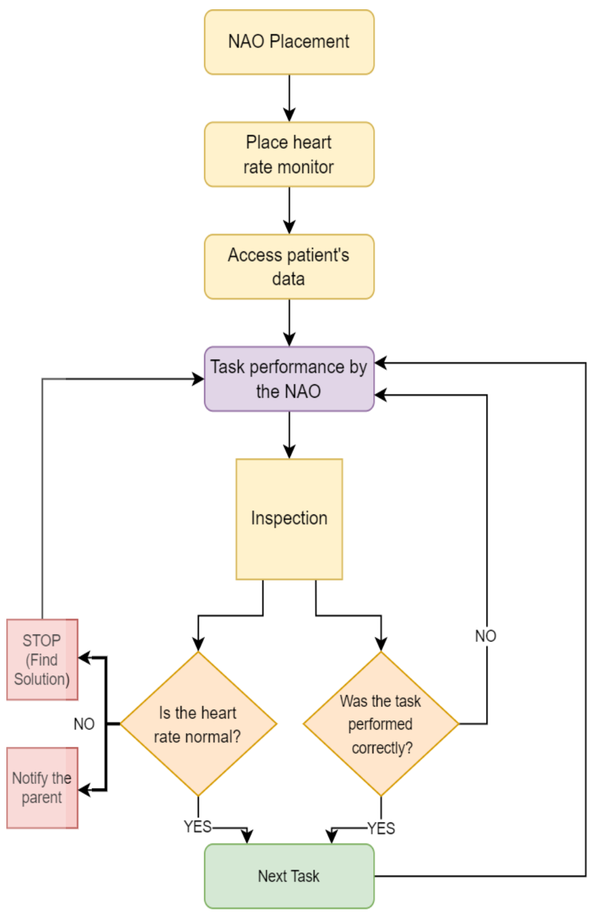
Three primary subsystems that make up the system are demonstration, supervision, and inspection. The learning library that has been developed and the humanoid robot NAO make up the demonstration subsystem. The Kinect camera, which determines if a hand gesture is proper, is used in the supervisory subsystem's design. Finally, the inspection subsystem will be done by collecting data such as session timings, stress levels, time taken by the child to complete the course, and behavior reports that would be collected by the person operating the computer. A heart rate monitor is included as a safety measure to monitor the child's heart rate and a Bluetooth module will be utilized to inform the therapist when the child is under stress.

## RESULTS

We have created a robot-assisted system for children between the ages of 4 to 6 with autism spectrum disorder (ASD) that helps children with poor skills in simple addition operations, number counting, and alphabet learning with a word example. The system is also effectively able to supervise the child's motion to determine the correctness of the behavioral motion done. An ECG sensor keeps track of the child's heart rate in case the child's heart rate has dropped or increased above normal ranges.






## Senior Design Group:

# Autonomous lifeguard system

Students: Alreem Salem Alsuwaidi | Noura Mahmoud Abdelgalil | Mariam Matar Alketbi

Supervisor: Prof. Soliman Awad Mahmoud

Problem Statement:

Drowning is a prevalent issue in today's society, as it always has been. It is considered one of the leading causes of accidental death. Lifeguards face several challenges to recognize drowning cases and monitor the pool. This project involves implementing a smart autonomous lifeguard system that replaces regular lifeguards and effectively rescues drowning victims. The system comprised wearable wrist devices connected wirelessly to the autonomous underwater vehicles, and a sound alarm device.

# Autonomous Lifeguard System

Senior Design Group: Alreem Salem Alsuwaidi, Mariam Matar Alketbi, Noura Mahmoud Ahmed
Supervisor: Prof. Soliman A. Mahmoud | Mentor: Eng. Mohammad Saad
Examination Committee: Dr. Mahmoud Albreem, Dr. Saeed Abdallah
*Affiliation: College of Engineering | Department of Electrical Engineering*

جامعة الشارقة
UNIVERSITY OF SHARJAH
كلية الهندسة
COLLEGE OF ENGINEERING

## Problem Statement

Drowning is a prevalent issue in today's society, as it always has been. It is considered one of the leading causes of accidental death. Lifeguards face several challenges to recognize drowning cases and monitor the pool. This project involves implementing a smart autonomous lifeguard system that replaces regular lifeguards and effectively rescues drowning victims. The system comprised wearable wrist devices connected wirelessly to the autonomous underwater vehicles, and a sound alarm device.

## Technical Background

The following background helps in better understanding of the project:

- **Remotely operated vehicles (ROVs):** These devices operate with human assistance and are unable to perform tasks autonomously.
- **Autonomous underwater vehicles (AUVs):** Vehicles were constructed for ocean exploration.
- **Wearable device (drowning detection):** Measuring and detecting drowning situations without taking action.

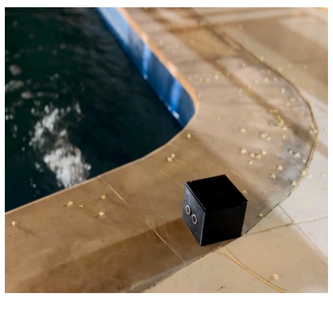
Autonomous underwater vehicle design factors: **isolation, bouncy, visibility, stability, hydrostatic pressure & damping, and structure.**

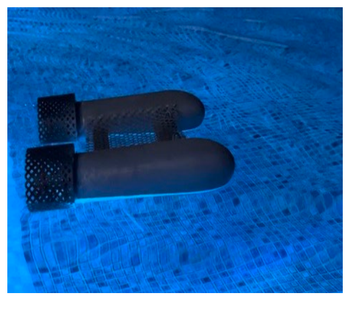
During drowning, critical signs in the body change: **heart rate** may drop below 50 BPM, while **oxygen level** may fall below 90%.

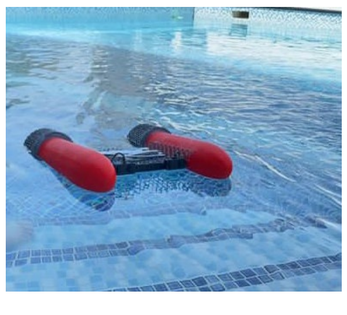
To determine the position of the drowning, the system will be able to measure the distance and position using **angle of arrival** and **triangulation method**.

## Conclusion

There were some difficulties during the assembly of the Autonomous Rescue System, however, it was still able to clearly demonstrate the rescue process and showcase how the wearable device and the vehicle communicated during the rescue operation. The sound alarm device operated and fulfilled its purpose. Ultimately, the final version of the autonomous lifeguard system operated efficiently.

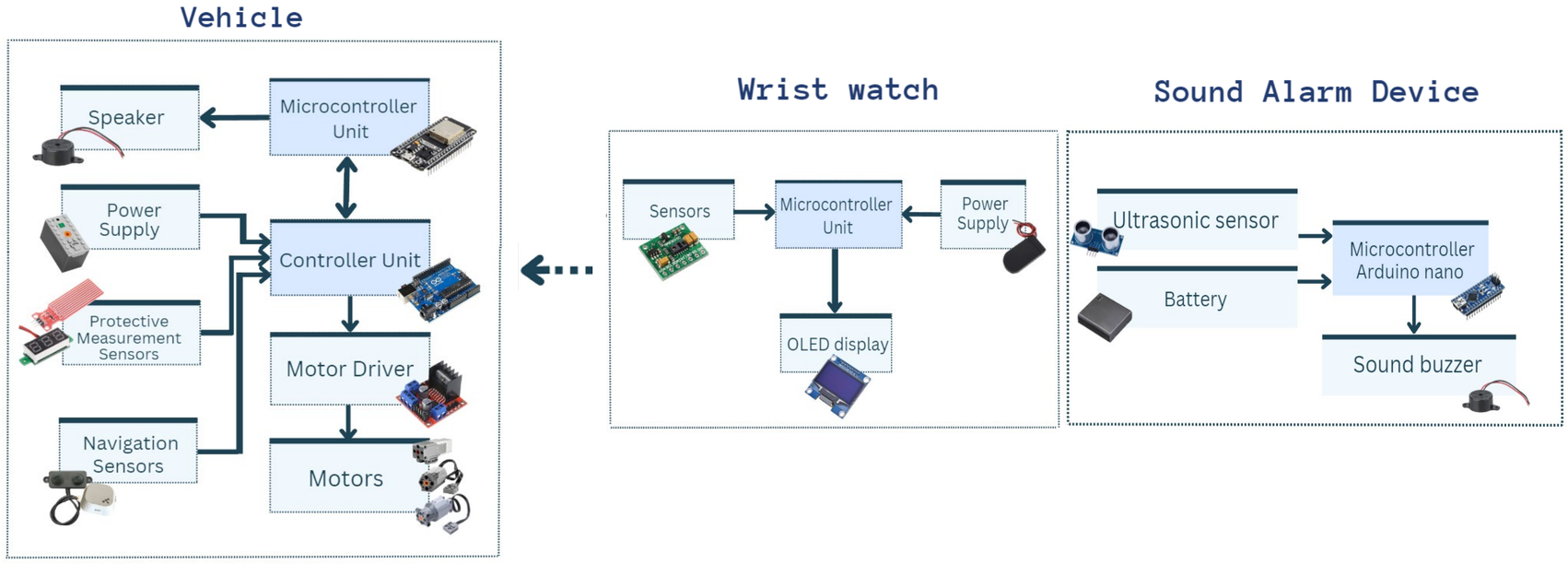






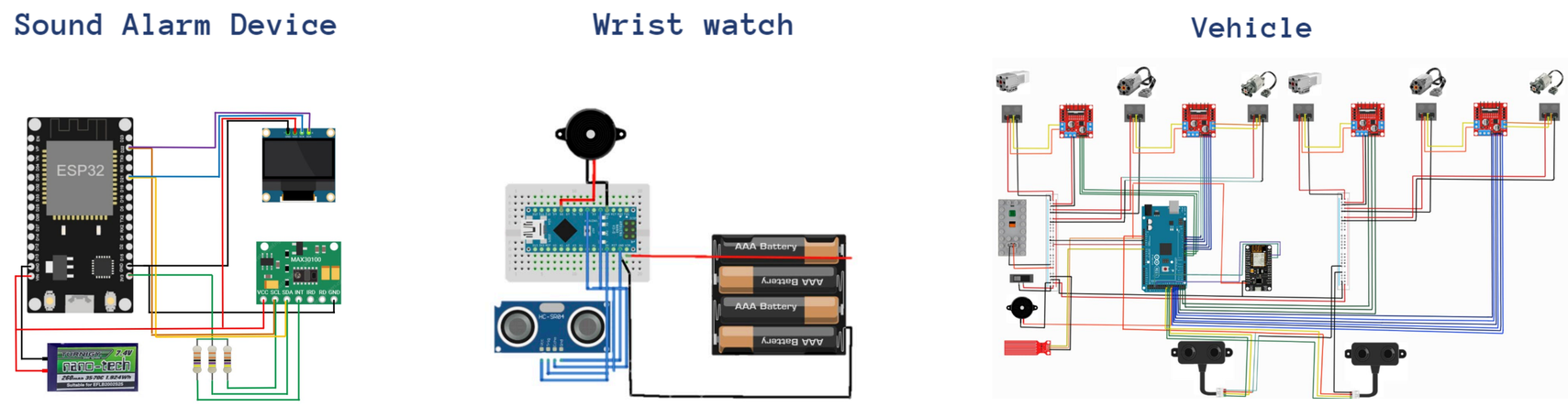
## METHODS

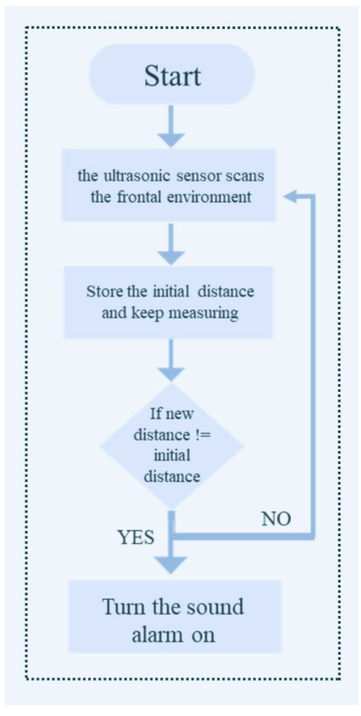
The project is an automated rescue system with the ultimate objective of reducing drowning incidents for children. It functions by using wristwatches that assess vital signs such as the level of oxygen and heart rate. A drowning case will be identified if any of the measured values are out of the normal. The watch will direct the underwater vehicles to take action. Then, the rescue vehicle will travel to the victim and dive beneath him. Then it will emerge carrying him to the poolside.

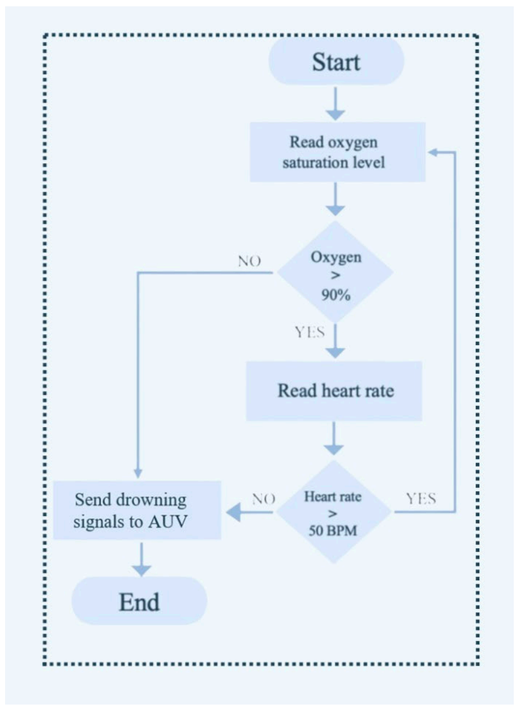


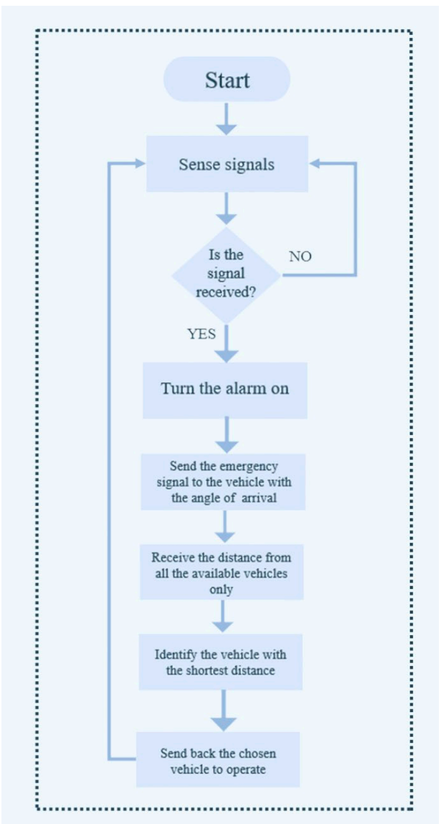

## Proposed System

The sound alarm device is designed to store the distance and keep measuring constantly. If there is a change in the distance measured, indicating the presence of someone near the pool, then the device will turn on the alarm buzzer. As for the wearable devices it will continuously measure the heart rate and oxygen level. If the wearable device reads an abnormal vital sign then a drowning case will be identified and it will notify the AUV to start the rescue process It will measure the distance from ultrasonic. Then it will calculate the position of the victim using triangulation method. Following that the device will drive to the victim, and dive under him. Then it will continue the process of rescue by emerging carrying the victim and driving to the side of the pool.




## RESULTS

The alarm and wearable devices functioned as intended, detecting the presence of people near the pool and monitoring vital signs. A simulated test confirmed that the communication between the watch and the vehicle was effective, as the vehicle promptly initiated the rescue procedure. The vehicle successfully executed the triangulation technique to locate the victim, approached and dived slightly beneath them, then resurfaced with the victim.

**Supervisor:**
**Prof. Soliman A. Mahmoud**

**Examination committee:**
**Dr. Mahmoud Albreem**
**Dr. Saeed Abdallah**

# Emirati Sign Language Recognition Using Deep Learning

Students: Waad Arif Aljanaahi | Asma Jassem Mohammed |Esraa Ahmed Alawadhi

Supervisor: Dr. Saeed Abdallah

## Problem Statement

Sign language is a popular form of communication used by roughly 70 million people around the world, mostly by hearing and speech impaired people. Even with today's advanced technology, people with disabilities still face difficulties expressing themselves, their thoughts, and their emotions. Thus, we designed and implemented a sign language recognition system to communicate with them easily. The system is based on Deep Learning techniques to recognize Emirati sign language and convert it into a written text.

# Emirati Sign Language Recognition Using Deep Learning


Asma Jassem Al-Ali
U19101094

Esraa Ahmad Alawadhi
U19101069

Waad Arif Aljanaahi
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Supervisor: Dr. Saeed Abdallah, Mentor: Eng. Alya Alhammadi
Examination Committee: Prof. Hissam Tawfik, Dr. Anwar Jarndal
College of Engineering | Department of Electrical and Electronics Engineering


## Problem Statement

Sign language is a popular form of communication used by roughly 70 million people around the world, mostly by hearing and speech impaired people. Even with today's advanced technology, people with disabilities still face difficulties expressing themselves, their thoughts, and their emotions. Thus, we designed and implemented a sign language recognition system to communicate with them easily. The system is based on Deep Learning techniques to recognize Emirati sign language and convert it into a written text.

## Technical Background

**Deep Learning:**
A type of Machine Learning that describes algorithms that analyze data with a structure similar to the human brain. This structure is called Artificial Neural Network (ANN) and it learns from a huge amount of data.

**YOLO (You Only Look Once):**
A Deep Learning technique that can perform object detection at video streaming frame rates and detect objects in real-time. YOLO can process 45 frames per second which makes it extremely fast.

**Raspberry Pi:**
Popular boards used in Deep Learning applications. Linux is the default operating system running on Raspberry Pi, typically programmed in Python. To operate the desired processes, Raspberry Pi provides several input and output pins to control and read external devices.

## Implementation:

Our project went through 3 phases:

**Phase 1 — Building the dataset**
We collected videos of each sign in various backgrounds and lighting conditions. In total, we collected around 900 videos, averaging 75 videos for each class.

**Phase 2 — Training in YOLO**
We trained the model in Google Colab using the YOLO model.

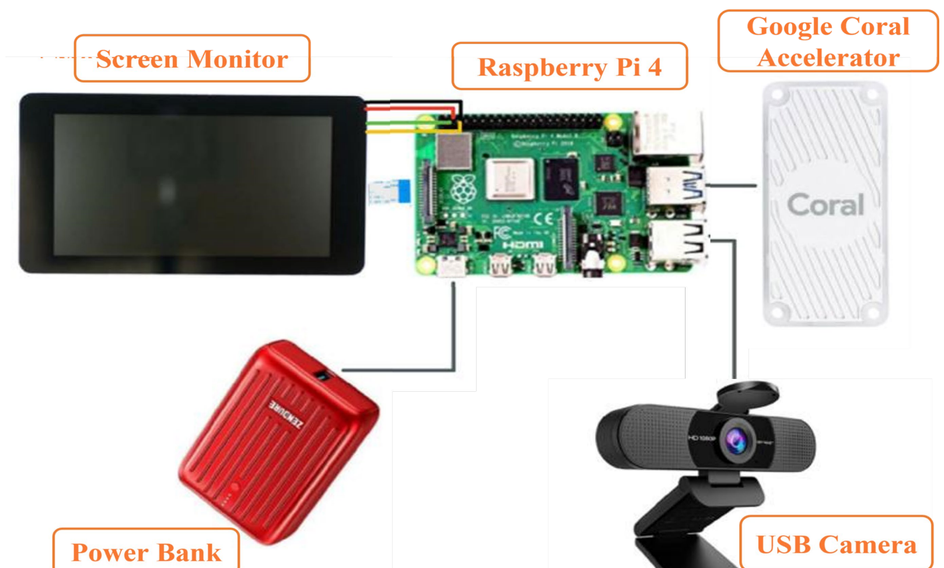
**Phase 3 — Deploying the Model**
After the system was able to detect each class, we wrote the code that would combine the classes that form dynamic gestures.

## Methodology:

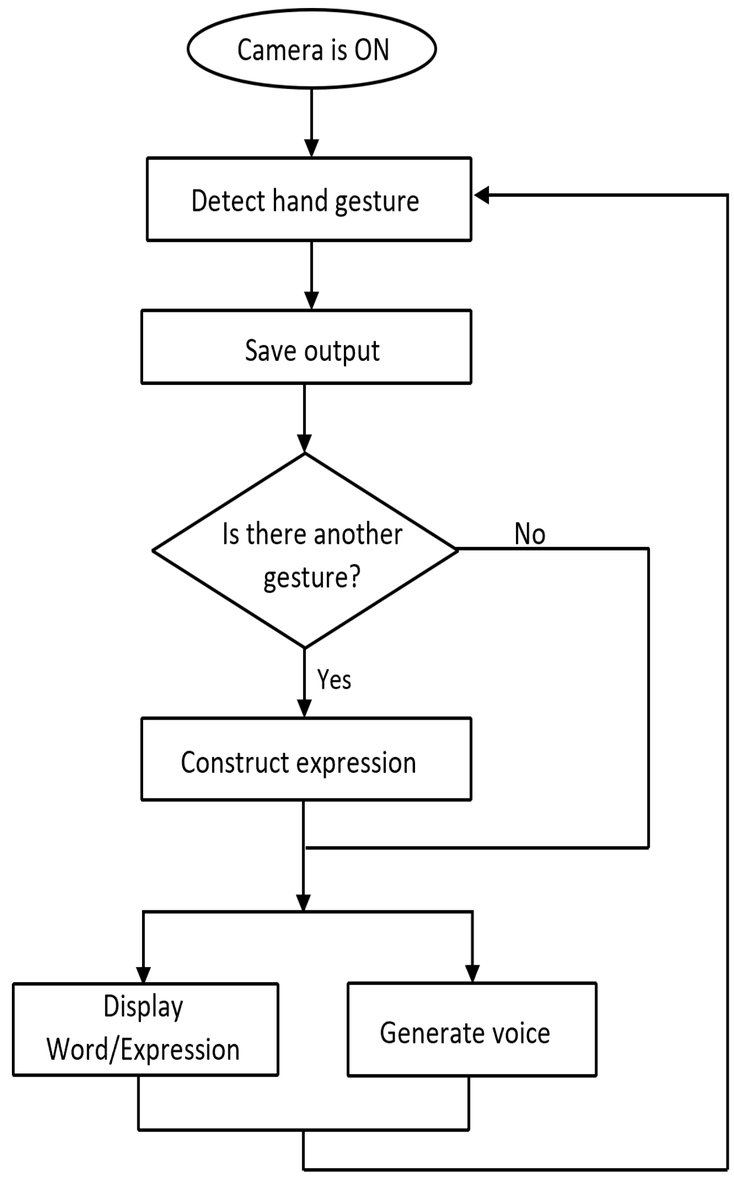
Our system will operate as follows:

1. Check if the camera is on.
2. Wait until any hand gesture appears in the frame.
3. Detect, classify, and save the hand gesture.
   The gesture could be:
   - Static: Detected within one frame to form a word.
   - Dynamic: Another gesture is detected within 3 seconds to form an expression.
4. If dynamic, construct the two gestures together.
5. Output an Arabic text.

