جامعة الشارقة
UNIVERSITY OF SHARJAH

كلية الهندسة
COLLEGE OF ENGINEERING

College of Engineering
Selected:Students Senior Design Projects
Exhibition Catalog
May 2024

Table of Content

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, synthesi 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

Dr. Mohammad Ahmad Qasim Al-Shabi
Committee Chair
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Dr. Aref Mohamad Maksoud
Architectural Engineering

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Civil & Environmental Engineering

Dr. Sohaib Majzoub
Electrical Engineering

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Industrial Engineering & Engineering Management

Dr. Zafar Said
Sustainable & Renewable Energy Engineering

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Dr. Saleh Abu Dabous
Civil & Environmental
Engineering

Dr. Syarif Junaidi
Mechanical & Nuclear
Energy Engineering

Architectural Engineering

Table of Content

From Risk to Resilience

Residential Buildings to Mitigate Fire Risk and Climate Change

Students: Yousra Mushtaha | Jameelah Bahbouh | Farah Abuamara

Supervised by Prof. Emad Mushtaha | Dr. Samir Dirar

WINNER

Introduction:

The passage of time, however, has made these buildings increasingly vulnerable to the whims of fire risk or gradual changes in the climate of the environment. From Risk to Resilince explores how Sharjah's residential buildings can be preserved and fortified as we seek to find transformative solutions by combining sustainable and resilient design solutions to ensure these time-honored structures can withstand risks. Considering the past and future, we aim to build a Sharjah that can withstand the unpredictable forces of the environment.

From Risk to Resilience:

Design guidance for Resilient and Sustainable Residential Buildings to mitigate fire risk and climate change.

Yousra Mushtaha Jameelah Bahbouh Farah Abuamara
Prof. Emad Mushtaha *Dr. Samir Dirar*

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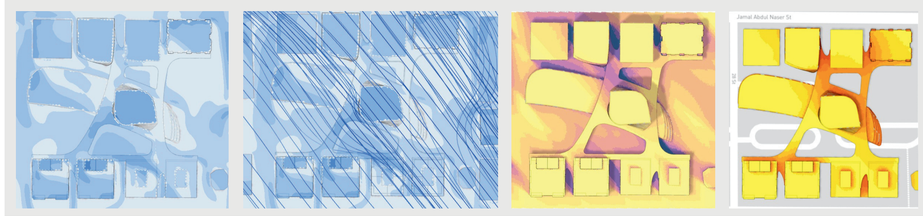
2D & 3D of The Site

Concept Development

Architectural Plans



By analyzing the site's weather conditions, including sun arrays, wind directions, and solar potential, we ensured our passive and active engineering solutions were applied efficiently.

Water Features & Landscape Elements

Interior Renders

Falaj Agresort
Where Agriculture Meets Architecture

Students: Majid Albastaki | Amna Almurshed | Fatma Almaazmi

Supervisor: Ahmad Sukkar

Overview

In Al Dhaid area in Sharjah, we're creating a resort that blends with nature and celebrates local culture.With agritourism experiences and sustainability at its core, our goal is to offer memorable stays while fostering community integration

FALAJ AGRISORT

WHERE AGRICULTURE MEETS ARCHITECTURE

MAJID ALBASTAKI AMNA ALMURSHED FATMA ALMAAZMI

SUPERVISED BY DR. AHMAD SUKKAR

PROJECT OVERVIEW

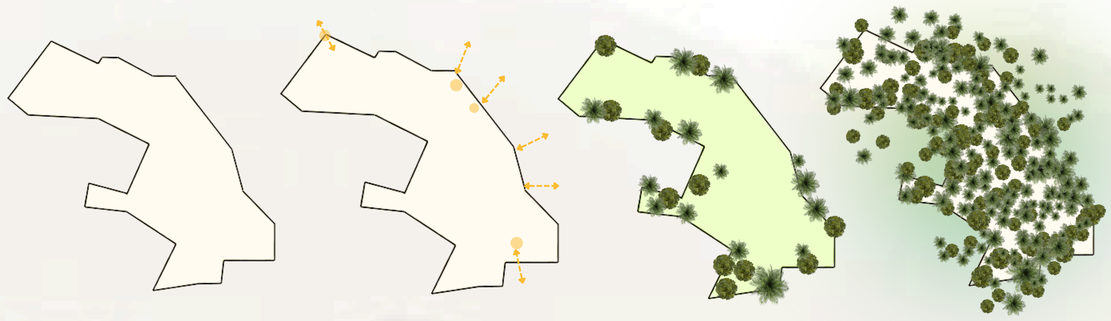
In Al Dhaid area in Sharjah, we're creating a resort that blends with nature and celebrates local culture. With agritourism experiences and sustainability at its core, our goal is to offer memorable stays while fostering community integration

CONCEPT

Our project concept combines traditional farming experiences and cultural workshops, centered around Al Dhaid and its historic Falaj waterway. Guests participate in farming activities and cultural events, celebrating the heritage of Al Dhaid in a holistic experience.

SITE CONCEPTUAL DEVELOPMENT

BUILT UPON AGRICULTURE



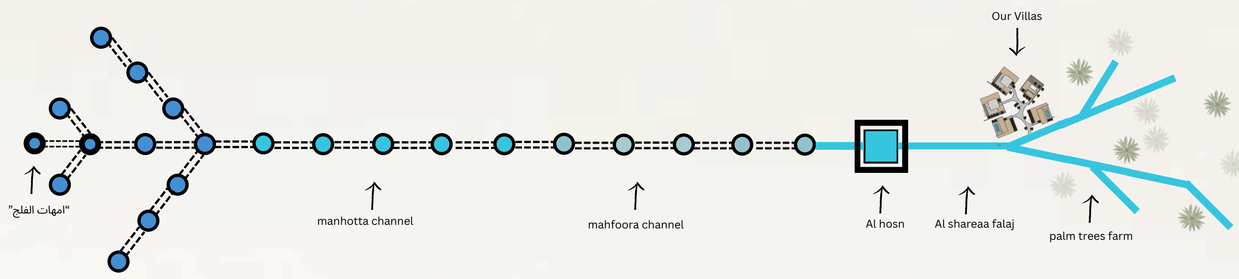
SITE BOARDER

PEDESTRIAN ENVIRONMENT AND PEDESTRIAN ACCESS

EXISTING TREES IN THE SITE

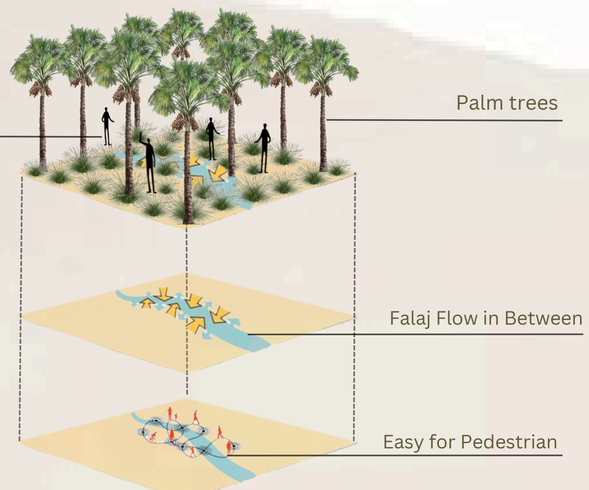
OUR PLAN IS TO PLANT MORE THAN 21,000 TREES IN OUR SITE

FALAJ NETWORK



ACTIVITIES

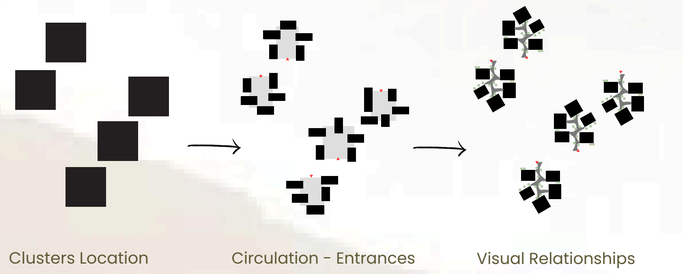
AGRITOURISM ACTIVITIES

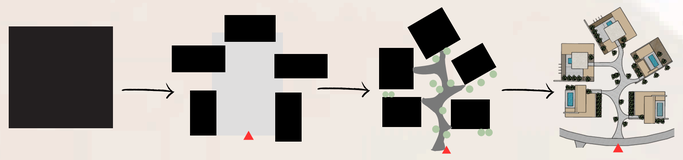


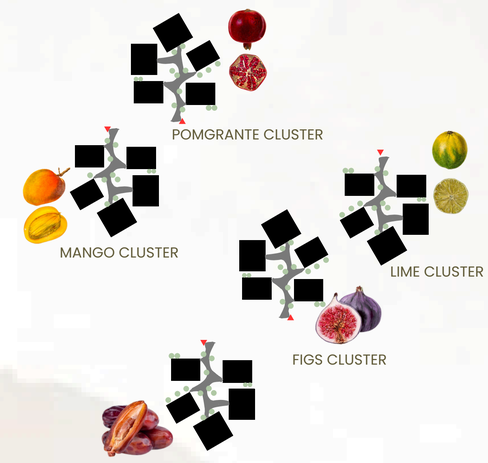
Collecting Fruits & Dates Activity

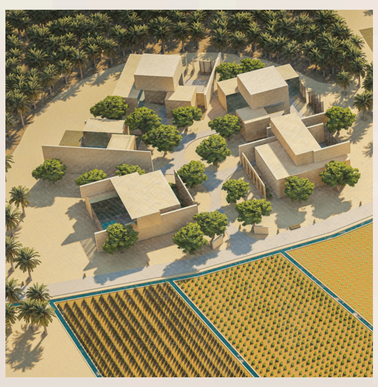
Harvest seasonal fruits and dates directly from our trees, offering our guests farm experience and connecting with nature in a memorable way.

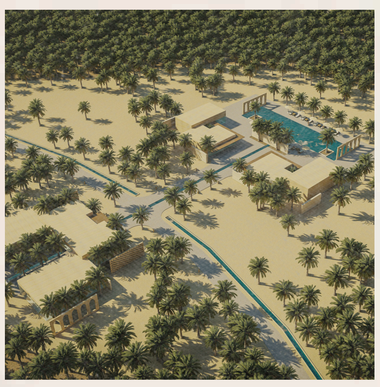
CLUSTER ORIENTATION DIAGRAM

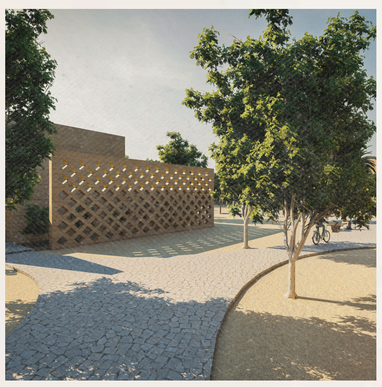












Hassad
A Sustainable Agriculture District

Students: Hanan Hamwieh | Sarah Abdulwahed | Boushrah Abdulwahed

Supervisor: Vittorino Belpoliti

Overview:

The Hasad project introduces a sustainable agriculture district in Dubai that combines farming, education, entertainment, and business. Hasad aims to create a dynamic environment where food production is at the forefront, but it also fosters community engagement and learning. Hasad employs a variety of farming methods, including vertical farming, hydroponics, and controlled biomes. The district's design maximizes the use of space by stacking vertical farms underground, while controlled biomes occupy above-ground spaces, creating a more efficient land use strategy.