## System layout:



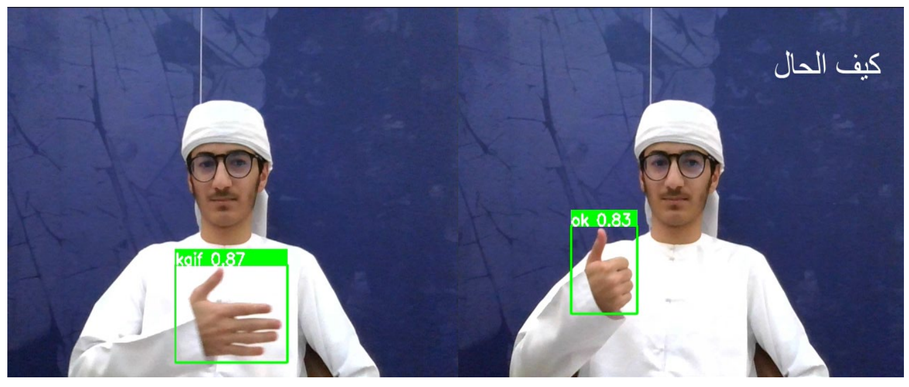

## Flow Chart:



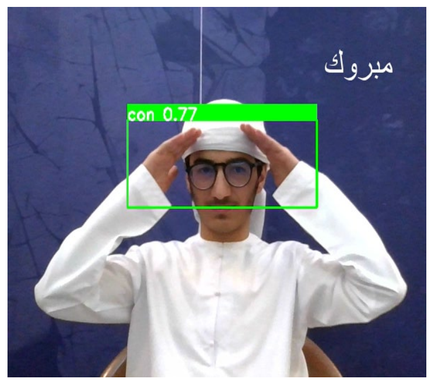

## Results:

Our model is able to detect 3 static signs and 6 dynamic signs that are a combination of two signs. The testing accuracy reached 98.9% overall. The following figures show the detection results:










Supervisor

Examination Committee

# Solar - wireless electric vehicles charging system

Students: Nouf Ibrahim Ahmed | Shaikha Eissa Murad Al Mandoos

Supervisor: Dr. Ali Ahmed Adam Ismail

Problem Statement:

- Some stations are inaccessible to anybody who drives a car with a different type of plug since
- Each manufacturer of electric vehicles has a unique charging plug cable
- Providing a plug for every vehicle is inefficient since drivers demand convenient plug-and-play options.
- If the electricity goes off, the regular charging station will be useless
- Misuse the plug cable or connect it wrongly, which damaging the car's plug.

# Solar - wireless electric vehicles charging system

Senior Design Group: Nouf Ibrahim Ahmed - Shaikha Eissa Almandoos
Supervisor: Dr. Ali A Ismail
Examination Committee: Prof. Ramesh Bansal, Prof. Amr Elnady
*Affiliation: Collage of Engineering, Department of Electrical Engineering*

جامعة الشارقة
UNIVERSITY OF SHARJAH
كلية الهندسة
COLLEGE OF ENGINEERING

## Problem Statement

- Some stations are inaccessible to anybody who drives a car with a different type of plug since
- Each manufacturer of electric vehicles has a unique charging plug cable
- Providing a plug for every vehicle is inefficient since drivers demand convenient plug-and-play options.
- If the electricity goes off, the regular charging station will be useless
- Misuse the plug cable or connect it wrongly, which damaging the car's plug.

## Technical Background

1- The solar charging unit:
- a. Sunlight
- b. Solar panel
- c. Solar charge controller
- d. Batteries

2- Station microcontroller:
- a. Sensors
- b. Servo motor to rotate the solar panels
- c. Valve motor to empty cooling water tank when it is turbid
- d. Motor for cooling and cleaning purposes

1. The car's part consists of two main parts:
   1. Microcontroller:
      a. Voltage sensor: to measure the battery's voltage and send the value to microcontroller
      b. GSM module: to notify the user by SMS when the car's battery is fully charged.
      c. IR transmitter: to send signal to the station once the car's battery is fully charged to preserve power and reduce power loss.
      d. Car's battery and charging board

2. Wireless charging receiving unit
   a. Wireless charge receiving module: this module is responsible for receiving the charging current from the wireless transceiver of the station.

   b. Relay: to switch on/off wireless charge receiver depending on battery status. If the battery is fully charged the relay will cut-off current from the wireless receiver to stop further charging.

## Conclusion

- We were able to build a charging station based on wireless charging technology that can charge electrical vehicles without physical plug.
- The station can operate automatically to detect presence of the EV inside it and recharge it automatically.
- The system can notify the user by SMS when their cars are fully recharged.
- The solar-wireless station can monitor the solar panels' temperatures and cool them down when the temperature rases more than 50 °C.
- The system was able to manage car insertion to the perfect charging spot

## THEORY / METHODS

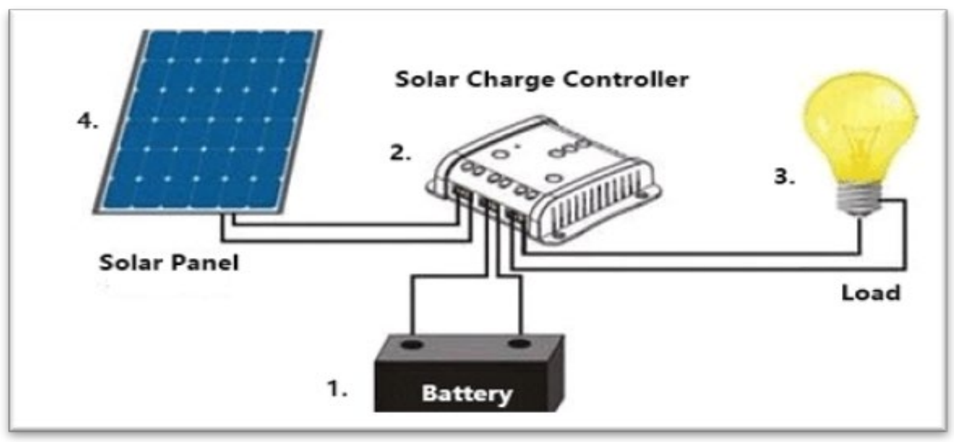
- ❑ The Solar wireless station can charge the EVs with wireless technique
- ❑ The system mainly consisting of hardware part and software part.
- ❑ System's sensors representing in LDR sensor, voltage sensor and Temp sensor
- ❑ Servo motor and ESC were used to direct the PV to sun location
- ❑ The software part is based on C-Language to write the project code
- ❑ and then burn it to microcontroller chip for one time as no need furthermore coding

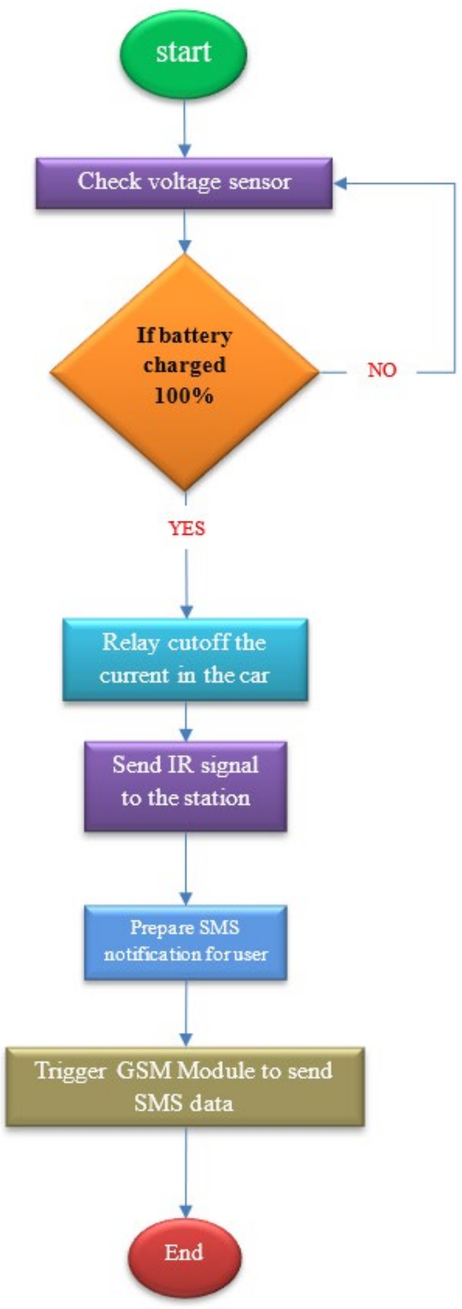
## SETUP, EXPERIMENTAL

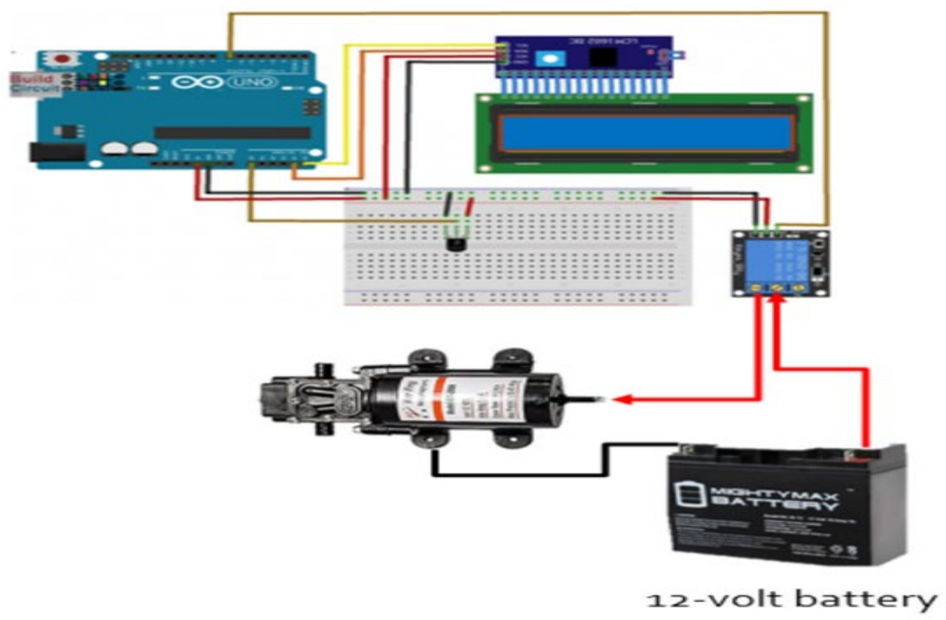
- ❖ We used modeling and simulation pc apps like Fritzing pc programs to create the system circuit
- ❖ Our system can be connected to EV owner using a GSM module.
- ❖ We utilized the C-language, "a programming language," to create the system's function commands.
- ❖ Our code writing program is the IDE since it is a universal software and open source
- ❖ We started a real scenario of using wireless charger and the circuit worked perfectly

## RESULTS

- ✓ We were able to measure the car's batteries voltage.
- ✓ The GSM module send the battery status over SMS within 6 seconds
- ✓ The cooling system for the PV starts immediately when the temperature is over 50 °C.
- ✓ The rotating procedure worked to rotate the PV with sun location.
- ✓ The system can reuse the water for further using in cooling in cooling process.

12-volt battery

## Future improvement:

1. Increase the charging voltage to actual value to recharge a real EVs with using bigger wireless coils
2. Use big battery capacity to increase working time in case of heavily using
3. Build a diagnostic battery system to check the EVs battery viability to avoid accidents or explosions
4. Optimization of charging efficiency: One area for future work would be to optimize the charging efficiency of the wireless charging system. This could involve developing new techniques for power transfer or exploring the use of varied materials for the charging pad.

# Industrial Engineering & Engineering Management

# Table of Content

# Design and Implementation of a Digital Twin for Fault Detection on a Compressed Air Energy Storage System

Students: Rawnaq F. Hussein Ababneh |Lamis A. Al Khatib | Rawad Al Koutoubi | Dana I. M. Saqallah

Supervisor: Dr. Concetta Semeraro


## Introduction:

Using CAES system provides stable and reliable electricity to the grid when using renewable sources. Therefore, it is important to increase dependability and security. Especially, the CAES system has some limitations, which this project main goal is to eliminate. CAES, for example, may face energy losses during the process, resulting in lower system efficiency (Sarmastetal.,2023). This can be done by creating a digital twin using artificial intelligence specifically machine learning. Its main goal is to identify probable faults in the machinery so that it can be repaired before the fault occur. Detection technique aids in achieving the intended set of goals required to satisfy the need, which enables energy to be available quickly and efficiently.

# Design and Implementation of a Digital Twin for Fault Detection on a Compressed Air Energy Storage System

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كلية الهندسة
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## INTRODUCTION

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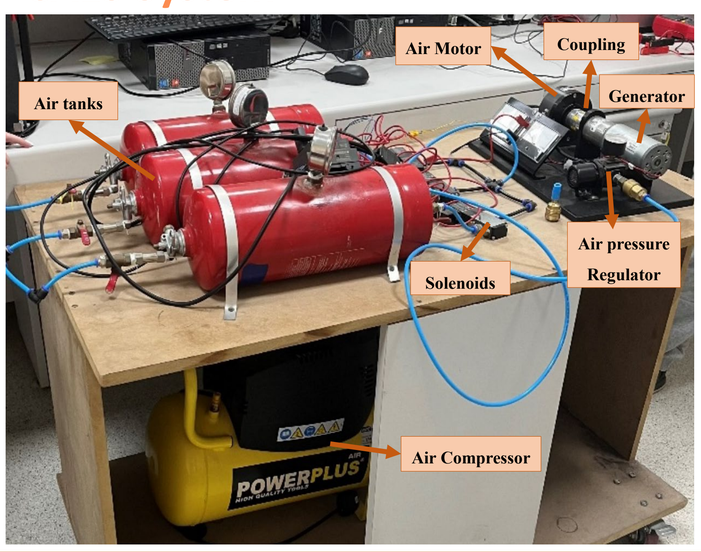
## THEORY

**This project aims to create a digital twin on CAES system for fault detection.** A data acquisition model (DAQ) was created to collect data from the CAES system. The DAQ model consists of three one wire temperature sensors, two voltage sensors, a vibration sensor, a current sensor, a pressure sensor, and a real time clock for a time stamp. Additionally, an acoustic sensor was used along with four thermocouples. Data was collected and inserted into MATLAB that was used to create a predictive model, using supervised machine learning specifically classification bagged trees. The model is used to classify faults into four different classes of healthy system (HS), fault 1 (F1), fault 2 (F2), and fault 3 (F3).

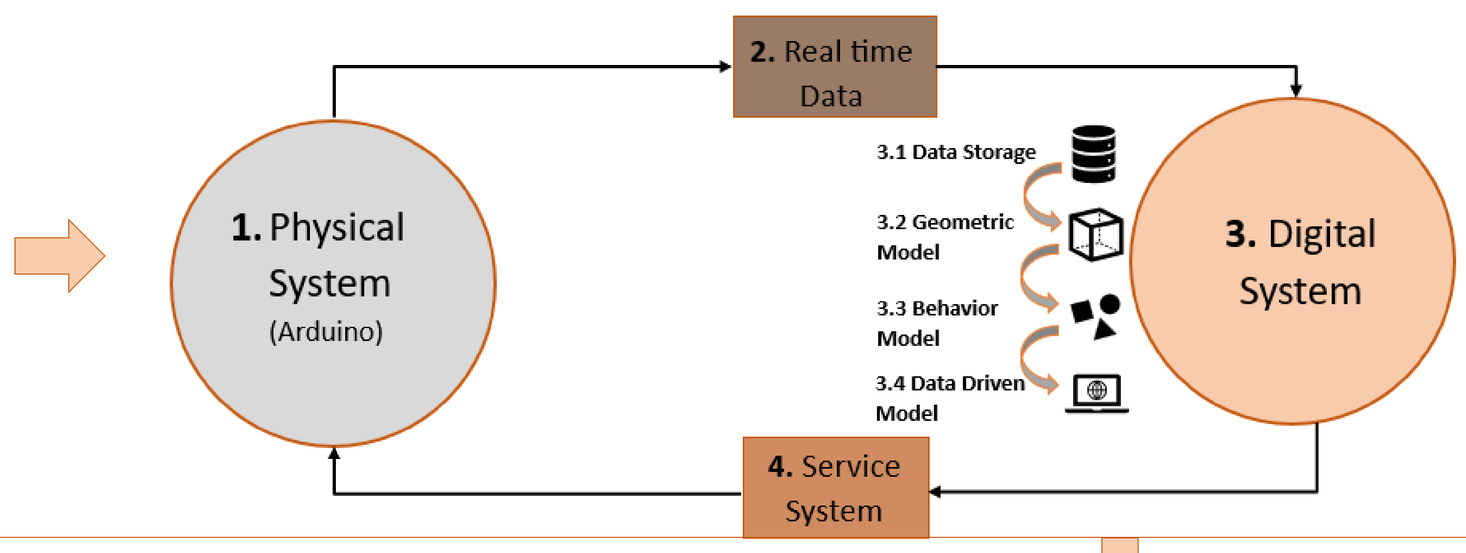
## EXPERIMENTAL SETUP

We used experimental methods to collect data that was used in creating our predictive model. The experiment ran for three days, and we were able to collect 1,218 measurements of data. The experiment consisted of four different stages. At stage one (HS), data of a system in its normal state was collected. At stage two (F1) a leak was introduced into the system by punching holes into the tubes. At the third stage (F2) the leak was removed and arbitrary friction into the coupling was introduced. The friction simulates obstruction in the joint connecting the air motor and generator. Lastly (F3), friction was removed, and we increased load on the generator to simulate overly using the system.

### CAES System




### Digital Twin Architecture




## BACKGROUND

For this project we created a digital twin on a CAES system.

- CAES stands for Compressed Air Energy Storage System. It is typically employed for energy storage and demand control. Especially for renewable energy sources such as wind and solar electricity during peak hours.

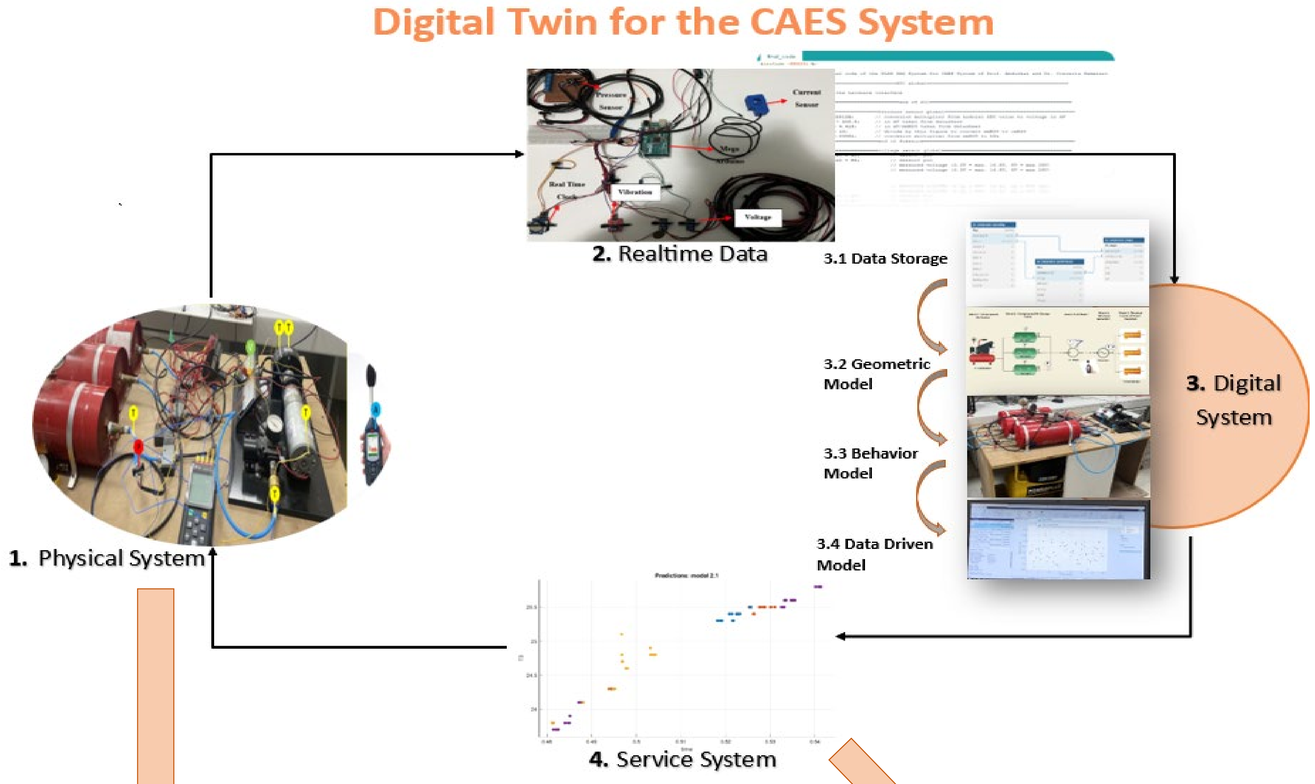
We aim to create a digital twin on the CAES system.

- A digital twin is *"A set of adaptive models that emulate the behavior of a physical system in a virtual system getting real time data to update itself along its life cycle. The digital twin replicates the physical system to predict failures and opportunities for changing, to prescribe real time actions for optimizing and/or mitigating unexpected events observing and evaluating the operating profile system"* (Semeraro et al. 2020).

## CASE STUDY AND RESULTS

1) Supervised classification machine learning technique was utilized specifically Bagged trees algorithm.
2) The accuracy of the predictive model trained is 99.7%.
3) Model was able to predict F1, F2, and F3.
4) Applying digital twin on CAES system increases productivity and reduces maintenance cost.

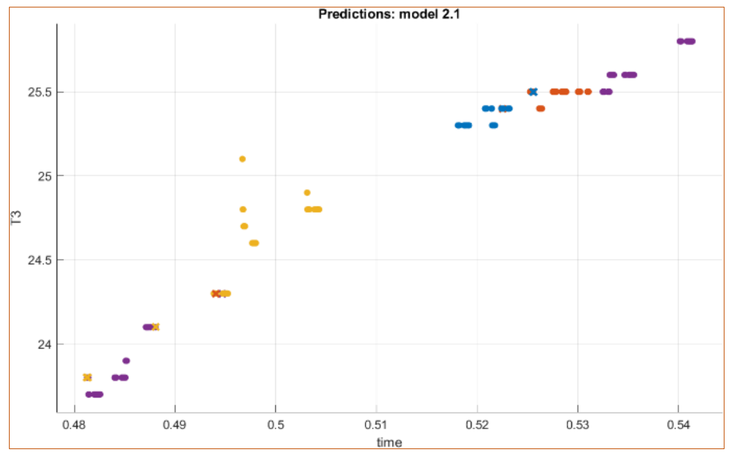
### Digital Twin for the CAES System




| Day | Date | Time | Status | AI generated |
|---|---|---|---|---|
| Tuesday | 18.04.2023 | 11:42:20 | HS | HS |
| Tuesday | 18.04.2023 | 11:42:22 | HS | HS |
| Tuesday | 18.04.2023 | 11:42:25 | HS | HS |
| Tuesday | 18.04.2023 | 11:55:44 | F3 | F3 |
| Tuesday | 18.04.2023 | 11:55:46 | F3 | F1 |
| Tuesday | 18.04.2023 | 11:55:49 | F3 | F3 |
| Tuesday | 18.04.2023 | 11:55:51 | F3 | F1 |
| Tuesday | 18.04.2023 | 11:55:53 | F3 | F3 |
| Tuesday | 18.04.2023 | 12:32:37 | F1 | F1 |
| Tuesday | 18.04.2023 | 12:32:42 | F1 | F1 |
| Tuesday | 18.04.2023 | 12:32:45 | F1 | F1 |
| Tuesday | 18.04.2023 | 12:37:11 | F2 | F2 |
| Tuesday | 18.04.2023 | 12:37:14 | F2 | F2 |
| Tuesday | 18.04.2023 | 12:37:16 | F2 | F2 |

*The table below shows the actual status of the system vs what the algorithm gave as a response.*

### Digital Twin Service




*The graph shows, Temperature of Generator vs Time Two symbols were used, the small circle denotes a correct prediction, and the x denotes a wrong prediction. In addition, four different colors were used to distinguish each class: purple for the healthy state (HS), yellow for the leak fault (F1), blue for the coupling fault (F2), and red for the high load fault (F3). Data can be easily visualized in two dimensions using scatter plots, where the y-axis is dependent on the parameter of interest and the x-axis is time, as shown.*

## DISCUSSIONS

- Based on the results, the technique of the bagged tree that we employed in this project is a suitable approach for a particular problem of supervised classification in machine learning. This algorithm, which is a sort of decision tree algorithm, was created or employed using the data from the system we obtained throughout the experiment. It uses bootstrapping to generate multiple decision trees from the original dataset. Furthermore, it offers a more precise and trustworthy prediction for classification tasks.
- It is essential to set up cybersecurity systems to defend against potential dangers and guarantee the safety and security of the digital twin and the data it produces during the development and deployment stages.
- Operators of Compressed Air Energy Storage (CAES) systems can better understand the behavior of the system and enhance its performance, which boosts productivity.
- A digital twin spot possible maintenance issues before they happen on visually, enabling predictive maintenance
- Four separate classes were found by using MATLAB's classification technique to create predictions: Healthy State (HS), Leak Fault (F1), Coupling Fault (F2), and Load Fault (F3).

## CONCLUSION

The creation and implementation of predictive maintenance by a digital twin on a CAES system to find faults by collecting readings at various times and dates. In order to make predictions, Supervised Machine Learning was applied using the classification algorithm in MATLAB, after the system had been trained to divide data into four groups. The system's predicted outcomes have a 99.7% accuracy rate. If further study needs to be done on this case, it is advised to train the model to identify the precise location of the fault.

## ACKNOWLEDGEMENT & REFERENCES

All praise and honor are due to Allah (Subhanahu Wa Taala), who blessed us with the patience and courage necessary to continue with this research and made us reach the situation we are in. Our supervisor, Dr. Concetta, is deeply appreciated for her efforts, leadership, inspiration, support, and help in any circumstance. We would especially like to thank Professor Abdul Hai Al-Alami, Engineer Mohammed Siraj Eddin Shikhli, and Engineer Rahsid Ahmed Alrashid. Nevertheless, we would never forget our department, IEEM, or any of the faculty members who taught us the various courses that gave us the knowledge we hold today. Special thanks to the SREE labs. We are extremely grateful to our families and friends for always believing in us and helping us succeed through various means.

References:

C. Semeraro, M. Lezoche, H. Panetto, E.M. Dassisti, Digital twin paradigm: a systematic literature review, Comput. Ind. 130 (2021), 103469.

# Reducing Patient Waiting time in the University Hospital of Sharjah Pharmacy

Students: Shouq E. Mohammed Alabdan Alshamsi | Nouf M. H H S Alotaibi | Shaikha K. Nasser Khamis Alsuwaidi | Aisha S. Salim Khalfan Alhashmi

Supervisor: Dr. Ridvan Aydin

## Introduction:

This study aims to identify the root causes of high waiting times in the pharmacy of the University Hospital of Sharjah, focusing on critical factors such as prescription, processing, payment process, and insurance approval. Arena software will be used to develop a simulation model to examine the current situation of the processes and waiting times based on collected data. After identifying the root causes, three alternative solutions are proposed and analyzed using simulation modeling to determine their effectiveness. The study concludes by recommending the most effective solution for reducing out-patient waiting time and improving pharmacy overall service efficiency.

# Reducing Patient Waiting time in the University Hospital of Sharjah Pharmacy

***Student Names & IDs: U18101143-Shoug Alshamsi, U18102511-Nouf Alotaibi, U18102597-Aisha Alhashmi, U19103526-Shaikha Alsuwaidi***
***Supervised by: Dr. Ridvan Aydin***

## INTRODUCTION

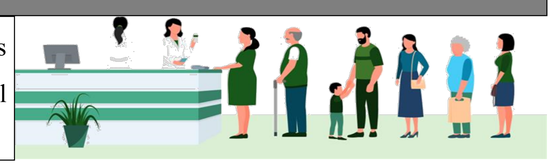
This study aims to identify the root causes of high waiting times in the pharmacy of the University Hospital of Sharjah, focusing on critical factors such as prescription, processing, payment process, and insurance approval. Arena software will be used to develop a simulation model to examine the current situation of the processes and waiting times based on collected data. After identifying the root causes, three alternative solutions are proposed and analyzed using simulation modeling to determine their effectiveness. The study concludes by recommending the most effective solution for reducing outpatient waiting time and improving pharmacy overall service efficiency.

## BACKGROUND

Long patient waiting times negatively affect the quality of healthcare services provided by pharmacies. To improve patient satisfaction and ensure the safe and effective delivery of healthcare services, pharmacies should prioritize reducing patient waiting times. This can be achieved through the implementation of effective strategies to manage waiting times and optimize pharmacy operations. The extended waiting time at the University Hospital of Sharjah pharmacy has had a significant negative impact on patient's satisfaction, resulting in complaints and a shift towards alternative pharmacies. This situation has the potential to cause significant consequences. Reducing waiting time can improve the pharmacy's performance. Simulation modeling can be used to identify areas for improvement in the system. By building a simulation model that illustrates the current process, including customer arrival, waiting time, service time, and departure time, the hospital can better understand the situation and identify areas for improvement. The report will investigate and discuss the current inadequate situation of the University Hospital of Sharjah pharmacy. It emphasizes the need to take a critical and close look at this matter and highlights the importance of taking steps to solve it.

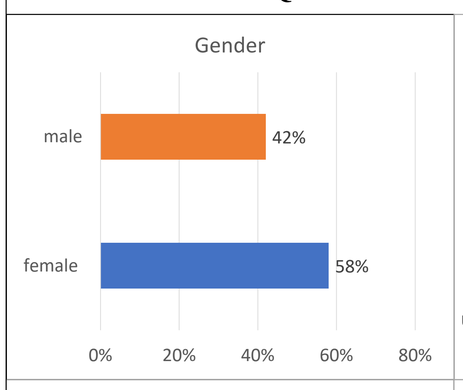
## PROBLEM STATEMENT

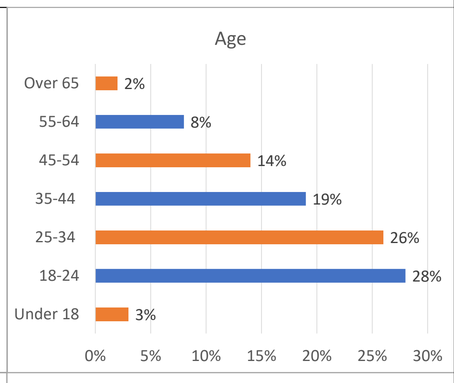
In the University Hospital of Sharjah Pharmacy the extended waiting time played a huge role in affecting the consumers satisfaction negatively. An immense number of customers will decrease, affecting the profitability rates. The hospitals reputation is very likely to get affected on a big scale, the experience undergone will affect how people view the hospital which will affect the quality of patient care.

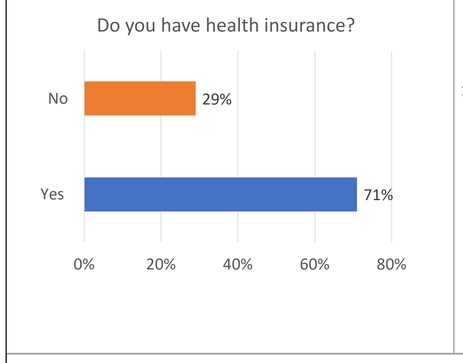


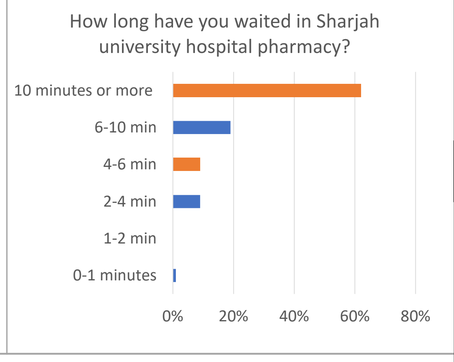
## METHODOLOGY

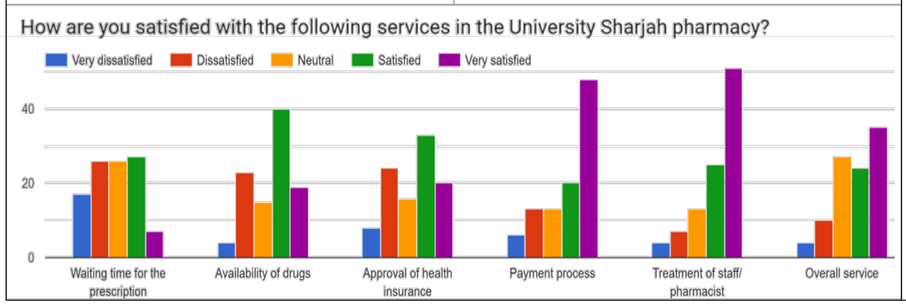
### Questionnaire Development



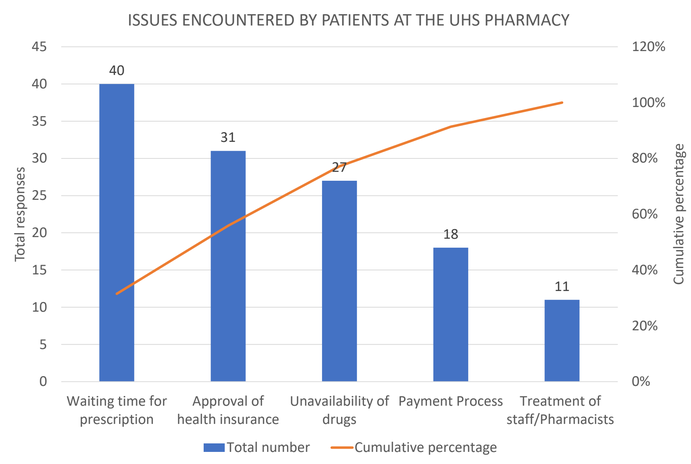



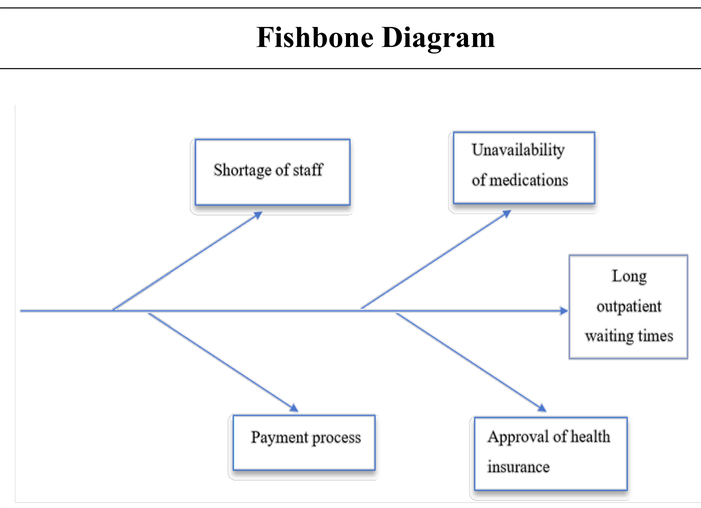




### Pareto Chart




### Fishbone Diagram




### Simulation Modelling

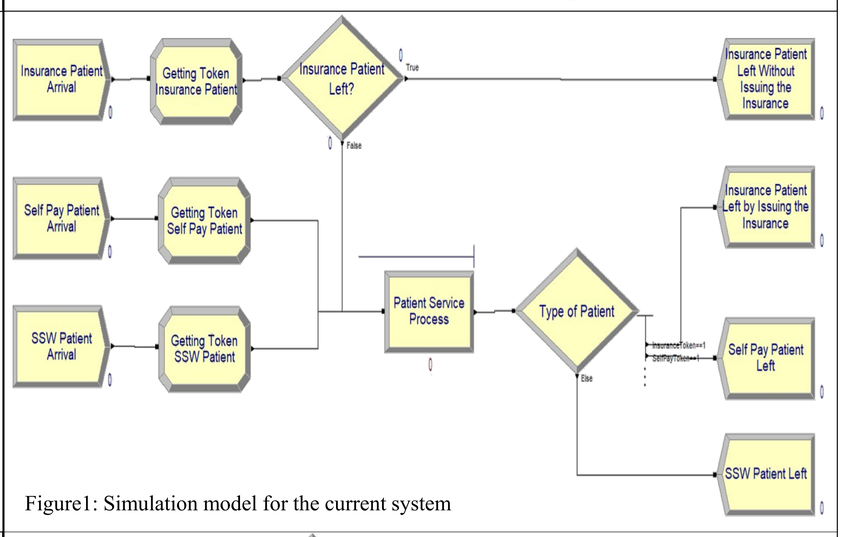



Figure1: Simulation model for the current system

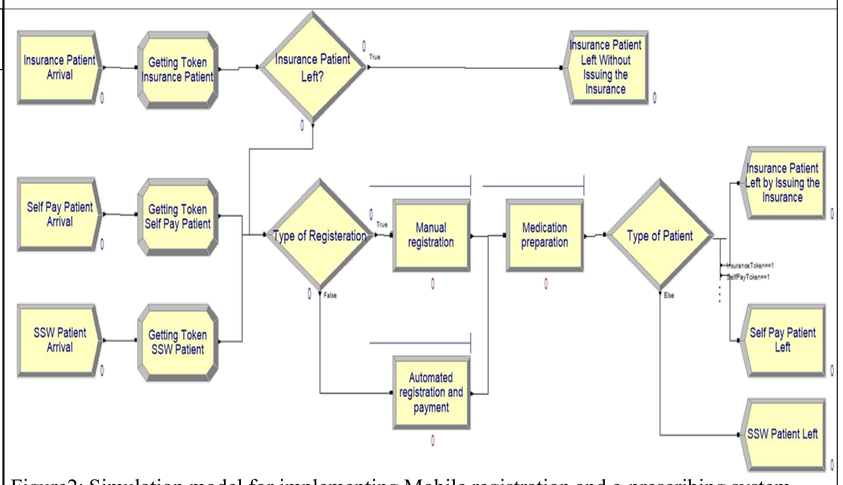



Figure2: Simulation model for implementing Mobile registration and e-prescribing system.

## RESULTS AND DISCUSSIONS

- All three simulation models were generated with a replication length of 12 hours, which is the number of hours the pharmacy operates in a day. The models were run for 2 replications to test their validity.
- According to the results, the current situation does need improvement.
- All of the alternative solutions showed major system enhancements.
- The study found the Mobile Registration and E-Prescribing System as the most effective solution for reducing patient waiting time since the main goal is reducing the total waiting time.
- The implementation of the best alternative solution requires high initial costs for the creation of an automated system, as well as some costs related to maintenance and information technology services, however, the number of pharmacists will decrease by 1.

Table1: Comparison table that summarizes the results of all simulation models

| System | Waiting Time (minutes) | Serving Time (minutes) | Total Time (minutes) | % Reduction in total service time | Average number of pharmacists | Number Waiting | Scheduled Utilization |
|---|---|---|---|---|---|---|---|
| **Current** | 15.92 | 5.50 | 21.42 | NA | 5.16 | 15 patients | Pharmacy counters: 93% |
| **Additional counters** | 1.96 | 5.73 | 7.70 | 64% | 8.33 | 1 to 2 patients | Pharmacy counters: 64% |
| **Job specialization** | 1.47 | 3.84 | 5.31 | 75% | 5.16 | 0 to 1 patients | Pharmacy counters: 74% Registration and Payment counters: 56% |
| **Mobile registration and e-prescribing system** | 1.66 | 3.46 | 5.12 | 76% | 4.58 | 0 to 2 patients | Manual Registration counters: 42% Patient Service counters: 70% |

## CONCLUSION

To conclude, it was noted in this study that the prolonged patient waiting time was the cause of customer dissatisfaction in UHS pharmacy. To improve customer satisfaction, focus should be given to eliminating factors that cause inefficiency and lower satisfaction levels. Various tools were used in the study, including a questionnaire, pareto chart, fishbone diagram, and simulation modeling. The proposed solutions, adding counters, job specialization, and automation, were found to improve the system and reduce patient waiting time, leading to higher satisfaction levels and streamlined processes.

## ACKNOWLEDGEMENT

We would like to thank the University of Sharjah, our families, colleagues, and friends for their continuous support during this project. Special thanks to our research supervisor, Dr. Ridvan Aydin, for inspiring us to focus on project management. We are grateful to the University Hospital of Sharjah (UHS) for providing us with valuable data, and to everyone who assisted us in completing this project successfully.

# Application of Machine Learning Techniques on Fuel Cell System for Performance Enhancement

Students: Abdulla A. Mohamed Alshebani | Marawan A. Mohamed Ahmed | Abdallah Atoui | Mohammed Sami M. Ghebeh

Supervisor: Dr. Concetta Semeraro

Abstract:

The progress of technology and the development of Industry 4.0 increased the chances of improving machinery performance to achieve high production rates with minimal operating costs. In particular, Machine learning techniques became a primary way to achieve this. This project focuses on measuring multiple parameters of a fuel cell system in order to predict the failure which leads to improvement in the overall performance using MACHINE LEARNING (ML) techniques. The use of ML techniques during the design phase can help in preventing possible failures and impose corrective actions by obtaining aggregated data from different sources. The project follows some engineering software and simulation tools to enhance the fuel cell performance.

# Application of Machine Learning Techniques on Fuel Cell System for Performance Enhancement

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## ABSTRACT

The progress of technology and the development of Industry 4.0 increased the chances of improving machinery performance to achieve high production rates with minimal operating cost. In particular, Machine learning techniques became a primary way to achieve this. **This project focuses on measuring multiple parameters of a fuel cell system in order to predict the failure which leads to improvement in the overall performance using MACHINE LEARNING (ML) techniques .** The use of ML techniques during the design phase can help in preventing possible failures and impose corrective actions by obtaining aggregated data from different sources. The project follows some engineering software and simulation tools to enhance the fuel cell performance.

## BACKGROUND

Managing manufacturing systems increased in complexity due to demand fluctuation along with the requirements of high product quality, low cost, short lead-time and high customization.

- Advancement of new information technology is crucial for interaction and merging of real and virtual spaces.
- This creates opportunities for enhancing technologies and organizational circumstances in design, production, and service industries.
- Cyber physical systems" use advanced control and embedded software systems for enhanced human-machine interaction.
- Products and means of production get networked and can communicate, enabling new ways of production, value creation, and real-time optimization.

The ML techniques in the design stage can help designers to configure and validate more quickly the future scenarios to predict possible failures and prescribe corrective actions.

## OBJECTIVES

1) Predict the degradation of fuel cells and take proactive measures to prevent it.
2) Reduce the cost of fuel cells and make them more competitive with traditional energy sources.
3) Utilizing ML techniques to provide insights into the performance and behavior of PEMFC that are unknown.

## DISCUSSION

We discovered there was a rise in pressure (P2) and a fall in temperature (T8), caused by heat loss.

- A model-based approach was used to understand the system.
- Unsupervised Machine Learning technique showed inverse correlation between Pressure (P2) and Temperature (T8) due to heat loss.
- Supervised Machine Learning technique Pressure was used to predict the Pressure (P2) in order to prevent heat loss (T8).
- SolidWorks was used to refine the fuel cell design.