Hassad

A Sustainable Agriculture District

Hanan Hamwieh U19101057
Sarah Abdulwahed U19103377
Boushrah Abdulwahed
Supervised by Dr. Vittorino Belpoliti

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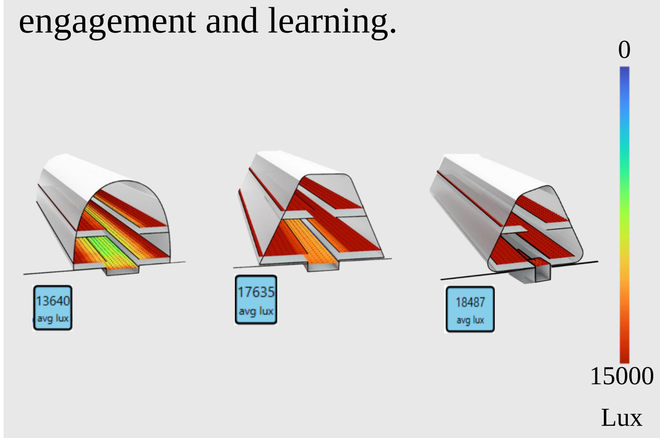

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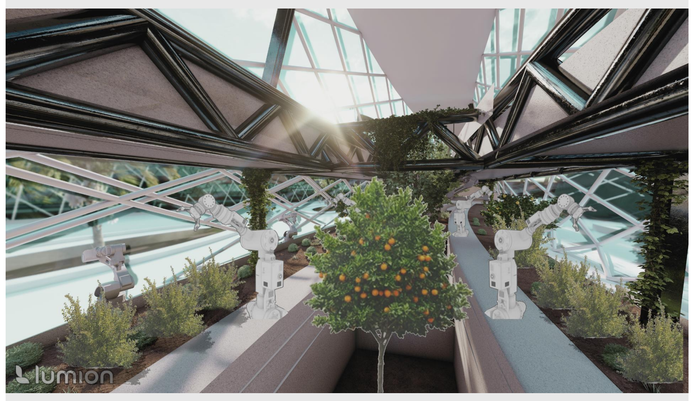
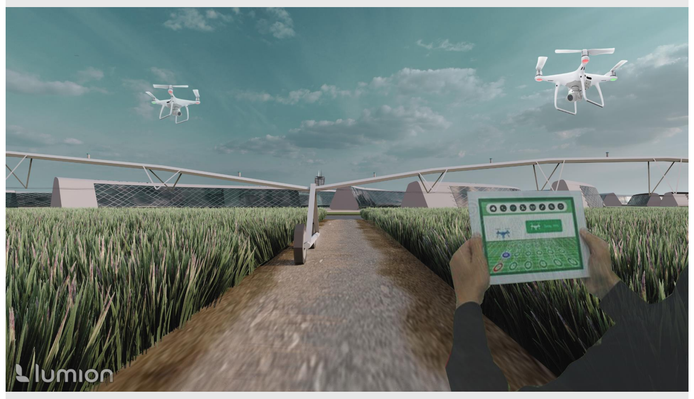
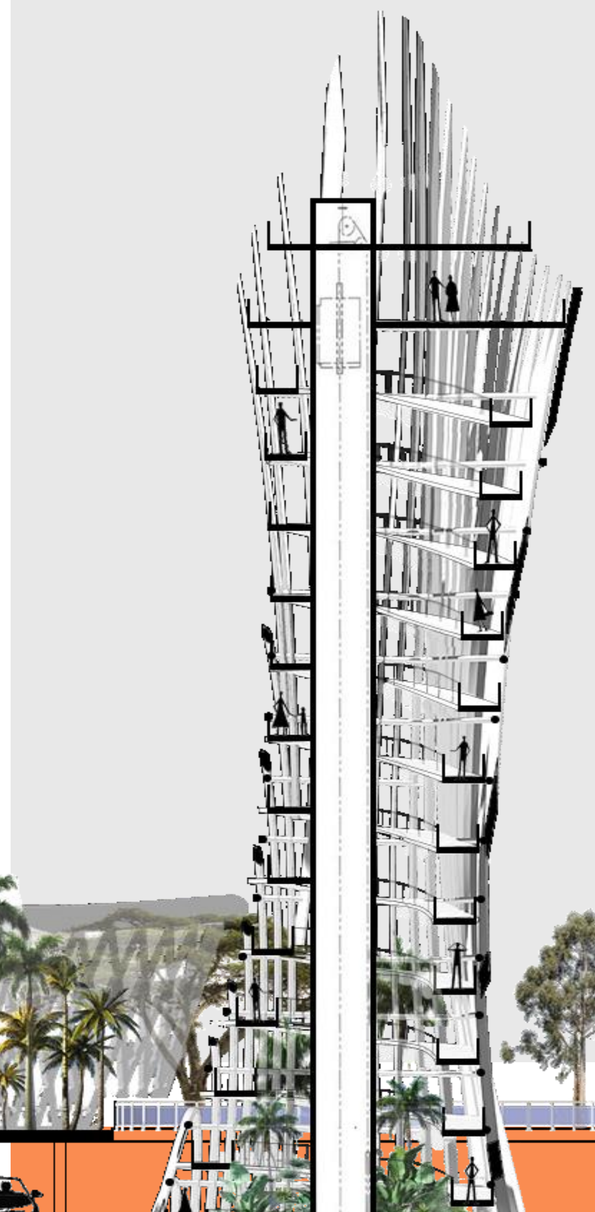
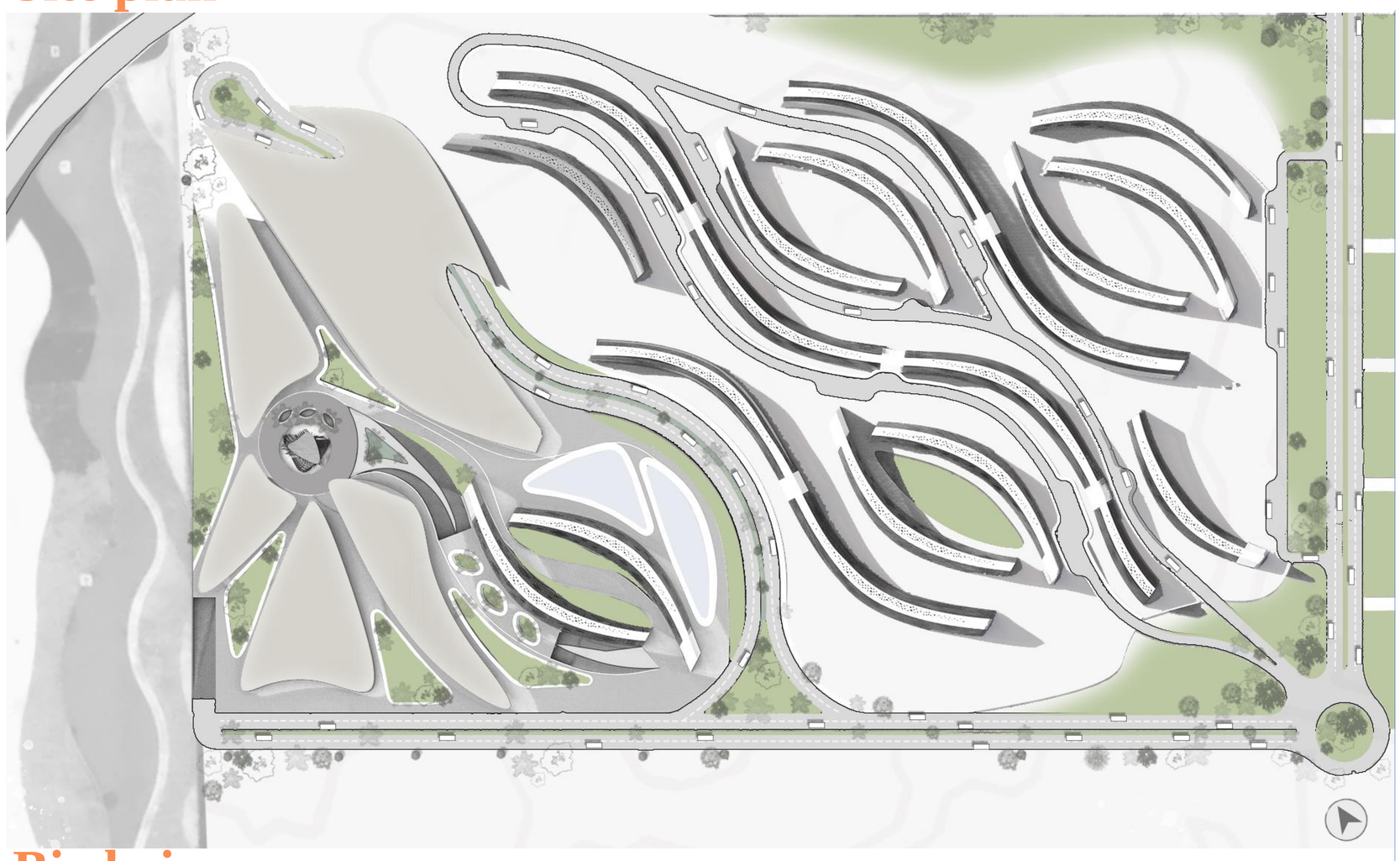