## METHODOLOGY

1.Apply model-based technique → 2.Data storage (SQL) → 3.Apply unsupervised machine learning → 4.Validate the outcomes → 5.Apply supervised machine learning → 6.CAD & Simulation models

## EXPERIMENTAL SETUP

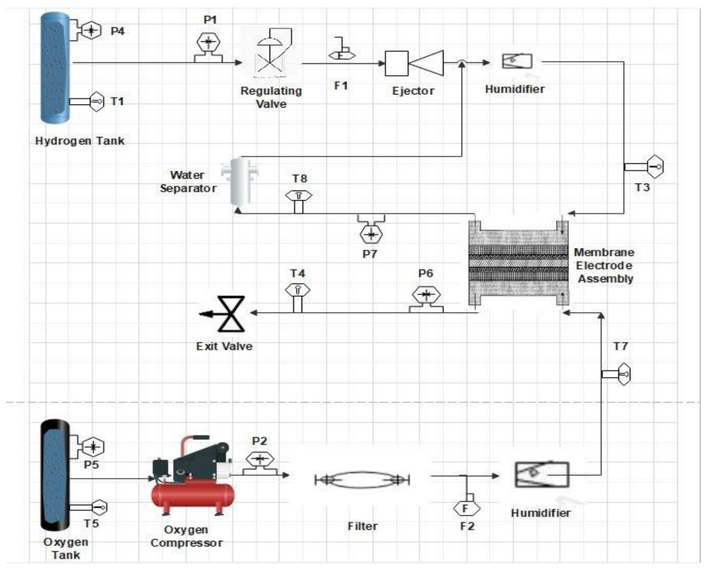
Real data from experiments using a 50 $cm_2$ polymer electrolyte membrane (PEM) fuel cell is included in the dataset. The raw data file is organized in a way that there is one raw datum for each clock time, where the acquisition time was 1 s. All attributes recorded during the experiment are presented in columns and the locations of the different instrumentation are shown in the system model .

Later on, we shrinked the attributes (parameters) based on their presence in the system model. To determine the accuracy (how close the value is to the ideal value), we divided each attribute range into 5 intervals. This will help to spot the data value in one of the intervals and accordingly its status will be defined; ideal, warning zone, or danger zone.

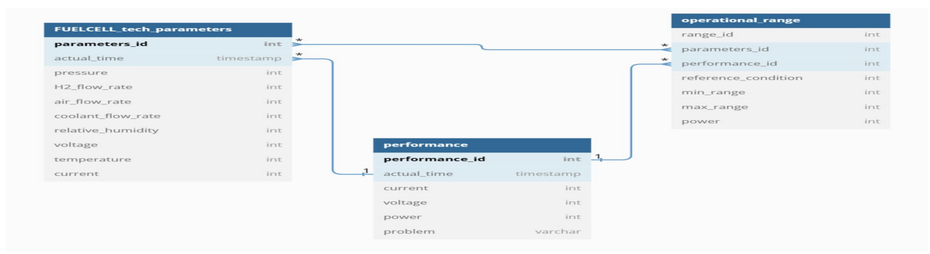
P2.1 P2.2 P2.3 P2.4 P2.5

## CASE STUDY AND RESULTS

### 1. PEMFC System Model



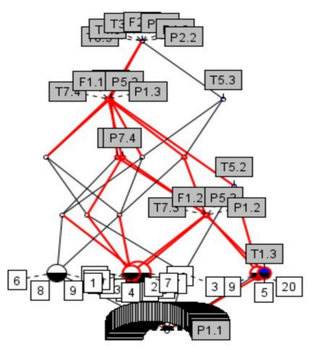

### 2. System Modelling (ER Model)




### 2. Knowledge Structure

| Object | Attributes | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Time | Pressure1.1 | Pressure1.2 | Pressure1.3 | Pressure1.4 | Pressure1.5 | Pressure2.1 | Pressure2.2 | Pressure2.3 | Pressure2.4 | Pressure2.5 | ... |
| Time1 | . | . | X | . | . | . | X | . | . | . | |
| Time2 | . | X | . | . | . | . | . | X | . | . | |
| Time3 | . | . | X | . | . | . | X | . | . | . | |
| Time4 | . | X | . | . | . | . | X | . | . | . | |

### 3. Design Pattern (Unsupervised Machine Learning) and Association rules




- < 5 > P1.2 P2.3 P4.3 P6.4 T5.3 T7.3 =[100%]=> < 5 > P5.4 P7.3 F1.2 F2.2 T1.2 T3.3 T4.4
- P2.3 P4.3 P6.4 F1.2 T7.3 =[100%]=> < 15 > P7.3 F2.2 T1.2 T3.3 T8.3;
- P2.3 P4.3 P6.4 F2.2 T7.3 =[100%]=> < 15 > P7.3 F1.2 T1.2 T3.3 T8.3;
- P2.3 P4.3 P6.4 T5.2 T7.3 =[100%]=> < 12 > P2.2 P5.3 P7.3 F1.2 F2.2 T1.2 T3.3 T8.3;
- P2.3 P4.3 P6.4 F1.1 =[100%]=> < 12 > F2.2 T3.3 T8.3;
- P2.3 P4.3 P5.4 P6.4 T5.3 T7.3 =[100%]=> < 11 > P7.3 F1.2 F2.2 T1.2 T4.4 T8.3;
- P2.3 P4.3 P6.4 P7.4 T5.3 T7.3 =[100%]=> < 8 > P5.3 F1.1 T3.3 T4.4 T8.3;
- P2.3 P4.3 P6.4 F2.2 T5.3 T7.3 =[100%]=> < 16 > T4.4 T8.3;
- P2.3 P4.3 P6.4 T1.2 T4.4 T5.3 T7.3 =[100%]=> < 18 > T8.3;
- P1.1 P4.3 P6.4 =[100%]=> < 7 > P2.1 P5.5 P7.4 F1.5 F2.5 T3.2 T4.4 T7.3 T8.4;
- P1.2 P2.3 P4.3 P6.4 T4.4 T5.3 T7.3 =[100%]=> < 10 > T8.4;
- P2.3 P4.3 P5.4 P6.4 T4.4 T5.3 T7.3 =[100%]=> < 7 > P1.2 F2.4 T8.4;
- P2.3 P4.3 P6.4 P7.3 T1.1 T5.3 T7.3 =[100%]=> < 10 > P1.3 P5.3 F1.2 F2.3 T3.3 T8.4;
- P2.3 P4.3 P6.4 P7.3 T3.2 T5.3 T7.3 =[100%]=> < 11 > P1.2 P5.4 F1.4 F2.4 T1.2 T8.4;
- P2.3 P4.3 P6.4 P7.3 T4.4 T5.3 T7.3 =[100%]=> < 30> T8.4;
- P2.3 P4.3 P6.4 F1.2 T4.4 T5.3 T7.3 =[100%]=> < 2 1> P1.3 P5.3 F2.3 T1.1 T3.3

- 2.2 P4.3 P6.4 T1.1 T4.4 T5.3 T7.3 =[100%]=> < 3 > T3.3 T8.4;
- 2.2 P4.3 P6.4 T1.2 T3.2 T5.3 T7.3 =[100%]=> < 3 > P1.2 F1.4 T4.4 T8.4;
- 2.2 P4.3 P6.4 T3.2 T4.4 T5.3 T7.3 =[100%]=> < 3 > P1.2 F1.4 T1.2 T8.4;

**IF<15>P2.3, P4.3, P6.4, F1.2, T7.3 =[100%] THEN => < 15 > P7.3, F2.2, T1.2, T3.3, T8.3;**

- IF THE PRESSURE (P2) INCREASES, THE TEMPERATURE (T8) DECREASES.
- IF THE PRESSURE (P2) INCREASES, THIS LEADS TO THE HEAT LOSS (T8) IN THE FUEL SYSTEM.
- ***What does it mean? Predicting the Pressure (P2) will prevent the Heat Loss Problem (T8).***

### 5. Pressure Prediction (Supervised Machine Learning)

```
Command Window
  To make predictions on a new table, T:
    yfit = trainedModel.predictFcn(T)
  For more information, see How to predict using an exported model.
  >> yfit = trainedModel.predictFcn(M2)

  yfit =

       3.2659
       3.2671
       3.2650
       3.2671
       3.2635
       3.2635
       3.2635
       3.2635
       3.2635
       3.2635
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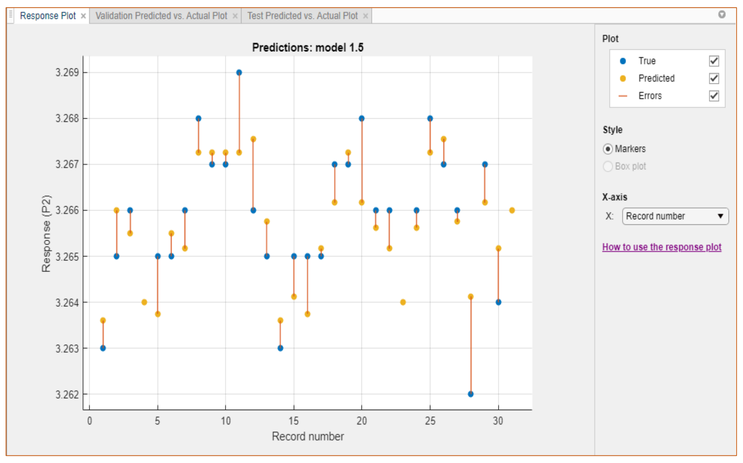
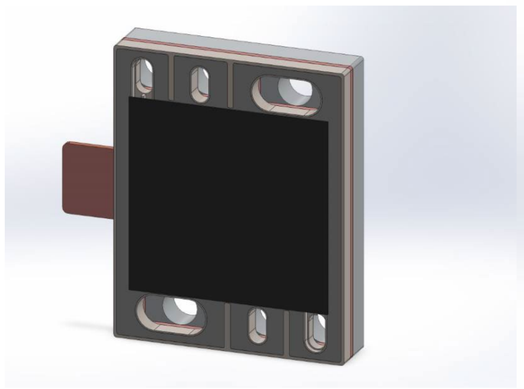
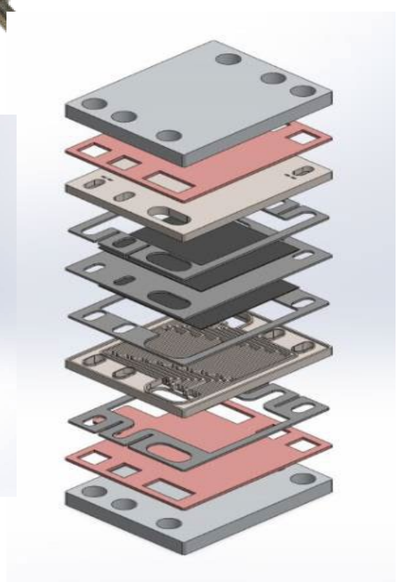
       3.2635
       3.2635
```




### 6. CAD Model



## ACKNOWLEDGEMENT

We extend our sincere thanks to God who brightened our way throughout this project, Dr. Concetta Semeraro who transferred her knowledge to us during the past few years and families for their unwavering support throughout this project.

# Implementation of Lean Six Sigma in Manufacturing Company

Students: Saleh H. Abdulaziz M.A.Rahim Alawadhi | Saeed A. Saeed Rashed Alhassani | Ahmad M. Shafiq Mustafa | Abdelhalim B. Abdelhalim Mohamed

Supervisor: Dr. Malek Masmoudi

## Introduction:

The purpose of this project is to study and improve a paper products process in the paper industry by applying Lean Six Sigma (LSS). LSS aims to produce high quality products through continuous improvement to meet or exceed customer requirements. This report reviews the various products of the selected company, as well as gathers one-year data of the defects, then implementation of the Pareto chart to determine which products have the most defects by using the 80/20 rule. Then, detailed kinds of literature on the application of the LSS in manufacturing and service organizations are reviewed to gather clear knowledge about the process improvement approach. Finally, DMAIC (Define-Measure-Analyze-Improve-Control) approach is proposed to identify the root causes of the excessive defects and variations to further improve the process. As a result of LSS implementation, the DPMO decreased from 112,000 to 26,000, the Sigma level increased from 2.75 to 3.45, and OEE increased from 56.28% to 76.45%.

# Implementation of Lean Six Sigma in a Manufacturing Sector Company

Group Code: 22F07
Student Names and IDs: Abdelhalim Bahaaeldin - U18100079, Saleh Alawadhi - U19101590, Ahmad Shafiq - U18100815, Saeed Alhassani - U18100181
*Supervisor(s): Dr. Malek Masmoudi*

## INTRODUCTION

The purpose of this project is to study and improve a paper products process in the paper industry by applying Lean Six Sigma (LSS). LSS aims to produce high quality products through continuous improvement to meet or exceed customer requirements. This report reviews the various products of the selected company, as well as gathers one-year data of the defects, then implementation of the Pareto chart to determine which products have the most defects by using the 80/20 rule. Then, detailed kinds of literature on the application of the LSS in manufacturing and service organizations are reviewed to gather clear knowledge about the process improvement approach. Finally, DMAIC (Define-Measure-Analyze-Improve-Control) approach is proposed to identify the root causes of the excessive defects and variations to further improve the process. As a result of LSS implementation, the DPMO decreased from 112,000 to 26,000, the Sigma level increased from 2.75 to 3.45, and OEE increased from 56.28% to 76.45%.

## BACKGROUND

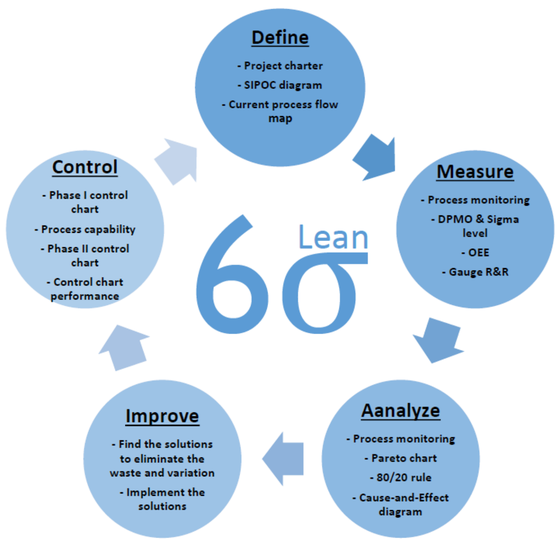
Lean Six Sigma (LSS) is a process improvement methodology, that has shown to be very beneficial since the 1990s. It's a combination of lean methodology and Six Sigma methodology. Lean is a methodology that aims to create value for the customers by minimizing/eliminating wastes, it means doing more with less while doing it better. The philosophy behind lean comes from the Japanese manufacturing industry in the post-World War II 1950s and 1960s by Toyota under the name Toyota Way or Toyota Production System (TPS). Lean is a methodology that focuses on providing value to the customer, eliminating wastes, continuous improvement, and reducing cycle time. Six Sigma methodology was developed by Motorola in 1987 it aims to reduce time, defects, and variability experienced by processes in an organization. Six Sigma has two major methodologists DMAIC and DMADV. DMAIC is an acronym of define, measure, analyze, improve, and control, it used when the company has to improve an existing product, process or service. While DMADV is an acronym of define, measure, analyze, design, and verify, it is used when the company has to create a new product or service from scratch, it is also called DFS or design for Six Sigma.

## CONCLUSION

In conclusion, our project aimed to address the problems faced by TESCO Industries LLC for paper products and eliminate them using the Lean Six Sigma (LSS) methodology - DMAIC approach, because we focused on improving an existing process which is the manufacturing process of paper roll products. In the define phase, we aimed to define the problem in general, define the opportunities, define the project's parameters, define the requirement expectation, and well understand the process by using the project charter, SIPOC diagram, and constructing a process flow map. In the measure phase, we aimed to measure the current process performance by using different KPIs such as DPMO and Sigma level, OEE, and Gauge R&R analysis. In the analyze phase we aimed to analyze the causes of defects and sources of variation by using the Pareto principle and Cause-and-Effect analysis. In the improve phase, we aimed to improve the process to eliminate variations, defects, and waste by using Jidoka concept. And finally, in the control phase, we aimed to monitor and control the process and sustain the improvements by using different types of Shewhart control charts.

## THEORY / METHODS

Lean Six Sigma has two major approaches: DMAIC (Define-Measure-Analyze-Improve-Control) and DMADV (Define-Measure-Analyze-Design-Verify) approaches. DMAIC approach focuses on improving an existing process, while DMADV focuses on designing a new product, service, or process. Our goal in this project is to enhance an existing process in a factory, so we will go with the DMAIC approach.



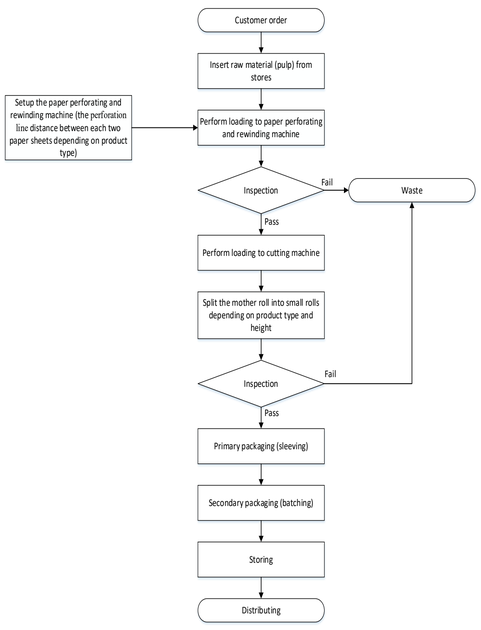

## RESULTS

### *Define*

In the define phase, we aim to define the problem in general, define the opportunities, define the project's parameters, define the requirement expectation, and define the process.

| Project Charter |
|---|
| **Business Case:** |
| This project supports the quality goals of TESCO Industries LLC for paper products, namely, improving customer satisfaction and reducing waste and the number of defective products by improving the process performance through the implementation of LSS - DMAIC approach. |
| **Opportunity Statement:** |
| An opportunity exists to close the gap between our customer expectations and our actual performance by reducing the number of defective products. There is also an opportunity for significant cost savings due to the reduction of defective products and rejected lots. |
| **Project Scope:** |
| Focusing on the most defective products which are Kitchen towel, Maxi roll, and Toilet roll sheets. |
| **Goal Statement:** |
| Reduce the overall waste, cost, and defective products to improve overall customer satisfaction and company profit. |
| **Team Members:** |
| • SDP team:<br>- Abdelhalim Bahaaeldin<br>- Saleh Husain<br>- Ahmad Muhammad<br>- Saeed Ahmed<br>• Quality engineer<br>• Shop-floor operators |
| **Project Plan:** |

| Activity: | Start Date: | End Date: |
|---|---|---|
| **Define** | 1/14 | 1/19 |
| **Measure** | 1/21 | 2/02 |
| **Analyze** | 2/04 | 2/16 |
| **Improve** | 2/18 | 3/16 |
| **Control** | 3/18 | 4/06 |




### *Measure*

In the measure phase, we aim to measure the current process performance in order to define the areas of deficiencies and specify the areas where improvement is needed.

DPMO stands for Defects Per Million Opportunities. It is a quality metric used to measure the number of defects or errors in a process per million opportunities. The opportunities refer to the number of chances for a defect to occur in a process. DPMO can be used to determine the sigma level, DPMO = 3.4 which means the process exhibits a Six Sigma level.

$$\text{DPMO} = \frac{\text{Total number of defects} \times 1{,}000{,}000}{\text{Number of units} \times \text{Nunber of defects opportonities per unit}}$$

$$\text{DPMO} = \frac{224 \times 1{,}000{,}000}{500 \times 4} = 112{,}000$$

Sigma Level = 2.75

OEE stands for Overall Equipment Effectiveness. It is a KPI used in lean manufacturing to measure the effectiveness of a production line or manufacturing process. It considers three factors: availability, performance, and quality, and provides a holistic view of the performance of the production line that is operating.

$$\text{OEE} = \text{Avilability (A)} \times \text{Performane (P)} \times \text{Quality (Q)}$$

$$\text{OEE} = 91.6\% \times 90.9\% \times 67.6\% = 56.28\%$$

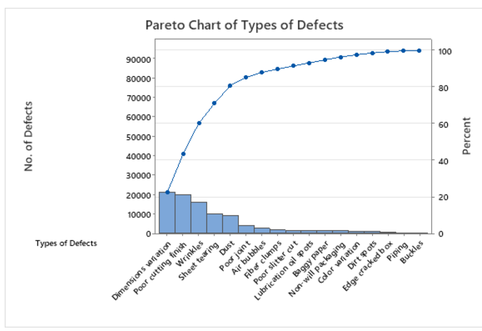
Gauge R&R is a measurement system analysis technique used to define the major source of the variability, we have three sources of variability, operator variability, quality characteristic measurement instrument variability, and production machine variability.

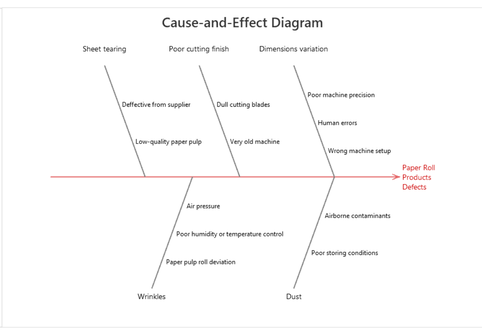
$\sigma_{\text{Repeatability}} = 1.50$ $\sigma_{\text{Reproducibility}} = 0.14$ $\sigma_{\text{Production}} = 1.82$

Based on magnitudes of these σ, we can decide that the main source of variability is production machines ($\sigma_{\text{Production}}$).

### *Analyze*

In the analyze phase, we aim to analyze the data and results obtained in the previous phases to find the causes and root causes of the problems.



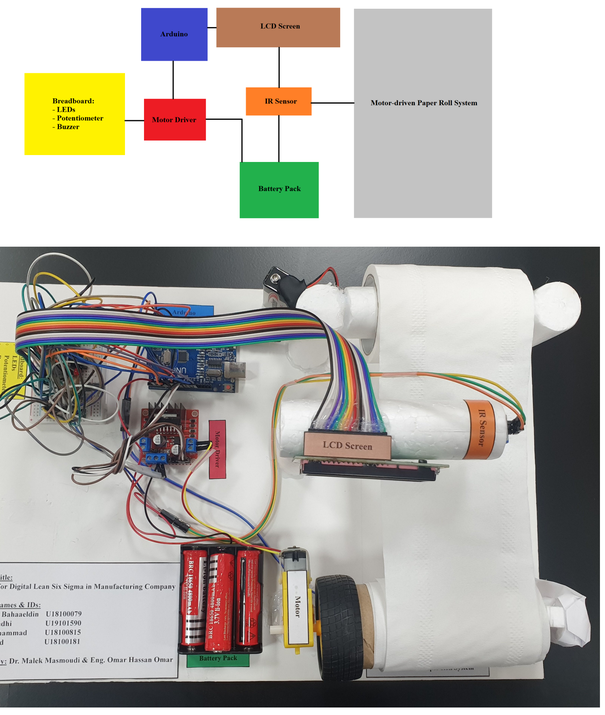

### *Improve*

In the improve phase, we aim to find the best solutions to eliminate the causes of defects, variation, and waste to improve the existing process.

The process we aim to enhance to eliminate defective products is the paper roll perforating and rewinding process.

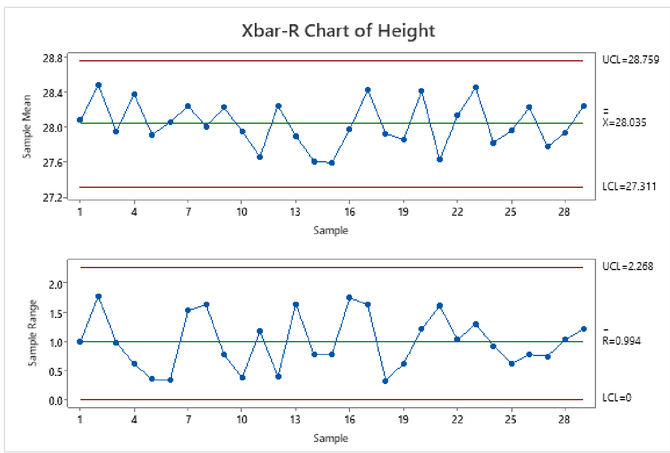
To effectively present the solution to the company. we decided to build a prototype based on Jidoka concept to present the solution to them in a practical way.

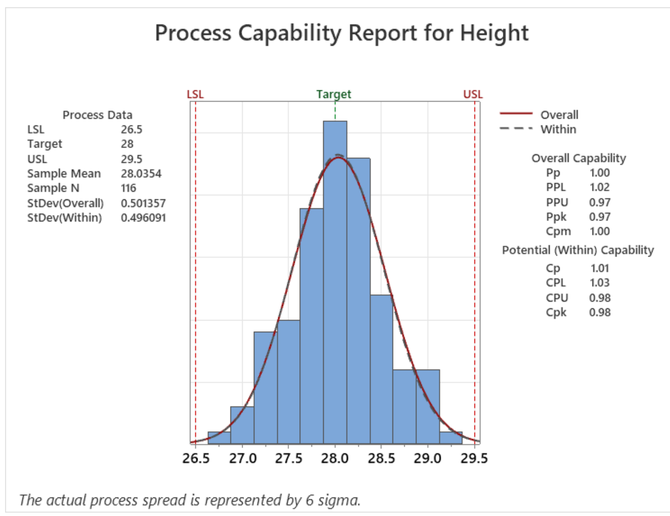
To prevent mistakes during building the solution prototype, we drew a diagram showing the location of each component in the process after enhancement.



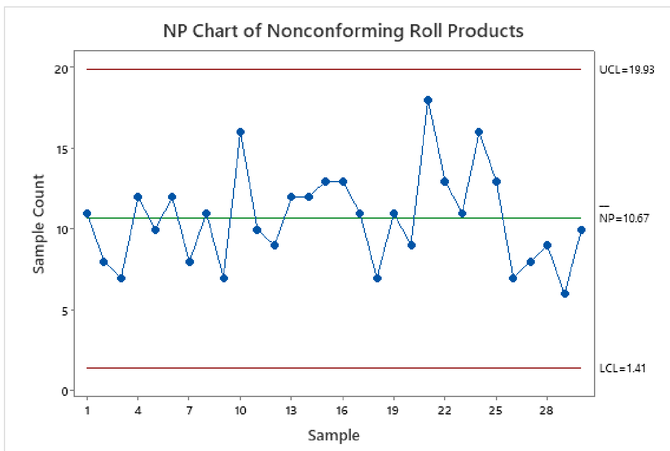

### *Control*

In the control phase, we aim to monitor and control the process and sustain the improvements accomplished through the improve phase.




*The actual process spread is represented by 6 sigma.*




| | Before LSS Implementation | After LSS Implementation |
|---|---|---|
| DPMO | 112,000 | 26,000 |
| Sigma level | 2.75 | 3.45 |
| OEE | 56.28% | 76.45% |

## ACKNOWLEDGEMENT

We would like to thank the University of Sharjah and all the faculty members in the Department of Industrial Engineering and Engineering Management for their support and for their continuous effort to always give us the best they can.

# Development of an Automated Safety Bench Press

Students: Khalid A. Salad | Anwar M. Alkhyami | Abdelaziz A. Zainal Abdelghfour Alkhaja | Humaid A. Ibrahim Abdalla Almaazmi
Supervisor: Dr. In Ju Kim

## Introduction:

The bench press exercise is a popular way to develop upper-body strength, but it also comes with inherent risks, such as the potential for injury to the neck or internal organs. While having a spotter present can improve safety, it may not always be feasible or effective.
This senior design project addresses the challenges of bench press training by developing a wearable sensor that leverages safety engineering methodologies like FTA and automation technology along side following the DMAIC cycle to develop an effective solution to the problem.
Automation aims to eliminate potential dangers associated with the exercise and create a safer lifting environment.
The project's goal is to achieve safety excellence in bench press training by using automated sensors to ensure the safety of lifters.

# Development of an Automated Safety Bench Press

Bench Press exercise injury prevention

Group Code: 22F08
By: Anwar Alkhiami, Khalid Abdi, Abdullaziz Abdulla, Humaid Abdulla
*Supervisor(s): Dr. In-Ju kim*

جامعة الشارقة
UNIVERSITY OF SHARJAH
كلية الهندسة
COLLEGE OF ENGINEERING

## INTRODUCTION

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Automation aims to eliminate potential dangers associated with the exercise and create a safer lifting environment.
The project's goal is to achieve safety excellence in bench press training by using automated sensors to ensure the safety of lifters.

## BACKGROUND

The bench press is a popular exercise that helps individuals develop upper body strength and muscle control. However, this exercise comes with inherent risks that could cause serious injury, especially if it is not performed correctly. Research has shown that up to 46% of injuries in the gym are caused by an improper bench press, highlighting the need for safety measures to reduce the risk of injury.

Fortunately, with the advancement of technology, wearable sensors have become more sophisticated and effective in mitigating safety risks in weightlifting. By leveraging safety engineering methodologies and industrial automation, a wearable sensor device can be developed to monitor bench press training, ensuring safety during the exercise.

## CONCLUSION

The team conducted research on the Bench Press exercise and concluded that it poses a significant risk to lifters, irrespective of their experience level. This finding highlights the importance of safety measures during weightlifting exercises. However, existing solutions for reducing the risk associated with the Bench Press exercise remain incomplete and inefficient. As a result, the team recommended several procedures to be followed before attempting the exercise, such as warming up, using proper weight, having a spotter, and utilizing appropriate lifting techniques. By following these recommendations, lifters can significantly reduce the risk of injuries during Bench Press exercises.

To further address the issue, the team embarked on a project aimed at creating a safety device for the Bench Press exercise. They utilized automation and the DMAIC (Define, Measure, Analyze, Improve, Control) cycle to design and test a prototype. The safety device was made using durable materials and had a secure locking mechanism to ensure stability and safety during use. The team tested the effectiveness and performance of the safety device and found that it significantly reduced the risk of injury during Bench Press exercises. The feedback from fitness experts and weightlifters was also positive, highlighting the practicality and usefulness of the safety device.

The success of the project demonstrates the need for continuous research to identify and develop solutions that promote safety during weightlifting exercises. This is especially important for popular exercises like the Bench Press, which carry a high risk of injury if not performed correctly. By investing in research and developing practical solutions, we can help ensure that weightlifting remains a safe and enjoyable activity for everyone.

Based on the findings and outcomes of the bench press safety project, several recommendations have been identified to guide future work in this area.
Recommendations:
1- Incorporate machine learning algorithms
2- Enhance user interface and feedback mechanisms
3- develop a mobile application

## AIM & OBJECTIVES

The aim of the project is to improve the safety of bench press exercise by developing an automated model that can assist the lifter in the event of a failure to lift the weight. The model will incorporate sensor technology to detect failures and trigger automated responses to ensure the safety of the lifter.

The objectives of this senior design project are to:
1. Design and develop a wearable sensor system capable of monitoring bench press exercises in real-time.
2. Integrate the sensor system with automation technology to enable automated responses in case of failure to lift the weight.
3. Conduct testing and validation of the automated model to ensure its effectiveness in improving the safety of bench press exercises.
4. Evaluate the usability, feasibility, and reliability of the automated model.


## SETUP, EXPERIMENTAL

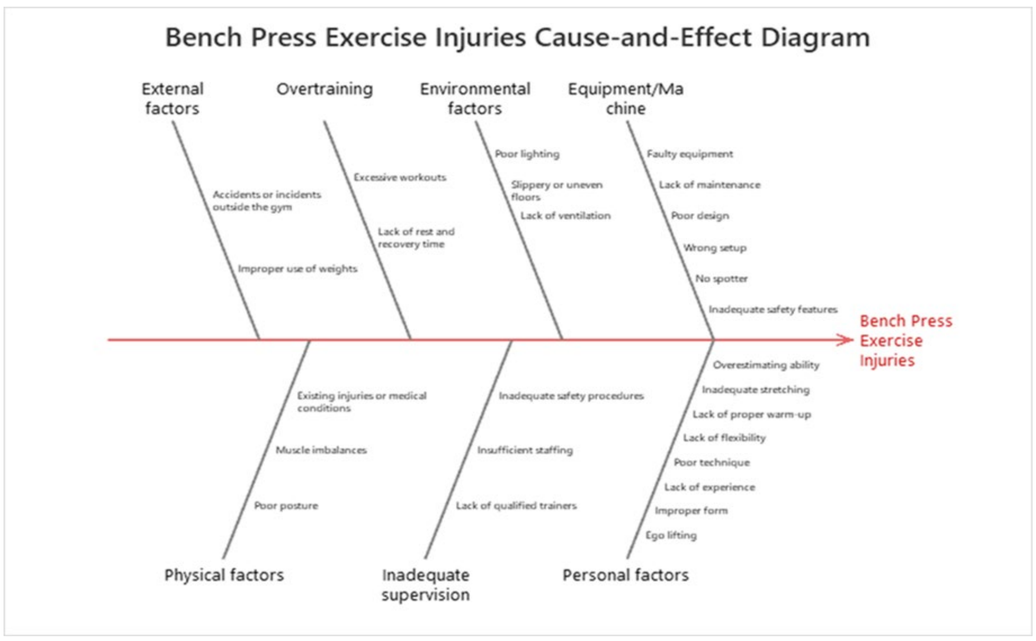
The DMAIC (Define, Measure, Analyze, Improve, and Control) cycle will guide the methodology of this project.
The Define phase: involved conducting a fault tree analysis to identify the underlying problem with the Bench Press exercise, and establish the objectives of the safety device.
the Measure phase: the team collected data on previous injuries that have occurred while performing the Bench Press exercise in gyms throughout the UAE. This data was gathered through surveys and interviews with weightlifters and gym trainers. The information will help quantify the extent of the problem and provide a foundation for further analysis.
the Analyze phase: the collected data will be analyzed to gain insights into the nature of the problem and the most effective approach to address it.
The Improve phase: involved the development of an improved Bench Press frame that incorporates automation to eliminate human error and minimize the risks of injuries.
the Control phase, the team will program the improved Bench Press solution using the C programming language. This will ensure that the safety device performs optimally.

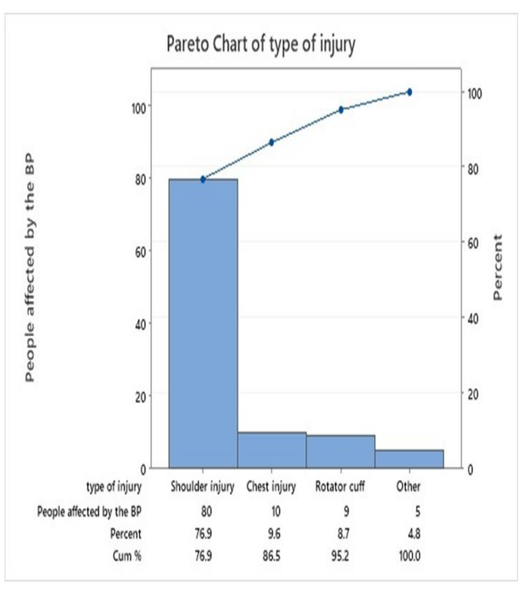
## RESULTS

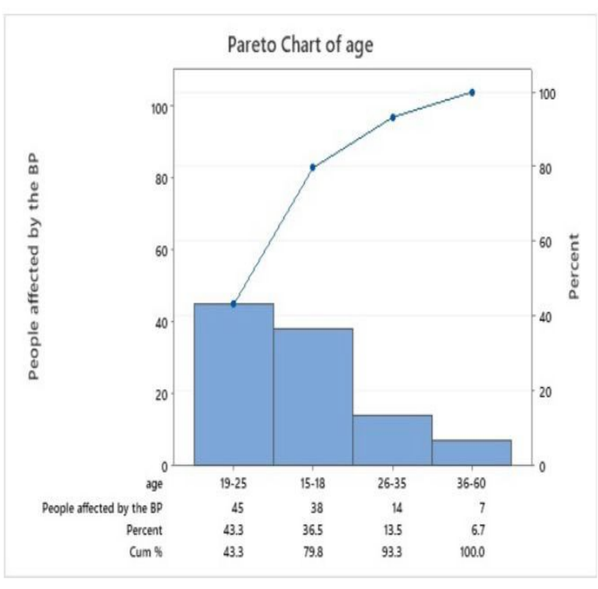
The DMAIC methodology was employed in the research project to identify the root causes and effects of injuries associated with the Bench Press exercise. The study was conducted in the UAE region, and data regarding real injuries, including age, gender, and type of injury, were analyzed. The findings of the analysis revealed a significant relationship between the age and gender of lifters and the types of injuries most commonly occurring during Bench Press exercise.

Based on these findings, an improved model of the Bench Press exercise was developed, incorporating a force sensor to detect when the barbell is stuck on the lifter, a motion sensor to detect the availability of a spotter, and an Arduino UNO R3 to send commands to two servo motors in case of any failure.

The prototype model was tested, and feedback was obtained from fitness experts through a forum to evaluate the effectiveness of the proposed solution. The results were overwhelmingly positive, indicating that the proposed safety device is practical and useful in reducing the risk of injury during Bench Press exercises. The success of this project highlights the need for continuous research and innovation to improve the safety of weightlifting exercises.




## DISCUSSIONS

- The team conducted a thorough literature review on the risks and injuries associated with the Bench Press exercise
- Various approaches had been tried to address the issue, but injuries still persisted
- The team observed that none of the studies reviewed had considered the use of automation as a solution
- The team recognized the potential benefits of using automation to reduce the risk of injuries during the Bench Press exercise
- Automated safety features could eliminate the potential for human error that often led to injuries
- The team aimed to design an automated safety sensor that would help prevent injuries during Bench Press exercises
- They utilized the DMAIC cycle (Define, Measure, Analyse, Improve, and Control) to ensure the project's success
- Through this methodology, the team identified the problem, collected data, analyzed it, and introduced automation to improve the Bench Press frame
- They then controlled the improved Bench Press solution by using programming language
- In conclusion, the team's innovative approach to incorporating automation could significantly enhance the safety of the Bench Press exercise and make it a more enjoyable experience for lifters.

## ACKNOWLEDGEMENT

The team would like to express their gratitude to their supervisor, Dr. In-ju Kim, for his continuous support and guidance throughout their Senior design project.
Also, a special thank engineer Omar Hassan Omar for providing helpful solutions and tools. The team acknowledges the contributions of the gym staff and participants who helped in the data collection process. Special thanks are given to the coaches who rated the project idea, making the project more manageable.

# Mechanical & Nuclear Energy Engineering

# Table of Content

# Solar assisted water purification system

Students: Mohd A M Zidan | Ahmad Zurgham | Muwaffaq Imran | Waleed Raed Mahmoud
Supervisor: Prof. Abdul Wahab Bin Mohammed


## Introduction:

Clean water access is a critical global issue, especially in developing nations. To address this issue, our project has developed an affordable and portable water purification system powered by solar energy. With increasing demands and rapid growth, the water crisis demands immediate attention. Our system eliminates contaminants and micro- organisms to make the water safe for consumption at a low cost. We focus on PV cells to generate electricity for water purification systems in areas with sufficient solar irradiance. Solar energy is crucial for achieving sustainable development and addressing the water crisis. Join us in our efforts to make clean water accessible to everyone.

# Solar Assisted Water Purification System

Mohd A M Zidan, Muwaffaq Imran, Ahmed Zurgham, Waleed Raed Mahmoud

*Supervised by: Prof. Abdul Wahab Bin Mohammad and Prof. Mohd Sobri Bin Takriff*

جامعة الشارقة
UNIVERSITY OF SHARJAH
كلية الهندسة
COLLEGE OF ENGINEERING

## INTRODUCTION

Clean water access is a critical global issue, especially in developing nations. To address this issue, our project has developed an affordable and portable water purification system powered by solar energy. With increasing demands and rapid growth, the water crisis demands immediate attention. Our system eliminates contaminants and micro-organisms to make the water safe for consumption at a low cost. We focus on PV cells to generate electricity for water purification systems in areas with sufficient solar irradiance. Solar energy is crucial for achieving sustainable development and addressing the water crisis. Join us in our efforts to make clean water accessible to everyone.

## BACKGROUND

Solar-assisted water purification systems use solar energy to provide eco-friendly and affordable clean water. They are especially useful in areas with limited access to safe drinking water. These systems combine solar panels and purification technologies to remove contaminants such as bacteria and chemicals. By using solar energy, they are cost-effective and sustainable, requiring no constant supply of electricity or fuel. The potential benefits of these systems include improving public health and economic development in areas with water scarcity.

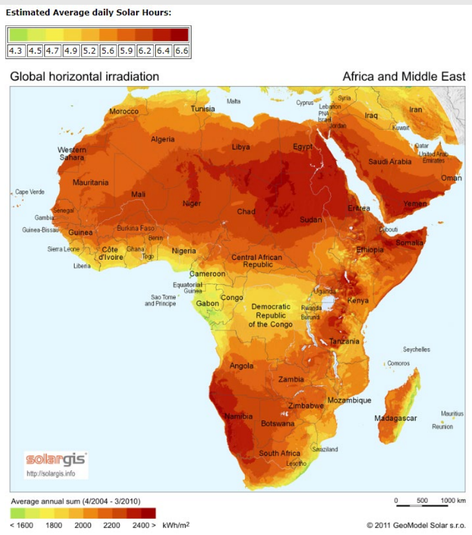



*Figure 5: shows the amount of solar radiation in Africa and the Middle East that can be utilized in a renewable way*

## CONCLUSION

A solar-powered, portable water purification system was developed through thorough analysis of purification techniques and solar panels. The resulting prototype demonstrated successful purification capabilities and energy efficiency, offering a cost-effective solution for remote areas and developing countries to access clean drinking water.

## METHODOLOGY

The project team conducted extensive research on purification systems, solar panels, and filtration systems to inform their cost-effective and efficient design. They analyzed various products on the market and made informed decisions on budgeting, materials, and components based on their criteria. The design focused on both the purification aspect and the physical outer system, with a goal of creating a portable solution.

## RESULTS

The solar-assisted water purification system successfully removed all contaminants from the contaminated tap water. The purified water had a TDS reading of 37.5 mg/L, which is well below the maximum allowable limit for drinking water. The pH, conductivity, and microbial content of the purified water were also within acceptable limits for drinking water. These results demonstrate the effectiveness of the solar-assisted water purification system in providing clean and safe drinking water.

*Figure 1: shows the solar-assisted water purification system prototype*


*Figure 2: shows the filtration system utilized in the prototype*


*Figure 3: shows the solar charge controller only using the solar panel*

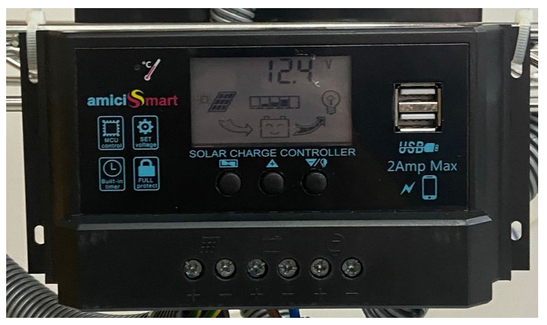



*Figure 4: shows the solar charge controller when the system is activated*

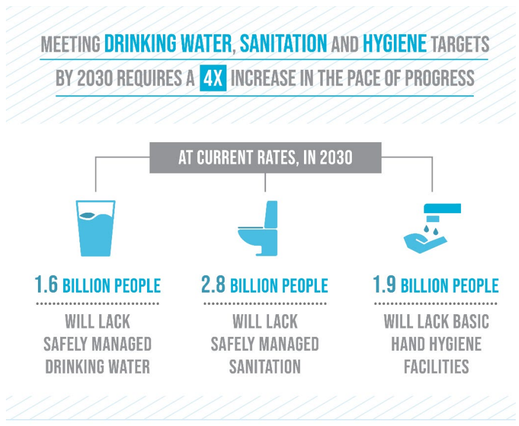



*Figure 6: shows the UN Goal 6, which is the goal to be met by this study*

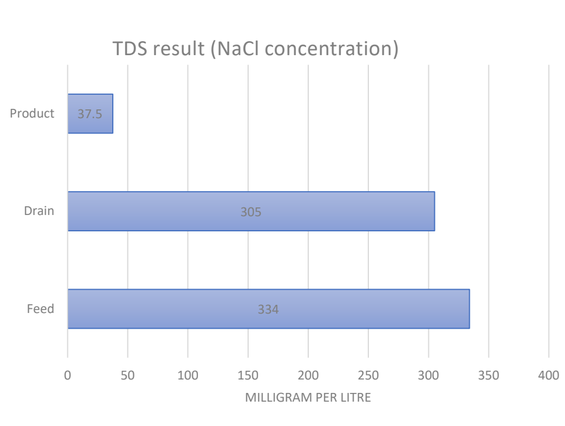



*Figure 7: shows the graph representing NaCl concentration in the water*

## EXPERIMENT

### Experimental Setup:

Samples of contaminated tap water were collected for testing with the solar-assisted water purification system, which included solar panels, a battery, a pump, a sediment filter, an activated carbon filter, a reverse osmosis membrane, and a UV light sterilizer. Purified water was tested for TDS to evaluate the system's efficacy.