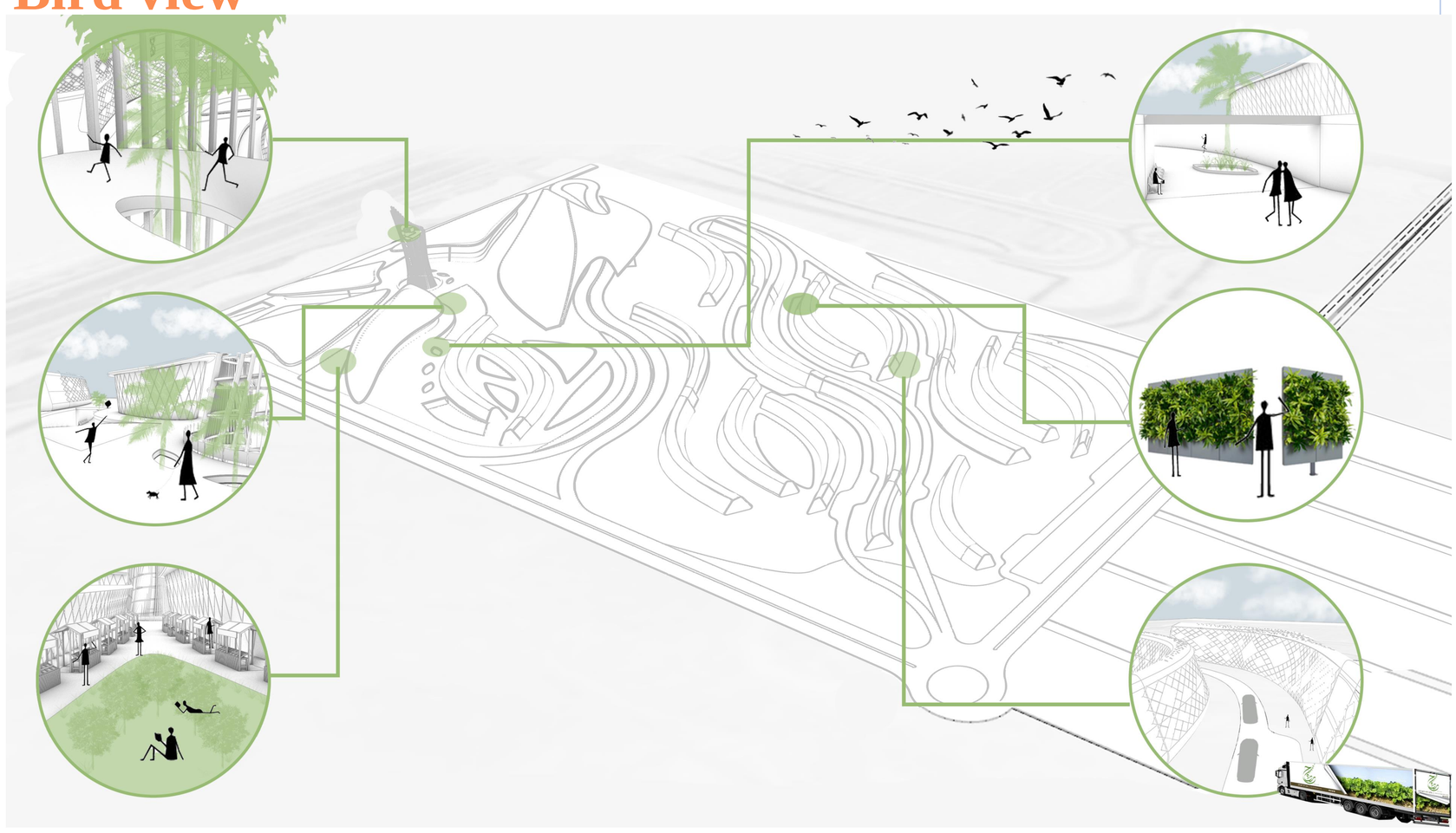




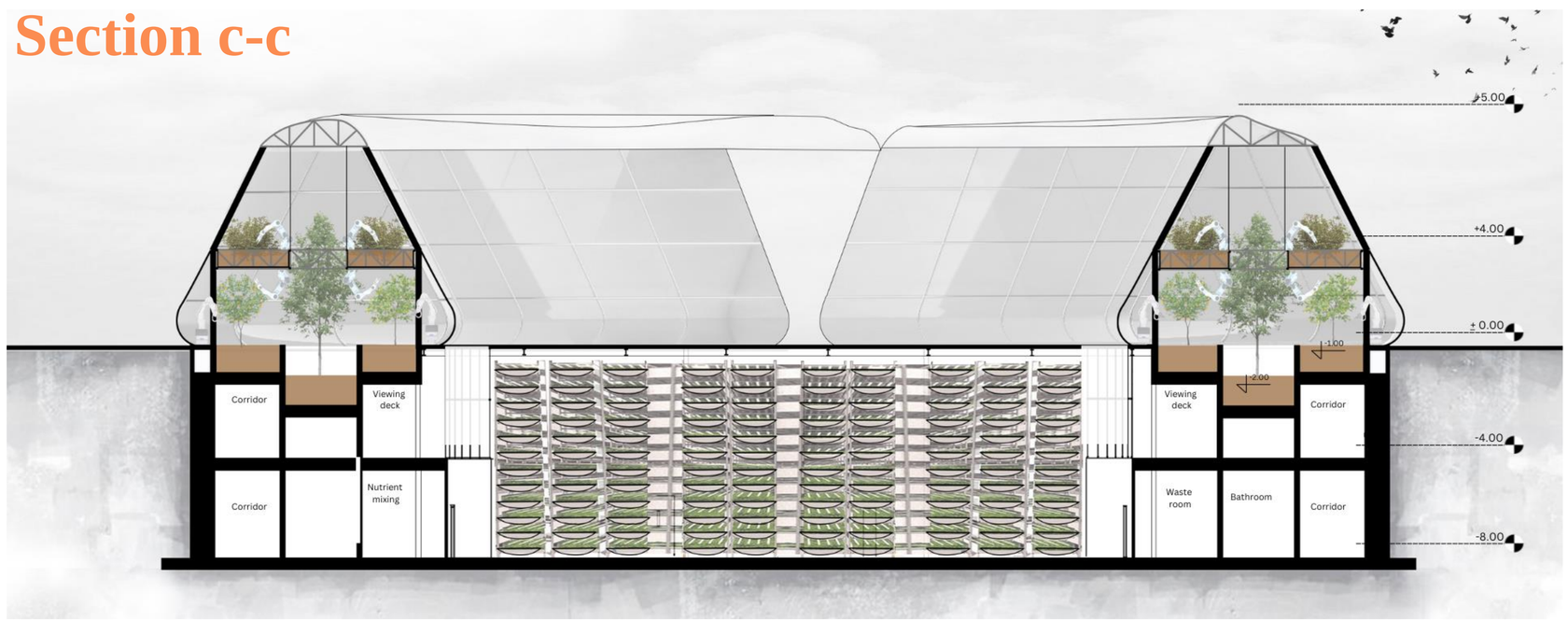
Site plan



Bird view



Section c-c



Rebirth from Memory: A Pioneering Memorial Museum and Park

Umut Museum & Park

Students: Maya Hasan | Ayah Al-Jaghoub | Ayah Alhaji

Supervisor: Dr. Mohammed Wasim

Introduction:

Driven by the increased frequency of natural disasters and calamities that inevitably impair a city's urban fabric, this project, at its core, is a manifestation of the tragedy's memories. The tragedy of the February 6th earthquake that struck Türkiye killed over 50,000 individuals, leaving the city of Kahramanmaraş, the epicenter, permanently scarred.

Rebirth from memory: a pioneering memorial museum and park

Umut Museum & Park

Done by : Maya Hasan
Ayah Al-Jaghoub & Ayah Alhaji
Supervised by Dr. Mohammed Wasim

UMUT
MUSEUM & PARK
Umut müzesi ve parkı

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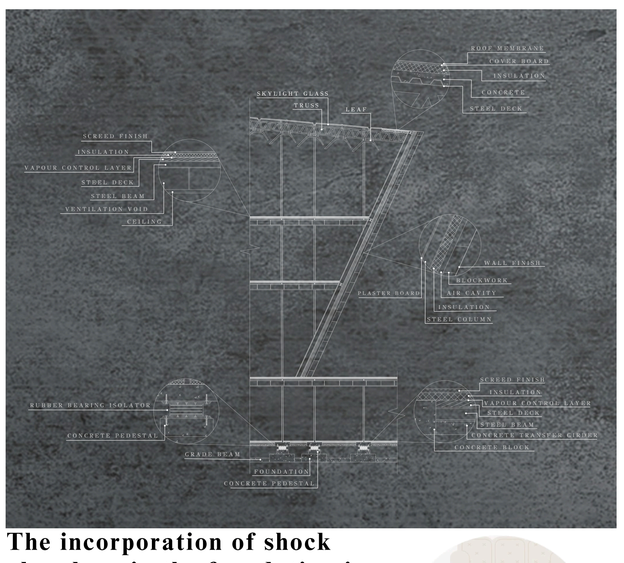
BACKGROUND

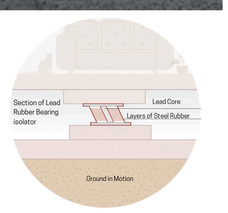