### Experimental Procedure:

Tap water samples were taken and analyzed for baseline readings of TDS. The solar-assisted water purification system was set up, and the contaminated tap water was filtered and purified. The purified water was then tested for TDS The data was analyzed to evaluate the effectiveness of the system.

## DISCUSSION

Solar-assisted water purification systems are a sustainable and cost-effective solution for providing clean water to communities that lack access to it. They are powered by renewable energy, eliminating the need for costly and polluting fossil fuels. These systems are also scalable and customizable to treat a wide range of water sources. However, their effectiveness may be limited for certain contaminants or environments. Therefore, it is important to carefully evaluate the community's specific requirements before deciding on this system. Our solar assisted water purification system uses absorbed sunlight to charge energy, providing a reliable source of power even in areas with limited sunlight or frequent cloud cover.

## ACKNOWLEDGEMENT & REFERENCES

We would like to show our thanks and appreciation to **Prof. Abdul Wahab Bin Mohammad**, Dean of the College of Engineering, and **Prof. Mohd Sobri Bin Takriff**, Coordinator of the BSC of Chemical and Water Desalination, for their continuous support, motivation and encouragement, which greatly aided in the completion of this project.

# Designing a Smart Tire Changing Kit

Students: Amal Khamis Alzeyoudi | Hala Ayman Ezeldin | Nada Ayman Ahmed

Supervisor: Dr. Hussien Hussien

Introduction:

Changing a tire can be a challenging task that requires knowledge and physical effort. Incidents related to tool-related injuries have occurred frequently in the past. To address this issue, a Tire Changing Kit will be designed to make the process safer, smarter, and faster. The kit will benefit elderly and female users who may have difficulty using traditional tools. This project will focus on re-selecting existing tools and incorporating a small movable crane to lift and move tires more easily. And it will be analyzed through force, stress and fatigue analysis and the design functionality will be checked using a laser printed model.

# Designing a Tire Changing Kit

Amal Khamis Alzeyoudi, Hala Ayman Massoud, Nada Ayman Aly
*Supervised by: Dr. Hussien Ali Hussien*

جامعة الشارقة
UNIVERSITY OF SHARJAH
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COLLEGE OF ENGINEERING

## INTRODUCTION

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## BACKGROUND

Almost all the tools included in our tire changing kit have been in use for many decades, such as hydraulic jacks, wrenches, and cranes. However, our kit will modify and re-select the tools based on our users' needs, which makes them safer, more cost-effective, and requires less time and effort. To design the kit effectively, we needed to understand and perform the steps involved in changing a flat tire and replacing it with the spare tire. We noted the difficulties we faced during this process, such as the weight of the tire, the time required to jack up the car and loosen the lug nuts, and the physical effort required to perform these tasks.
Our kit will minimize and solve these difficulties by selecting a motorized jack and wrench as well as designing a portable and movable crane. Decision matrices will be created to select the jack and wrench, and the crane will be designed by measuring the tire's weight from different cars and designing it according to the maximum weight (450 N). The tire changing crane will be made of Aluminum Alloy rectangular hollow section (RHS) and will have a winch pulley system to lift the spare tire from the trunk and lower it for easy installation.

## CONCLUSION

The project aims to create a tire changing kit that is safer, less time-consuming and requires minimal effort. The kit includes a crane to lift and lower the tire, an electric hydraulic jack to lift the car and an impact wrench to loosen wheel nuts. AutoCAD and Inventor were used for the design of the model, while SAP2000, MDSolids and ANSYS were used to ensure safety by calculating factors of safety, stresses, deflections, shear force, bending moment, axial load and deflection diagrams throughout the entire crane. The design is expected to replace standard tire changing kits in the future.

## METHODOLOGY

The goal of the project is to improve the safety, ease of use, and efficiency of tire-changing tools and kits. Decision matrices were used to select Toby's kit based on its positive reviews, cost-effectiveness, high carrying capacity, and user-friendly features. Various options were evaluated for the design of the tire changing crane, including a compound pulley system and a motorized winch. Eventually, a single pulley system was selected, and AutoCAD and Inventor were used to create a 3D model with dimensions tailored to car specifications, as shown in Figure 1. The crane was designed to be lightweight and portable, consisting of three main parts: the boom with the winch pulley system, the post with the support bar, and the post-leg connection with the legs, and the cross-sectional area, length, and weight of each is shown in Table 2. To ensure the crane's safety, force analysis, stress analysis, and fatigue analysis were conducted using SAP2000, MDSolids, ANSYS, and hand calculations, with all parts requiring a factor of safety of 2 or above. An accelerometer sensor (ADXL345) was also incorporated to detect instability in the crane's motion and alert the user with a buzzer for added safety.

*Table 1: Shows cross-sectional area, length and weight of each component.*

| Name | Cross section (mm) | Length (mm) | Mass (Kg) |
|---|---|---|---|
| **Boom** | 50x40x3 | 600 | 0.92 |
| **Post** | 40x60x3 | 1000 | 1.55 |
| **Support bar** | 20x10x1.5 | 460 | 0.10 |
| **Leg** | 30x20x3 | 1000 | 0.73 |
| **Open/ close connection** | 20x3 | 195 | 0.031 |
| **Post-Leg connection part 1** | 50x70x3 | 100 | 0.34 |
| **Post -Leg connection part 2** | 10x70x3 | 130 | |

## RESULTS

To test the functionality of the crane, we printed sections of each part using a laser printer and scaled them down by 45% to identify any design issues, as shown in Figure 2. This helped in identifying instability in the post-leg connection part, which was modified before manufacturing the product at the machine shop. We also optimized the design by finding the suitable cross-section area for each part through trial and error. Additionally, the team found that Toby's kit requires less effort and time to change a tire compared to a regular kit.

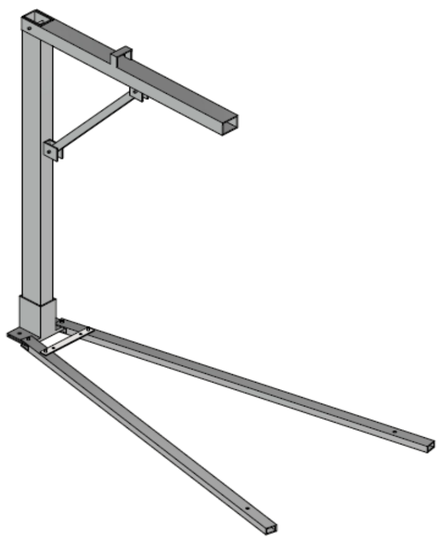

*Figure 1: Shows the tire changing crane created using Inventor*

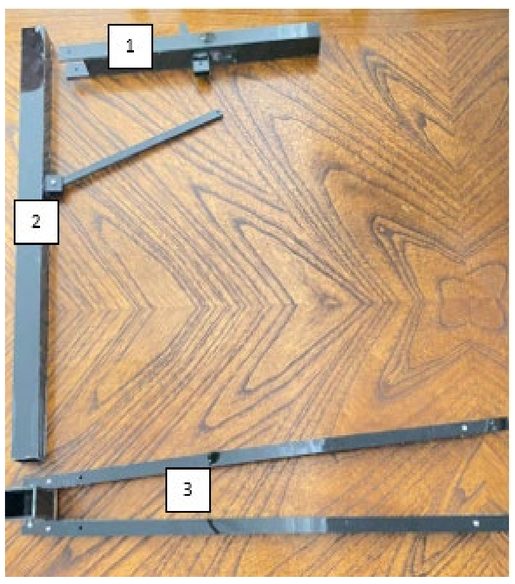


*Figure 2: Shows the tire changing crane prototype created by laser printing.*

## DISCUSSIONS

The tire changing crane has been designed to make the process of changing a tire safer and more efficient. The crane features a winch pulley block mechanism and Clevis brackets for easy assembly. The tire changing crane can fits easily into a car's trunk, as shown in Figure 3. While the scissor jack requires significant physical effort to operate, the motorized jack can be operated with a button, and the impact wrench takes only 1/3 of the time needed by the lug wrench. However, the boom's length may not be suitable for certain car models such as the Ford Edge, which has a bumper-to-cavity distance of nearly 62 cm, while the boom's length is only 60 cm. The inclusion of the accelerometer in the crane's design enhances safety by detecting instability in the rotational motion or linear acceleration of the crane and alerting the user with a buzzer.

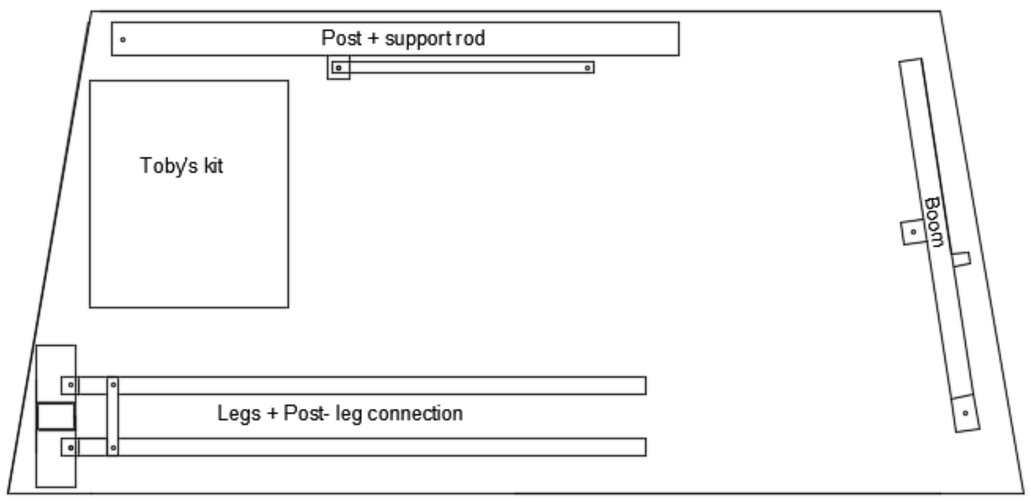


*Figure 3: Shows the tire changing kit placed in the trunk of Toyota Corolla 2016.*

## ACKNOWLEDGEMENT & REFERENCES

We would like to show our appreciation to Dr. Hussien Ali Hussien, Mechanical and Nuclear Engineering Department at the University of Sharjah for his valuable guidance and encouragement, which greatly aided in the completion of this work.

# Membrane-based Air Conditioning Using Nanofiltration Membrane

Students: Fatma Jamal Ahmad Alzeraim Alsuwaidi | Maryam Ayoub Abdelreda Refat Alzarooni | Reem Mohammed Abdullah Al-Yazidi

Supervisor: Prof. Tahar Laoui | Dr. Adewale Olalekan Giwa

## Introduction:

In our current world, pollution has caused harm to the human body and environment, Membrane technology can be used to solve such issues or to help maintain good indoor air quality. NEXAR, GO, and Pebax are the main components of the membrane we designed, its performance will be tested using MATLAB. The objective of this study is to produce cold, dry air by maximizing water recovery from hot ambient air.

# Design of a Membrane-based Air Conditioning system

Maryam Alzarooni – Reem Al Yazidi – Fatma Al Suwaidi

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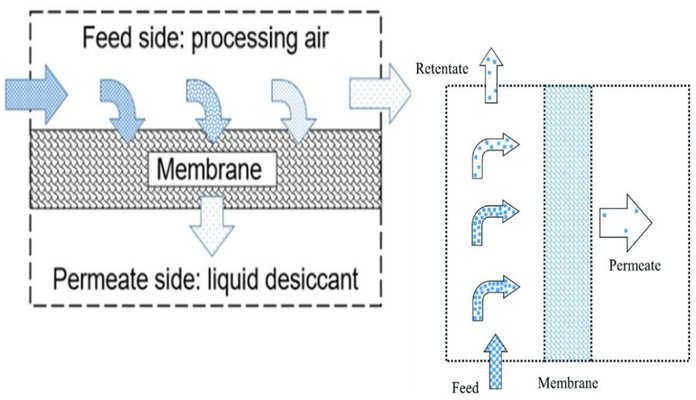
COLLEGE OF ENGINEERING

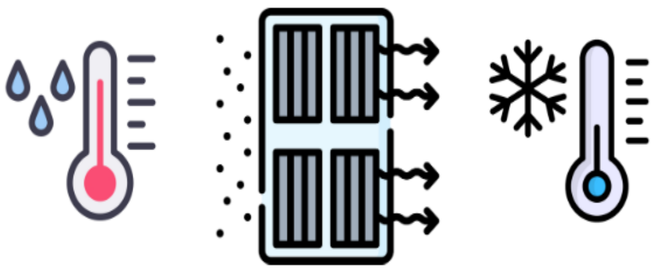
## INTRODUCTION

In our current world, pollution has caused harm to the human body and environment, Membrane technology can be used to solve such issues or to help maintain good indoor air quality. NEXAR, GO, and Pebax are the main components of the membrane we designed, its performance will be tested using MATLAB. The objective of this study is to produce cold, dry air by maximizing water recovery from hot ambient air.



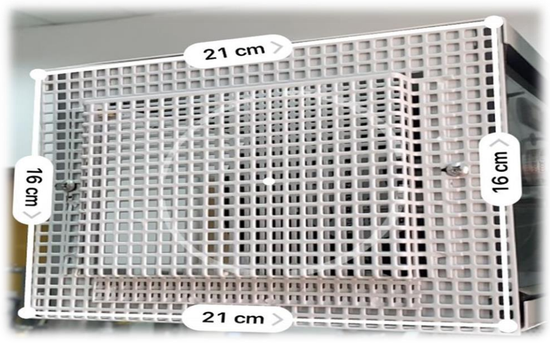

## BACKGROUND

Traditional dehumidification methods are used, but membrane-based air conditioning must be designed to create comfortable interior conditions while using little energy. In many regions around the globe, especially the middle east region, humidity, and hot climate are defined as serious problems since traditional AC systems have few side effects including high cost and many environmental effects. Evaporative cooling, membrane separation, and energy efficiency are the foundations and principles of the membrane-based AC systems.



## CONCLUSION

There are two main parts, theoretical and experimental. In the theoretical part, we analyzed the problem and designed a membrane using SOLIDWORKS with its housing, and used MATLAB to perform a simulation for some parameters. In the experimental part, we used literature reviews to settle on the best options for material selection, solution preparation, fabrication, performance testing, and characterization which will be carried out in SDP2.

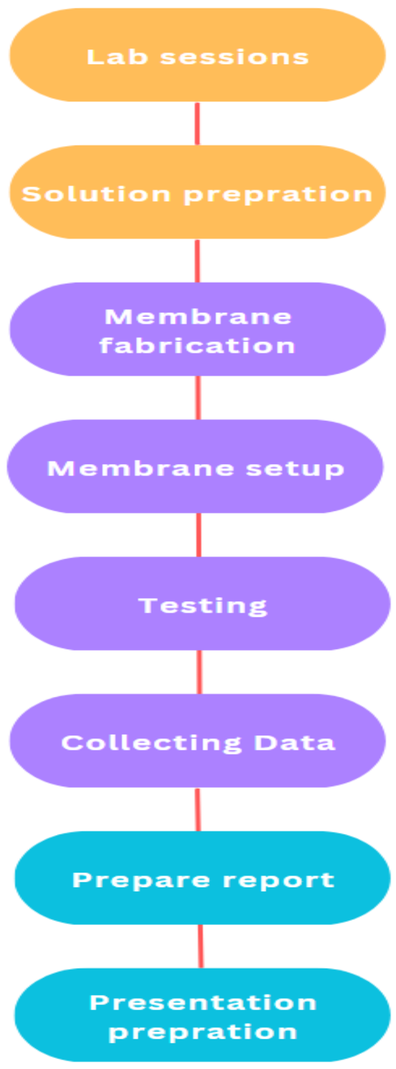



## THEORETICAL

The Theoretical design of the nanofiltrationmembrane technology starts by establishing a design criteria analysis and selecting the best design, then using SOLIDWORKS for membrane design and its housing. We used MATLAB to determine the parameters of the membrane Lastly, the obtained optimum parameters were used to calculate the mass flowrate and maximum water vapor removed.

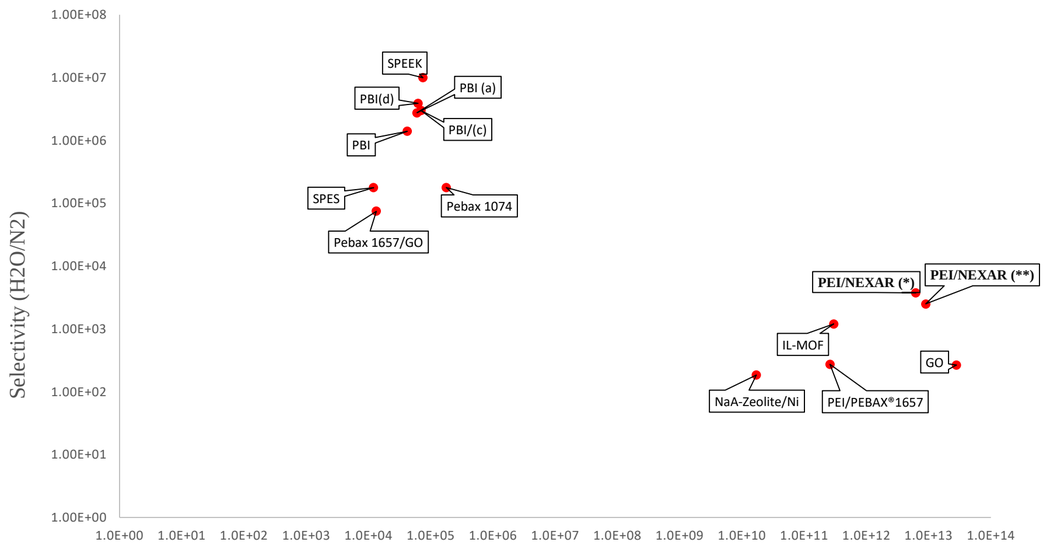
## EXPERIMENTAL

The experimental part starts with selecting the proper materials for the fabrication process. The solution preparation comes next. Then the fabrication process will be carried out using the casting method. After a careful drying process, the membrane shall be ready to use.

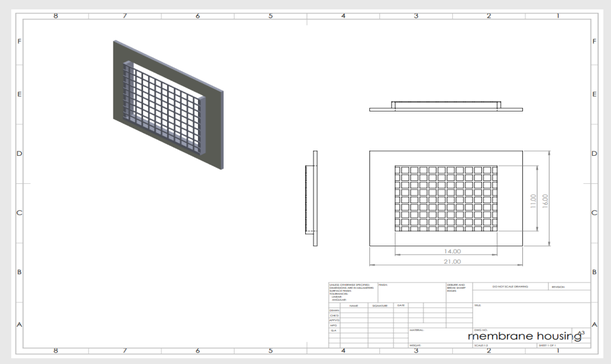



## DISCUSSIONS

Nanofiltration membrane-based AC systems utilize specialized membranes that enable the selective elimination of certain molecules from the air, thereby improving indoor air quality and lowering energy usage. These systems are extremely energy efficient, consuming up to 50% less energy than typical air conditioning systems. However, there are some drawbacks to these systems, such as the requirement for periodic membrane maintenance and the risk of fouling as well as scaling due to contaminants in the air.




## RESULTS




- The laboratory's AC unit's inlet is a rectangular duct, Since the permeance of the membrane is almost impossible to be seen with the bare eye, it has been presented by small holes through the membrane's surface. It has an opening from the top to allow insertion of the membrane. We did this analysis using SOLIDWORKS.

- By using MATLAB for modeling, we got the optimum results for each parameter and performance by selecting a range of numbers for each of the parameters. We noticed that the temperature remained constant.

```
Command Window

Optimum result value: 0.05184
Optimum factor levels: 600          0.75          0.001       1.25e-06          6e-09
Regression equation: y = 0.00 + 0.00*x1 + -0.00*x2 + -0.00*x3 + -2076.48*x4 + 2058000.00*x5
Initial mass flow rate of air: 0.0010 kg/s
Final mass flow rate of dry air: 0.9969 kg/s
Water vapor transfer rate through membrane: 0.5040 mol/s
Mass transfer rate through membrane: 0.0091 mol/s
Time for air to pass through the membrane: 7142.8571 s
Water removed from the air: 0.9979 kg
>>
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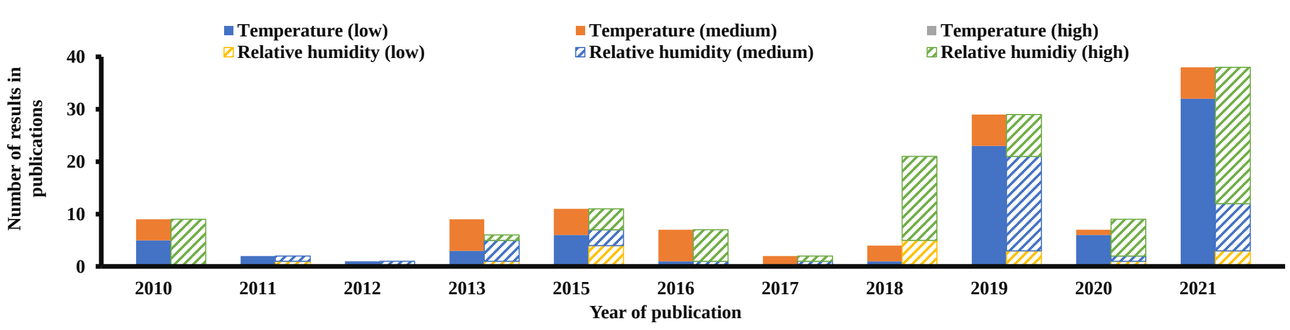


## ACKNOWLEDGEMENT & REFERENCES

We would like to thank our advisor, Professor Adewale Giwa, our co-advisor Professor Tahar Laoui, and our coordinator, Dr. Mohammad Al Shabi. Their advices were very valuable and made such a great help for the project benefit. Many thanks goes to all the engineers who work in the central labs for helping us understand the fabrication and the experimental processes of this project.

# Sustainable & Renewable Energy Engineering

# Table of Content

# Viability of Hydrogen Production From Food Waste

Students: Mariam Ali Abdelrahim Al Marzouki | Aisha Saif Mohamed Binruwaijda Alketbi | Meera Humaid Abdulkader Mohamed Albanna

Supervisor: Dr. Ahmed Galal Abokhalil


## Introduction:

The purpose of this study was to determine whether it was feasible to produce hydrogen by anaerobically digesting food waste. With the increase in the use of renewable energy sources, hydrogen came to be seen as a fuel that can replace petroleum products in the automotive sector. The biggest obstacle to the use of hydrogen as a fuel is its unavailability in nature and the need to find low-cost production methods. The transition from an economy based on fossil fuels to a hydrogen economy poses enormous technical challenges in terms of hydrogen production, storage and distribution. Anaerobic digestion (AD), which entails the degradation of organic matter by microbes in the absence of oxygen, is advised as a strategy to accomplish this.

# Viability of Hydrogen Production from food waste

Meera Humaid Albanna; U19100422
Mariam Ali Almarzouki; U18100085
Aisha Saif Alketbi; U18100377
*Dr. Ahmed Galal Abokhalil*

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## INTRODUCTION

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## BACKGROUND

Biological hydrogen production processes are recent and open up a new field of technological development that will make it possible to divert hydrogen production methods from the use of non-renewable fuels in the future. In general, all biological hydrogen generation processes are based on the presence of a hydrogen-producing enzyme capable of catalyzing the reaction between electrons ($e^-$) and protons ($H^+$) to generate molecular hydrogen ($H_2$). The type of microbe and the method utilized to produce hydrogen both affect whether these enzymes are present. Hydrogenase is widely distributed in anaerobic microorganisms. It has diverse phylogenetic origins and can be classified into two categories: hydrogen-consuming hydrogenase and reversible hydrogenase.

## CONCLUSION

The production of hydrogen by anaerobic fermentation has aroused great interest by fermentative bacteria that allows the generation of hydrogen continuously and at a sustained rate. In addition, fermentative microorganisms are more effective in producing $H_2$ in a short period of time, when compared to microorganisms responsible for photobiological processes. The fermentation process also allows the use of different types of residues as substrates, such as lignocellulosic materials, glycerin, food and dairy residues. In this perspective, the production of $H_2$ via anaerobic fermentation presents itself as an economically interesting and environmentally correct alternative

## THEORY / METHODS

The biggest obstacle to the use of hydrogen as a fuel is its unavailability in nature and the need to find low-cost production methods. The transition from an economy based on fossil fuels to a hydrogen economy poses enormous technical challenges in terms of hydrogen production, storage and distribution. In this project, a food waste management plan will be proposed. Waste bins will be optimally distributed in several locations to encourage residents to dumb their food waste in these bins. An optimal method for selecting hydrogen-producing will be investigated by applying a pretreatment method using heat treatment and acid treatment. In the same line, it is intended to derive optimal conditions for hydrogen production is investigated by applying a pretreatment method using heat treatment.

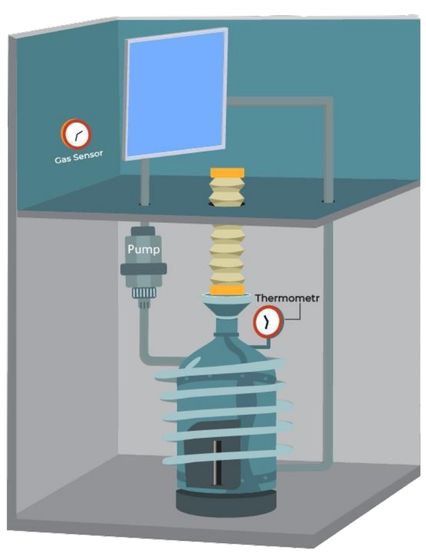
## SETUP, EXPERIMENTAL

In order to investigate the effect of pretreatment of mixed seed fungi on hydrogen production efficiency and optimal operating conditions for hydrogen production, pH and temperature were selected as experimental factors and a laboratory-scale anaerobic digestion tank was operated for 9 days. To investigate the effect of pH on the hydrogen production efficiency, the pH in the reactor was adjusted to pH 5, 6, and 7 with 5N-H2SO4 and 5N-NaOH solutions, and to investigate the effect of temperature, 35 ℃ and 55 after adjusting to ℃, the experiment proceeded. The experiment was divided into two parts. First, for the heat-treated, BESA-injected, and acid-treated mixed seedlings, the pH was adjusted to 5, 6, and 7 before cultivation, respectively, and then operated without pH adjustment during the operation period.

## RESULTS

From the data above, we notice that in Trial 1we gained maximum hydrogen production is 81.6 mL/g of food waste, which took place at 35°C, 5.5 PH, and 72hrs of fermentation. At the optimum temperature, moderate PH level, and long fermentation time, we gained maximum amount of hydrogen. In Trial 4, we kept the PH level and the fermentation time constant while increasing the temperature, compared with Trial 1, we gained 4.7 mL of hydrogen / g of food waste which is the minimum amount produced. From here we notice the effect of temperature on the production of hydrogen. By comparing Trials 2 and 3, we kept the temperature constant at 37°C while changing PH level and fermentation time. We notice that in Trial 3 we have gained more hydrogen. From here we notice the importance of the PH level and longer fermentation time. In summary, each factor (PH level, fermentation time, and temperature) has a significant effect on the production of hydrogen, such effect can be only determined through experimenting.

| | Temperatures | | | |
|---|---|---|---|---|
| | Trial 1 | Trial 2 | Trial 3 | Trial 4 |
| | 35°C | 37°C | 37°C | 55°C |
| PH | 5.5 | 6.5 | 5.5 | 5.5 |
| Fermentation Time (Hours) | 72hrs | 60hrs | 72hrs | 72hrs |
| **Max. Hydrogen Production** | **81.6 mL/g** | **22.5 mL/g** | **44.6 mL/g** | **4.7 mL/g** |


## DISCUSSIONS

The activity of bacteria during the anaerobic digesting process is substantially influenced by temperature. This approach uses thermophilic (50–60°C) and mesophilic (30–40°C) conditions, which are two widely used temperature ranges. Because of the enhanced microbial activity under thermophilic conditions, hydrogen generation rates are often higher. When evaluating total energy efficiency, it is important to take into account that this temperature range also requires more energy to maintain. Generally speaking, the duration of the process might range from a few hours to several days, depending on the kind of waste, the microbial consortium, and the setup of the system.

From the experiments, we notice an inversely proportional relation at (24hr) of fermentation and (24-48 & 48-72) hours of fermentation. Even though the amount of hydrogen produced has increased with increasing temperature at the first 24 hours, however, it then started decreasing significantly. This is the effect of temperature on hydrogen production, and balancing between temperature and fermentation hours is a crucial and most significant stage of the experiment. However, this balance can only be figured out experimentally by trial and error, which put a load on launching a successful experimentation considering all affecting components and factors. Moreover, when fermentation hours approach 72hrs, the hydrogen production increases significantly at 37oC reaching 135mL of hydrogen/gram of food waste. This confirms that 37oC is the optimum operation temperature and 72hrs is the optimum hours of fermentation.

## ACKNOWLEDGEMENT

We would like to extend our deepest gratitude to all those who have played a part in the successful completion of our senior design 2 project on the Viability of Hydrogen Production from Food Waste. Firstly, we would like to thank our project supervisor Dr. Ahmed Galal for his invaluable guidance, mentorship, and support throughout the project. Without his insightful advice, this project would not have been possible. We would like to acknowledge the contributions of all those who provided us with the necessary resources and facilities to carry out our research, including the Sustainable and renewable department and the Engineers laboratory. Additionally, we would like to thank all the staff members who assisted us during our research.

**Department of Sustainable and Renewable Energy Engineering**

# Irrigation and Climate Control of Hydroponic Greenhouse Powered by Solar Energy

Students: Mariam Sultan Senan Altaweel Alshuweihi | Fatma Rashid Saeed Binsulooma Alnuaimi | Kaltham Hassan Abdalla Hassan Alzarooni

Supervisor: Dr. Muhammad Tawalbeh

## Introduction:

This poster presents a design of an irrigation and climate control system for a hydroponic greenhouse powered by solar energy has been carried out. The climate control of the greenhouse is necessary for regulating the temperature and humidity inside the greenhouse to provide better crop growth conditions. The design of a climate control system is performed by using several sensors and other controlling devices. Moreover, a hydroponic farming system was implemented inside the controlled greenhouse. The whole greenhouse, including irrigation and the control systems, is powered by solar energy. An experiment was conducted to measure the temperature and humidity.

# Irrigation and climate control of hydroponic greenhouse powered by solar energy

Students Name:
Kaltham Hassan AlZarooni
Maryam Sultan AlShuweihi
Fatma Rashid AlNuaimi

*Supervisor name:*
*Dr. Muhammad Tawalbeh*

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## INTRODUCTION

This poster presents a design of an irrigation and climate control system for a hydroponic greenhouse powered by solar energy has been carried out. The climate control of the greenhouse is necessary for regulating the temperature and humidity inside the greenhouse to provide better crop growth conditions. The design of a climate control system is performed by using several sensors and other controlling devices. Moreover, a hydroponic farming system was implemented inside the controlled greenhouse. The whole greenhouse, including irrigation and the control systems, is powered by solar energy. An experiment was conducted to measure the temperature and humidity.

## BACKGROUND

The selected greenhouse type is the even span greenhouse since it has a good construction for maintaining a uniform temperature. The cover material is Polycarbonate, which helps in distributing light more evenly, which promotes plant growth and health. The frame is chosen to be galvanized steel frame since its very strong and has a high density, which results in a more stable structure that handles extreme conditions. The inside temperature and humidity of the greenhouse is controlled using a control system. The cooling system is the most suitable for UAE's hot climate. Hence, the fan pad system was implemented for cooling the greenhouse. Cellulose pad is the most appropriate pad type for the cooling system since it provides high efficiency and is available in the market. The exhaust fan is placed facing the pad. In addition to that the humidity influences the greenhouse, where it is controlled by the ventilation system. The NFT system of hydroponics is the most suitable system since it has high efficiency in water usage and nutrients. The greenhouse was powered by two solar panels where one was connected to the exhaust fan while the other was connected to the battery which was connected to the pump.

## CONCLUSION

In conclusion, the objective of designing an irrigation and climate control of a hydroponics greenhouse powered by solar energy was achieved. The three main systems focused on this project are greenhouse system, climate-controlled system to maintain the temperature and humidity, and hydroponics system to produce yields without the use of soil. It uses renewable energy sources to achieve an environmentally friendly system where solar panels were added to reduce emissions and improve the efficiency of the system.

## THEORY AND METHODS

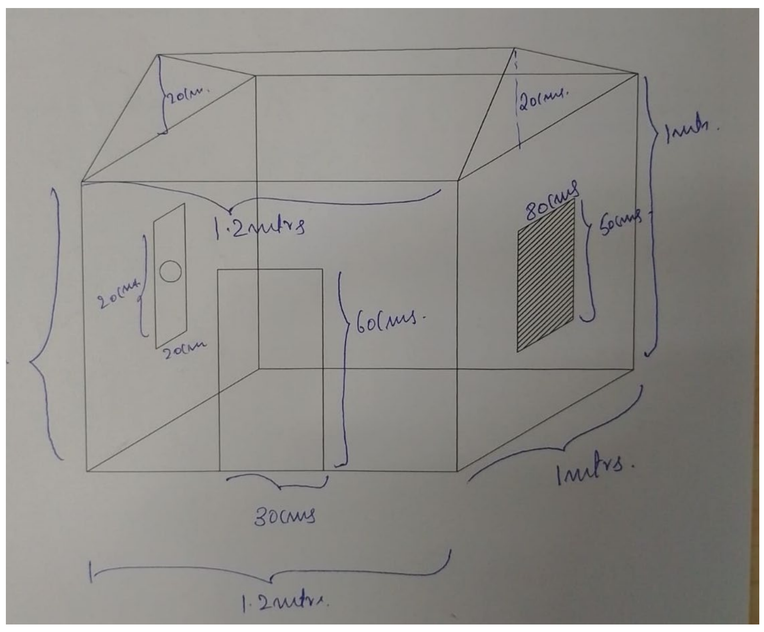
The main objectives are to design an irrigation and climate control system for a hydroponic greenhouse, to use a controlled solar-powered irrigation system to reduce emissions, to create an efficient system utilizing well-considered components and methods, and finally to implement a climate-controlled greenhouse system to maintain the required temperature and humidity. The irrigation and climate control of the hydroponic greenhouse system is installed in Sharjah, UAE, with latitude and longitude of 25.3462° N, 55.4211° E. Sharjah has a high-temperature climate, so solar panels were added to the greenhouse, The solar panels are south facing with an angle of 25°, facing the sun all day long.

## EXPERIMENTAL SETUP

The implemented structure is the even-span type greenhouse. Dimensions of the greenhouse 1 meter × 1.2 meters × 1.2 meters. For the frame of the greenhouse, the rods used are galvanized steel while the sheets used to cover the frame is a 3mm polycarbonate sheets for better light distribution. After that, the climate in the greenhouse was controlled using the fan and pad cooling system. On one side a cellulose pad was attached. While on the facing side, the exhaust fan was placed. A pump was connected to the pads with pipes in order to supply the water to the entire pad. The hydroponic system used in the greenhouse is the NFT Nutrient film technique, which consists of 4 channels where the water flows from the tank using a pump.

## RESULTS

An experiment was conducted where the greenhouse was placed outside in order to measure the temperature and humidity inside and outside the greenhouse. The data were taken every 20 minutes using a temperature and humidity sensor. The temperature outside was increasing with a range of (35-36°C ) while the temperature inside was decreasing with a range of (35-29°C) because of the fan and pad cooling system. For the humidity outside it was decreasing with a range of (42-38%) while the humidity inside was increasing with a range of (42-45%) because of the natural ventilation.




## DISCUSSION

The aim was to design and test the most suitable climate control system for a greenhouse in a dry and hot climate. The focus was to produce yields without the use of soil by a hydroponic system. The total energy produced by solar panels in one year was calculated to be 153.3 kWh. From the total energy produced , the total saved cost is calculated as 11497.5 AED . Finally, the total cost of the 2 pumps and exhaust fan when operating them at a range of 6-12 hours daily in 1 year has been calculated .The pump used for the hydroponics, pump used for the cellulose pad and the exhaust fan are 3.15, 2.628, and 1.64 AED, respectively. Since our greenhouse costed around 4995 AED, the levelized cost of energy in 1 year is 32.58 AED/kWh. This system contains 3 DC loads that include a 10W Exhaust fan that will operate for 6 hours and so the energy is 60Wh, a 19.2 W pump that will circulate the water for the cooling pads and will operate for 6 hours as well with a 115.2 Wh energy, and an 8 W pump that is used for the hydroponic system and will be operated for 12 hours with a 96 Wh energy. Later the total load of the greenhouse was calculated to be 37.2 W and the total daily consumption to be 271.2 Wh. The two pumps are connected to a 12 V battery

## ACKNOWLEDGEMENT

We would like to express our special thanks of gratitude and acknowledge Dr. Muhammad Tawalbeh for his guidance and patience. He provided us with the necessary information and support for completing this project. We would also like to thank and acknowledge engineer Sondus Al-qudah and engineer Monadhel Alchadirchy. And for our parents and everyone who provided us with the mental support needed. Finally, we would like to thank the University of Sharjah for funding our project and supporting us in every way we need.

**Department of Sustainable and Renewable Energy Engineering**

# Hybrid Electrical Storage System for RC Airplanes Using Supercapacitor and Fuel Cell

Students: Abdalmalik Noaman Attallah | Mohamed Fadil Hussain Abuseem Al-Ali
Supervisor: Dr. Bashria A. Yousef

## Introduction:

The airplane is currently the fastest mode of transportation, helping to connect all nations and cities worldwide and enabling people to travel and reach any location on Earth. Government officials and environmentalists have been constantly monitoring the industry due to the yearly increase in the number of planes and passengers. The biggest contributor to global warming is the excessive quantity of carbon dioxide released into the atmosphere during air travel, and as the number of flights and passengers rises, so will the impact of aviation pollution. Environmental researchers estimated that 2.1% of the carbon dioxide pollution in the atmosphere was caused by airplanes in 1990