Umut museum and park is a memorial museum-park complex that aims to take its visitors on a transformative journey. This journey is a culmination of a multitude of experiences that tackle the tragic memories of the victims and the cataclysmic earthquake, the transitional phase of learnings and adapting, and finally the yearning for hope. Ultimately, this project is a symbol of aspiration for allowing memories to pave the way for a safer and better future.

CONCEPT

ENGINEERING SOLUTIONS



The incorporation of shock absorbers in the foundation is advised to enhance stability and fortify resilience within the design. Additionally, shear walls are strategically located at intervals of 30 meters along the central axis to ensure effective dispersion of forces such as seismic activity and wind pressure

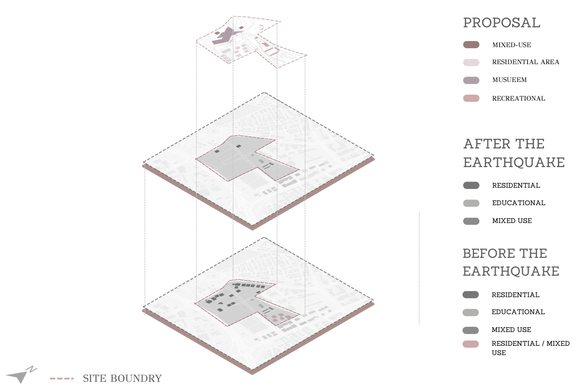


Isolating the Building From Ground Motion

MASTERPLAN

LANDSCAPE ELEMENTS

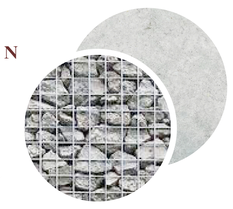
LAND USE RECOVERY



MATERIALS

RUBBLE LEFT BEHIND AFTER AN EARTHQUAKE

ADDRESS THE THEME OF RENEWAL AND SUSTAINABILITY



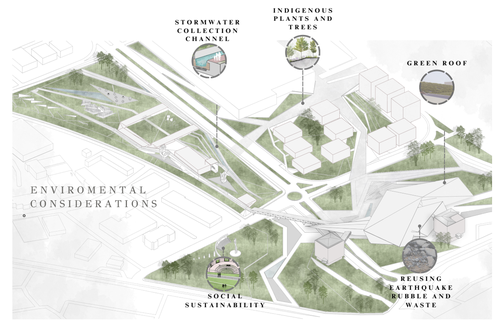
TRAGEDY ZONE — TRANSITION ZONE — HOPE ZONE