# Hybrid electrical storage system for RC airplanes Using supercapacitor and fuel cell

Abdalmalik Noaman Attallah

Mohamed Fadil Hussain Al Ali

*Dr. Bashria Youssef*

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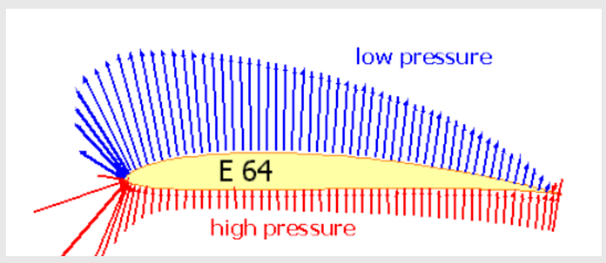
## BACKGROUND

Bird wings were the original concept of airfoils. George Quigley, an engineer, started examining the performance of airfoils in 1799 and published a report in 1810. The origins of aviation, aerodynamics. According to Bernoulli's law (conservation of energy), the theory of flight as the velocity of a fluid increases, the pressure reduced

$$p_1 + \frac{1}{2}\rho V_1^2 + \rho g H_1 = P_2 + \frac{1}{2}\rho V_2^2 + \rho g H_2$$

The Bernoulli equation states that the pressure above the wing is lower than below it Figure 1, therefore, the speed below the wing is lower than above the wing. The aerodynamic components that have an influence on aircraft are shown in Figure 1.




## CONCLUSION

the goal of this study is to propose a hybrid unmanned aerial vehicle (UAV) that is powered by a fuel cell and a supercapacitor, two sustainable energy sources. It also comprises choosing the flying wing design and completing aerodynamic calculations to assure dependable flight, . As a result, the chosen hybrid UAV component was ordered, and the whole cost is 4285 AED.

## THEORY / METHODS

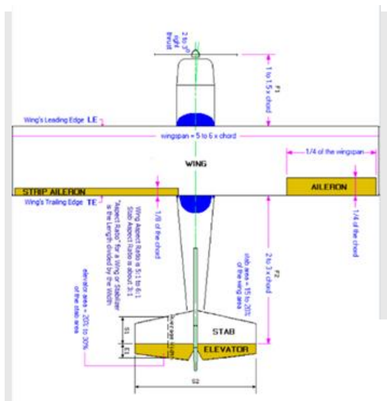
The objective of this project is to design and build an unmanned aerial vehicle (UAV) that only uses renewable energy sources, We suggest combining a fuel cell with a supercapacitor bank to achieve this. supercapacitors supply the energy required for power-intensive takeoff and climb, while the fuel cell manages level flight and cruising, The project will start by choosing the best aircraft shape, with a glider or flying wing being thought of as the optimal shape since it can carry a considerable payload, to support the essential power, propulsion, and control systems.

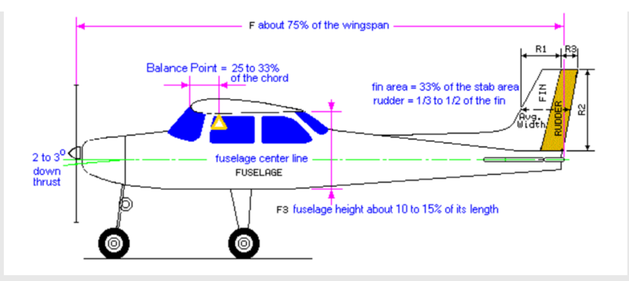
## SETUP, EXPERIMENTAL

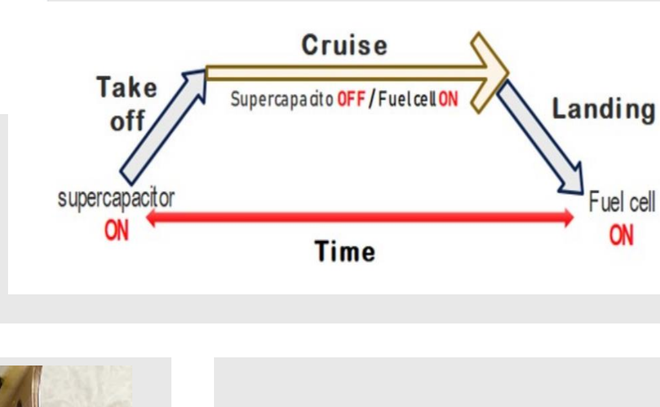
The system where designed and built during SDP one, because of its high power density at the takeoff the supercapacitor would be turned on and the fuel cell will be off, during cruising, the supercapacitor will be off and the hydrogen fuel cell will be on due to its high energy density, we were able to build our electric circuit and tested on a different designs to make sure that it's applicable.

## RESULTS

Hybrid electrical storage system for RC airplane consists of two main power sources supercapacitor and fuel cell this project is an electrical where the electrical components were proper selected then purchased with the cost around 3247 AED and all components were connected, we end up with an electrical system and we measure the total power needed for motor to lift and flight the airplane which we find out to be 652 W for one hour which is mean we need 1.78 W for the first 10 seconds which is the takeoff and we need 94 W for 10 minutes for the flying time.




## DISCUSSIONS

The supercapacitor is ideal for takeoff because it can provide a large quantity of power in a short period of time. Its 2560 J energy capacity allows it to run the engine at 256 W for 10 s, which is a large amount of power. On the other hand, The fuel cell with 100W can supply the motor with sufficient power during cruising flight. In cruising flight, less power is required, and the airplane relies more on its mechanical structure for stability than it does on the motor's electrical power. Supercapacitor and fuel cell are the two primary power sources for the hybrid electrical storage system for RC airplane. This project resulted in an electrical portion, and all the electrical components were properly chosen and acquired for a total cost of about 4285 AED. The Arduino code was coded, parts were linked, and an electrical system was created so that the total power required by the motor to lift and fly the 1216.4-g airplane for an hour was measured to be 632.04 W. Polystyrene foam was used to construct the airplane, and the fuselage cost 50 AED. All the outcomes met expectations and were satisfactory.

## ACKNOWLEDGEMENT

First and foremost, we would like to thank Allah for granting us the ability to finish this report. We would also like to thank our supervisor Dr. Bashria who worked really hard with us in order to make sure that our report was perfect, a deep thanks for our families and friends who believed in us and support us to complete this report.

**Department of Sustainable and Renewable Energy Engineering**

# Versatile Applications of Flexible Photovoltaics

Students: Alya Khalid Adil Abdalla Almemari |Dalfa Ali Hussain Habib Allowatya | Fatima Mukhtar Ibrahim Adam

Supervisor: Dr. Di Zhang

Introduction:

Floating PV (photovoltaic) refers to solar panels that are installed on bodies of water, such as lakes, reservoirs, or oceans. These solar panels are designed to float on the water's surface and convert sunlight into electricity. Floating PV is a relatively new technology that has gained popularity in recent years as a way to overcome the land-use limitations of traditional solar installations and to increase the efficiency of solar panels. Floating PV has several advantages over land-based installations, including reduced land use, increased energy production due to the cooling effect of water, and less need for cleaning. Floating PV is a promising technology that has the potential to significantly increase the amount of renewable energy that can be generated worldwide. Despite its benefits, floating PV is still a relatively new technology, and further research and development are needed to address challenges such as corrosion, water quality, and environmental impacts.

# TitleApplications of flexible PV in FPV

## Sub-Title: ELLISOL

Students Name: Alya Almemari, Dalfa Ali, Fatima Adam.

*Supervisor name: Dr. Di Zhang*

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## BACKGROUND

- **Floating structure:**

  The float is the main structure that holds the solar panels and keeps them afloat on the water. The floats are usually made of lightweight strong materials that can withstand the corrosive effects of water and sunlight. The shape and size of the float may vary depending on the specific requirements of the installation site and the weight of the solar panels.

- **Flexible Solar Panels:**

  Flexible PV is a type of photovoltaic technology that uses lightweight and flexible materials as the substrate for solar cells. Unlike traditional solar panels, flexible PV panels can be bent, rolled, or curved to fit a variety of surfaces. They are also more durable and resistant to damage than traditional solar.

- **Mooring:**

  The mooring system in water is a set of equipment and devices used to secure a vessel in a specific location, by anchoring it to the seabed using ropes, chains, or cables. It is designed to withstand the forces of wind, current, and waves, and to ensure the safety and stability of the vessel while it is not underway. Various types of mooring systems are available, but we have determined that the taut-leg mooring system is the most appropriate for our needs. This system will ensure that our floating photovoltaic (FPV) platform remains stable, and it will also prevent it from being affected by tidal movements.

## CONCLUSION

Ellisol, our creative unique design that generates clean energy while keeping the beautiful scenery of major cities. We focused on creating a cost-effective structure that receives sunlight from all directions, while having natural cooling and lighter structure. Not only that! It also produces up to 5.62% more energy than traditional alternatives. Isn't this a life changer? Just picture our cities with more land for us, more energy, and beautiful scenery! What more can we ask for!

## THEORY / METHODS

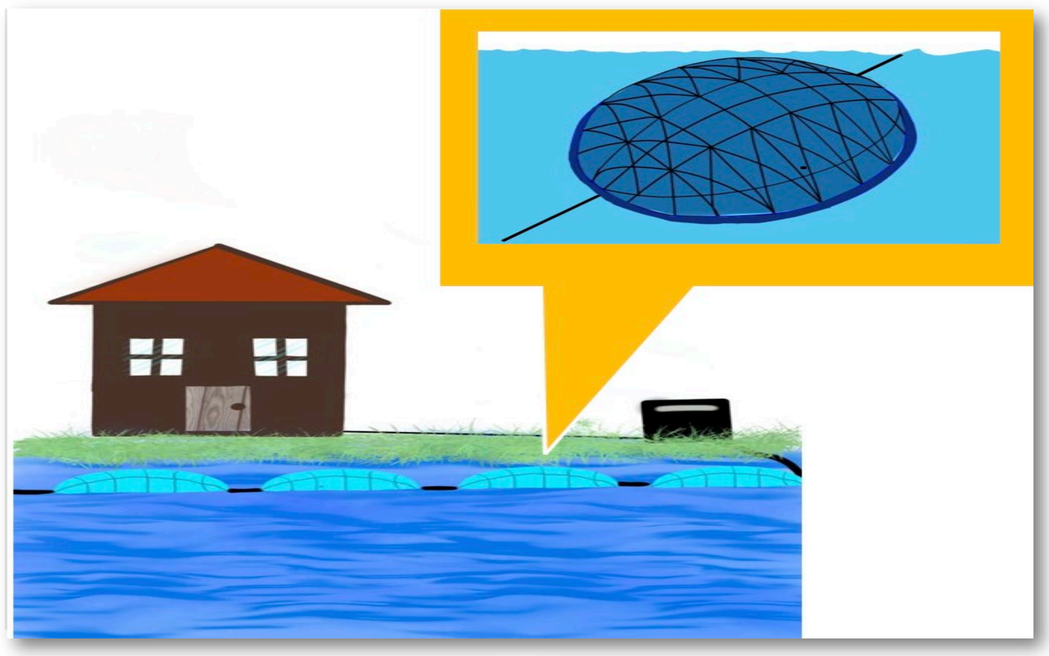
The main idea of this project is to develop a new proof of concept design to overcome the problems found in conventional PV such as high land area usage, the need for tracking systems, and the effects of heat on the solar cells. We tested our ellipsoidal design using simulations and conducting real life experiments to get the energy production of our system. We aim to power an island in Abu Dhabi, so we decided to work on a down-scaled prototype to represent the system. We used a small house module with an LED light connected to a battery to represent the energy consumption of one house.

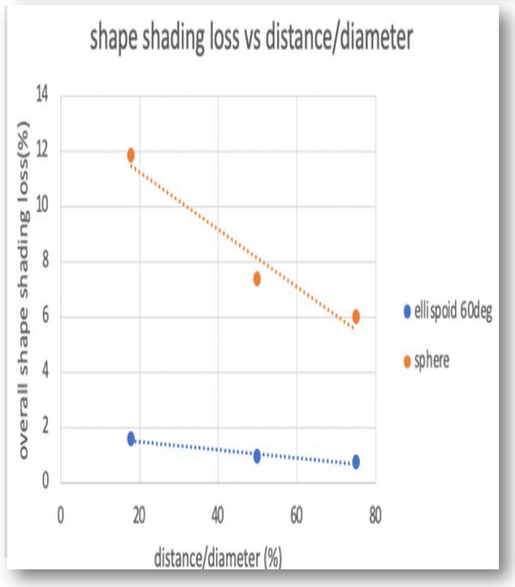
## SETUP, EXPERIMENTAL

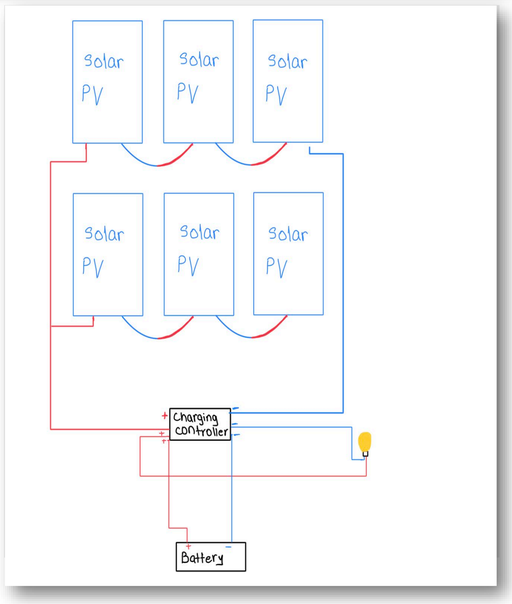
First, we used PVSyst simulation software to experiment on different shapes until we found the optimal design which is the 60˚ellipsoid. Then we built a prototype to start real life testing. The prototype size is 30 cm for the outer diameter, 26 cm for the inner diameter, and 7 cm for the height. Our constructed prototype is fully functional and very lightweight, which satisfies our aim, it also succeeded the floating test in the Arabian gulf, Sharjah. The materials used to construct this prototype are Amorphas silicon solar PV, Aluminum mesh, Graphite sheets, Float foam (Buoyancy ring), Solar charging controller, Battery, Light bulb, Electric wires, Tank, Bridle lines.

## RESULTS

We tested our design through multiple simulations and real-life experiments. Using PVsyst simulations, we observed a 5.62% gain in the energy production of FPV with water cooling compared to land. We also observed 85% less shading in our 60˚ ellipsoidal shape compared to the spherical one using PVsyst shading simulations. The project was also tested by conducting real life experiments and we got 51.4 Wh/day electricity production for our prototype.






## DISCUSSIONS

**Water Cooling Effect:**

Temperatures at sea are often cooler than land temperatures, as well as wind speeds are higher. This creates a great medium for cooling for solar panels since hot temperatures affect solar panels negatively. Therefore, we increased the thermal loss factor from 20W/m^K to 50W/m^2K in PVSyst to simulate this condition. However, the temperature difference obtained was different from calculated values, so we adjusted the values until we reached a value of 22.5W/m^2K, which was the closest to real life.

**Shapes:**

We assessed 4 different shapes for our application that are flat, ellipsoid 30 ,˚ ellipsoid 60 ˚ and sphere. Though after much testing and research we found the optimal shape for our application to be 60 ˚ ellipsoid, this is because the rest of shapes faced some major issues. Where flat received less energy because it has a small area, the sphere had losses due to shading, as seen in the graph, and ellipsoid 30 ˚ gave the same energy as the flat but was more costly.

**Corrosion protection:**

One of the main challenges for any floating technology is to protect the system of water and the harsh corrosive behavior of the marine environment. Floating systems mainly face galvanic corrosion, and environmental corrosion cracking. We can prevent corrosion by using corrosion-resistant materials such as stainless steel or aluminum, applying protective coatings like paint, epoxy, or zinc anodes to form a barrier between the metal structure and the saltwater, and ensure regular inspection and maintenance of the metal structure and electrical components, including cleaning and coating repair, to help prevent corrosion from occurring or spreading.

## ACKNOWLEDGEMENT

We wish to extend our appreciation and thankfulness to Dr. Di Zhang, our supervisor, for his invaluable guidance, advice, and direction provided throughout our SDP project. We would also like to acknowledge DEWA's Research and Development Centre for accepting our project in their Al-Baheth funding program for capstone projects, which will aid in elevating and expanding the project beyond its initial objectives.

# Mars Atmospheric CO2 for CO2/Al-Battery-Powered PV Cleaning

Students: Alyazyah Ahmed Abdulla Albadr Almahri | Aisha Abdalla Khamis Alhosan Alshamsi | Amna Abdalla Ahmed Almushtaghil Alnaqbi

Supervisor: Dr. Anis Allagui

## Introduction & Motivation:

Global warming now is very concerning because of its potential to cause significant long-lasting impacts on our planet, its ecosystem, and human societies. Global warming's main cause is the greenhouse effect which includes a high percentage of Carbon Dioxide (CO2).
Since CO2 emissions from fossil fuels, and land-use are increasing, renewable energy was introduced. Our country highly encourages the use of renewables as the UAE 2050 Energy Goals states
This encouraged us three ambitious students of the new generation of our society, to partake in this field. Energy storage is a crucial factor for any energy generation system. We got more familiar with batteries and came across the O2 -Assisted Al/CO2 battery, that was suitable for our concern and application. Moreover, we anticipate that this battery design can be applied equally for extra-terrestrial applications for CO2 capture purposes as well as for superior planets where CO2 consists in integral part of its atmosphere.

# O2-Assisted CO2/Al Battery for energy storage and CO2 Capture

**• Design and characterization of performance •**


Students Name & ID :-

Aisha Abdalla Alshamsi U19100497

Amna Abdulla Almushtagil U19100744

Alyazyah Ahmed Almahri U18100339

*Supervisor name: Dr. Anis Allagui*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## THEORY / METHODS

**Electrochemistry Reactions**

1. $2Al \leftrightarrow 2Al^{3+} + 6e^-$
2. $6O_2 + 6e^- \leftrightarrow 6O_2^{\bullet -}$
3. $3CO_2 + 3O_2^{\bullet -} \leftrightarrow 3CO_4^{\bullet -}$
4. $3CO_4^{\bullet -} + 3O_2^{\bullet -} \leftrightarrow 3CO_4^{2-} + 3O_2$
5. $3CO_4^{2-} + 3O_2 \leftrightarrow 3CO_4^{2-} + 3O_2$
6. $2\,Al_3+ + 3CO_4^{2-} \leftrightarrow Al_2(C_2O_4)_3$
7. 

**Overall reaction:**

**2 Al (g) + 6O2 (g) ↔Al2(C2O4)3 (ionic)**

**Theoretical Voltage**

Using thermodynamics table, we found Gibbs Free Energy at 20 degree Celsius by using enthalpy and entropy to approximate the theocratical voltage

$$E_{theortical} = \frac{-\Delta G}{X\,F}$$

where X is number of electrons and F is Faraday's Constant (C/ mol)

$$= \frac{-(-1084 \times 103)}{6 \text{ x } 96485} = 1.8 \text{ V}$$

**Nernst equation**

$$E_{T,P} = E^{\circ} - \left(\frac{RT}{nF}\right) ln \frac{a_{Red}}{a_{Ox}}$$

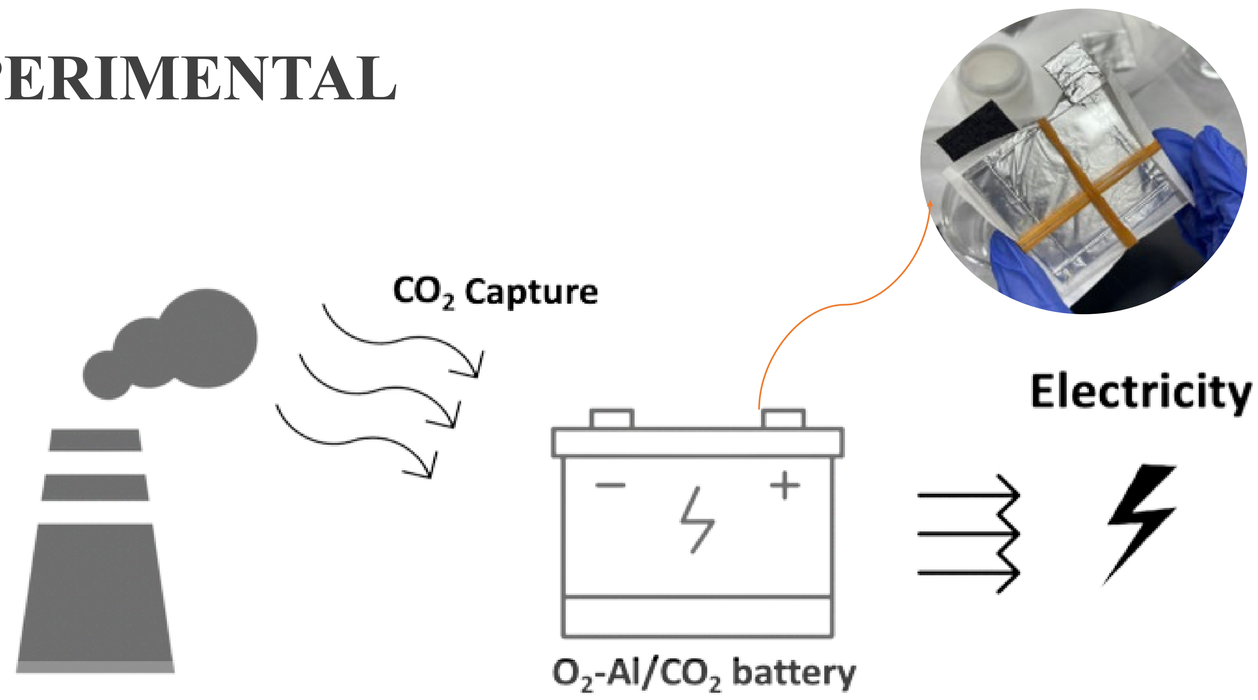
a: activity of elements

The Nernst Equation enables us to determine cell potential under non-standard conditions where this equation applies to all electrochemical reactions mentioned before in particular the variation of voltage.

## CONCLUSION

In conclusion, as a result of this project we fabricated and characterized a fully packaged O2- assisted Al/ CO2 battery which is a two-in-one system that provides on one hand electrical energy on demand via chemical-to-electrical energy conversion and on the other hand breaks apart the chemical energy stored in CO2, the battery consists of three parts: the anode (aluminum Current Collector), the cathode (porous carbon), and the electrolytic medium (ionic liquid). With an overall reaction of 2 Al (g) + 6O2 (g) ↔Al2(C2O4)3

## EXPERIMENTAL




**CO2 emissions in Earth's atmosphere as fuel for energy devices.**

**Battery Material :** The anode side is Aluminum current collector, while the electrolytic medium used is an ionic liquid, and for the cathode side we used porous carbon with a cloth to help ease the entry of the air molecules (CO2, O2) into the battery.

## RESULTS

1) Experimental Open Circuit Voltage = 1.5 Volts , Theoretical Voltage was found 1.8 V
2) Capacity = 2.5 milli coulomb at current 0.2 mA
3) Low Series Resistance = 23.83Ω

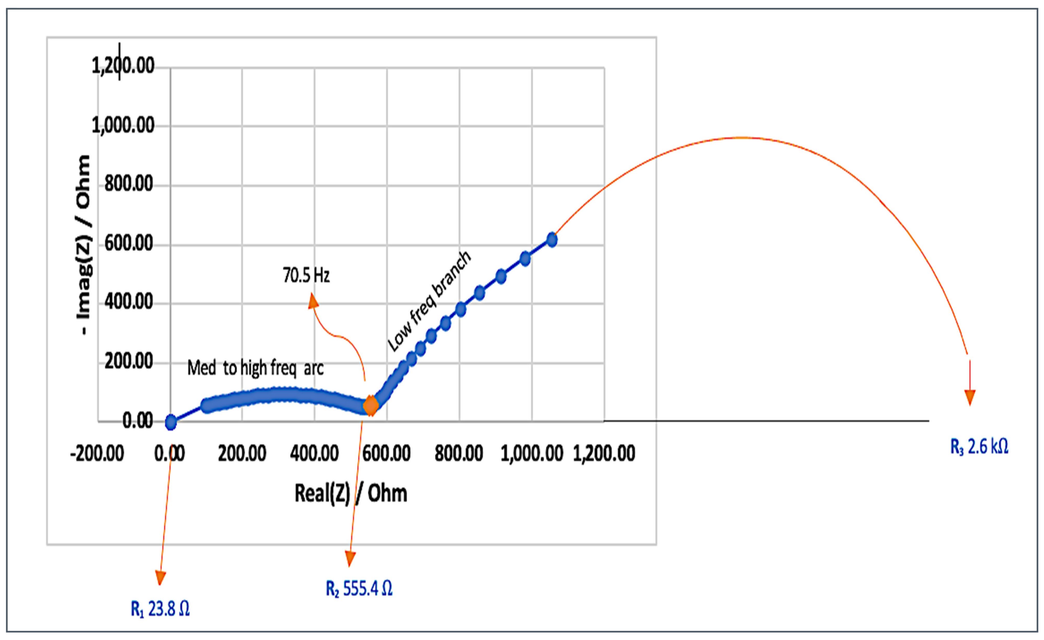



Figure 1: Impedance spectroscopy

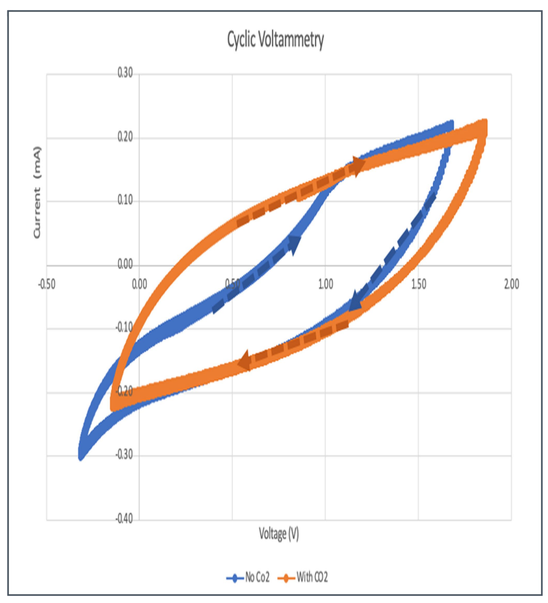



Figure 2: Cyclic Voltammetry

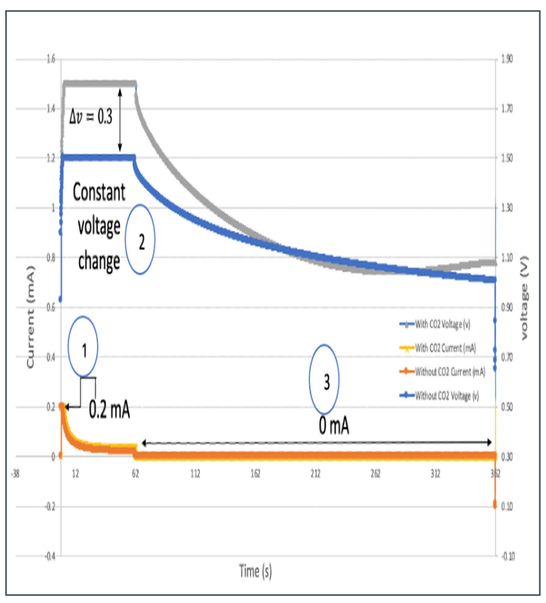



Figure 3: Galvanostatic Cycling with Potential Limitation

## DISCUSSIONS

**Figure 1:**
The curve shows practically an intercept with imaginary axis=0 which corresponds to the value of R1 = 23.83 ohm. Depressed arcs typically signify the presence of an RC system. Both low and high frequency arcs can be fitted with a resistor is parallel with a fractional order capacitor

**Figure 2:**
In this figure we measured and plotted the CV profiles of the battery when subjected to environmental conditions versus an injection of a CO2 flow:
(i) a positive shift in the voltage window of 0.19 volts. This increase in voltage can be related to the Nernst equation for the voltage as we discussed in theory chapter. (ii) we see also an increasing current magnitude in the voltage range (0 to 1) volts which indicates the involvement of CO2 -related reactions

**Figure 3:**
In this figure we show the voltage and current vs time in response to constant current / constant voltage / open circuit voltage conditions for the battery bubbled with CO2 flow and without CO2. The aim here is to evaluate the energy storage capability of the battery and its self-discharge behavior in both conditions.

## ACKNOWLEDGEMENT & REFERENCES


We would like to thank Dr. Sirugaloor Thangavel SenthilKumar for his great efforts and help with fabricating our O2-Assisted Al/CO2 battery. We want to extend our appreciation to Eng. Sondus Al-qudah for her kind efforts and guidance throughout the Senior Design Project. We would also like to think Eng.Baraa kalash for his help throughout our senior project.