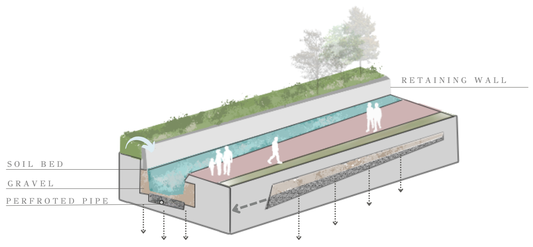
PARK PERSPECTIVE SECTION

JOURNERY
"PAST CREATOR OF THE FUTURE "

INTERIOR SHOTS

ENVIRONMENTAL CONSIDERATIONS





Bioswales, used as water channels in the park, are enhanced with native trees to boost biodiversity and resilience. This combination manages stormwater runoff while creating a habitat for local wildlife. Native trees stabilize soil, improve water quality, and attract various species, making the park more sustainable and enjoyable for all.

ACKNOWLEDGEMENT & REFERENCES

• URBAN DESIGN /ARCHITECTURE Dr. Mohammed Wasim
• URBAN PLANNER Dr. Aomar Oussadou
• STRUCTURE Dr.Samir Dirar
• SUSTAINABILITY Dr.Khaled Obaideen
• HATAY PLANNING CENTER

We extend our deepest gratitude to our families for their unwavering support and understanding throughout the duration of this project

Nemah

An Eco-friendly Mixed-Use Vertical Farm Development

Students: Alya Hamad Alghfeli | Fatma Mohammed Essa

Supervisor: Dr. Aref Maksoud

Introduction:

Introducing a modular building concept designed to enhance production, education and tourism in the city, while addressing diverse challenges in the Middle East. The core of the project is the indoor vertical farms, providing fresh and nutritious produce to both visitors and international markets from Sharjah. Furthermore, the project includes educational facilities aimed at expanding people's knowledge on agriculture. Additionally, a destination that supports UAE's agritourism initiatives

N'MAH

An Eco-friendly Mixed-Use Vertical Farm Development

Designed By: U19100210 Alya Hamad AlGhfeli - U19101661 Fatma Mohammed Essa

Supervised By: Dr. Aref Maksoud

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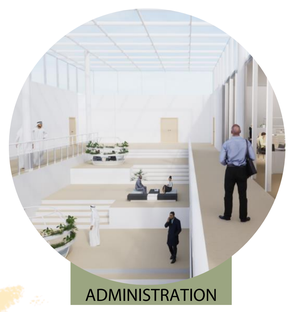
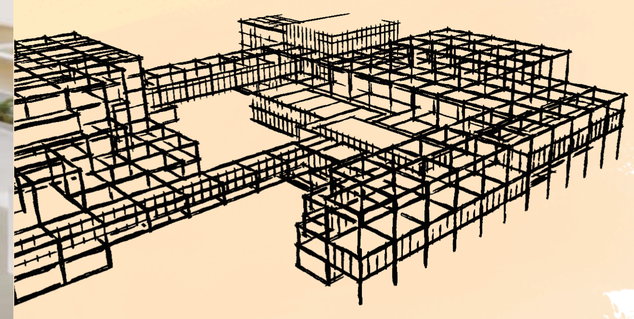
CONCEPT

The concept's inspiration came from the greenhouse's structure where it takes into account structural aspects, agriculture, and efficient production.

The concept development took into account:

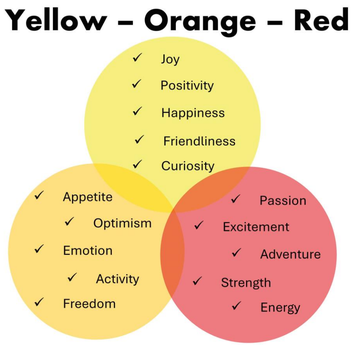
- **Modularity:** 8x8x8 grid that supports the functions of areas and future expansion.
- **Solar Panels:** support tracking system and can be placed at different angles to best optimize solar rays.
- **Crops:** support the growing plants vertically.





GLASS COLOR THEORY

Gradient of:
Yellow – Orange – Red



Sharjah's Name

- Means "Rising Sun" in Arabic.
- Shades of Sun: Yellow, Orange and Red.

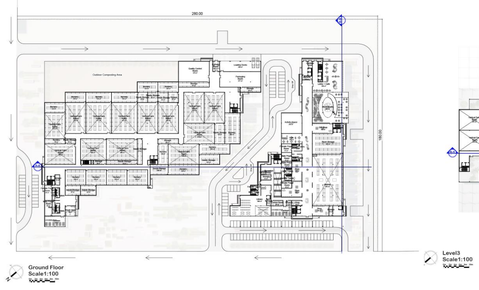
Sharjah

Sharjah City Brand

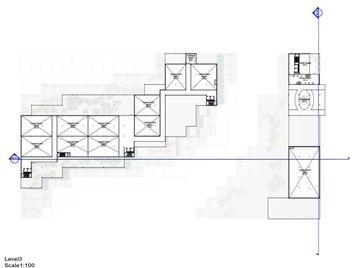
Orange Color Represents:

- Sun and Life
- The Love, Peace, and Mercy of people of Sharjah

GROUND FLOOR PLAN

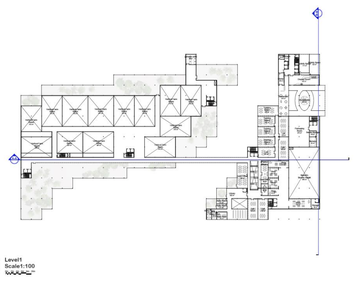


THIRD FLOOR PLAN

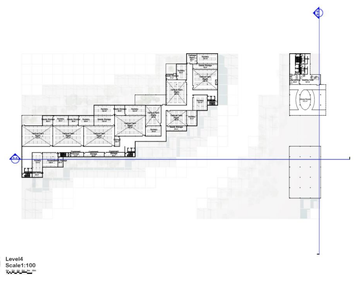


TOURS

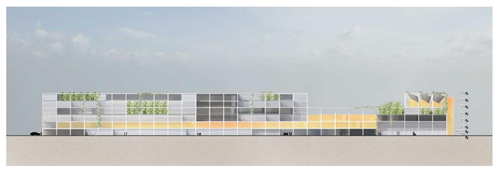
FIRST FLOOR PLAN



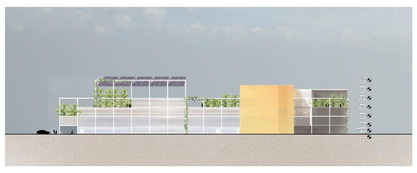
FOURTH FLOOR PLAN



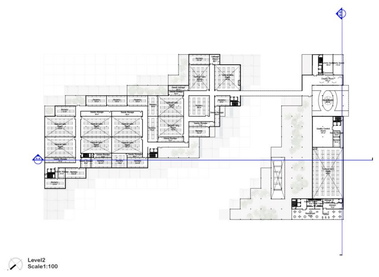
FRONT ELEVATION



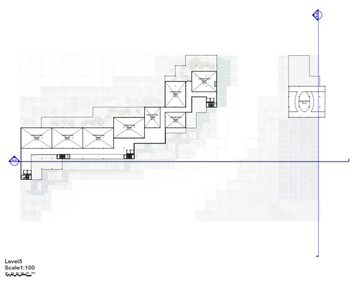
SIDE ELEVATION



SECOND FLOOR PLAN

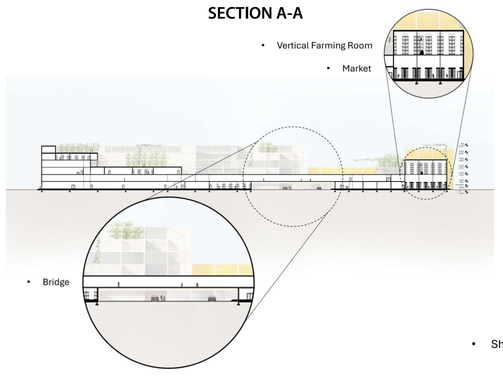


FIFTH FLOOR PLAN



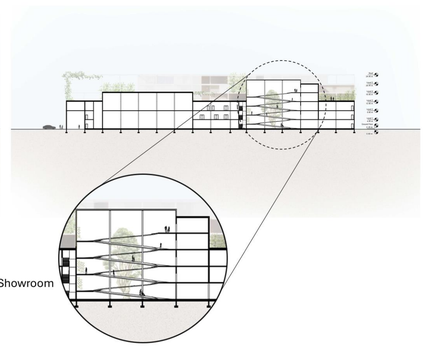
SECTION A-A

- Vertical Farming Room
- Market
- Bridge



SECTION B-B

- Showroom



The Link

Students: Majeda Mohammed | Sara Luae | Abdulaziz ALambaki

Supervisor: Dr. Aseel Ali Hussien

Introduction:

This project proposes creating a dynamic, multifunctional hub within expo city Dubai to revitalize the area by introducing diverse spaces and activities that cater to all ages, addressing issues like post-event stagnancy and climate-induced discomfort. to enhance visitor experience and utilization, it aims to enhance environmental sustainability, improve walkability and livability.

THE LINK

Senior Design

Majeda Mohammed
Sara Luae
Abdulaziz ALambaki

Affiliation: Authors

THE LINK
EXPO CITY

WEBSITE

جامعة الشارقة
UNIVERSITY OF SHARJAH

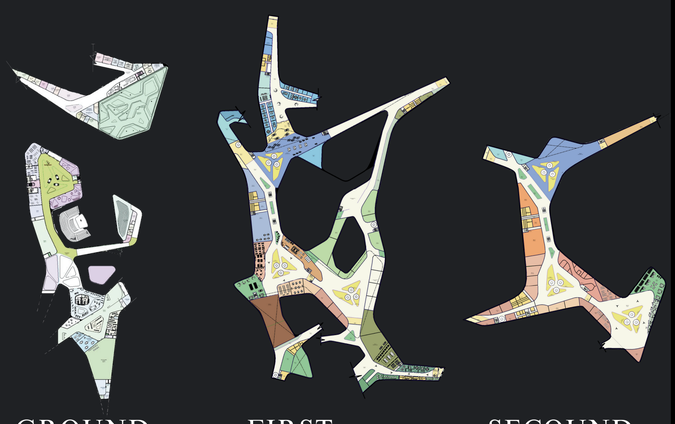
كلية الهندسة
COLLEGE OF ENGINEERING

INTRODUCTION

THIS PROJECT PROPOSES CREATING A DYNAMIC, MULTIFUNCTIONAL HUB WITHIN EXPO CITY DUBAI TO REVITALIZE THE AREA BY INTRODUCING DIVERSE SPACES AND ACTIVITIES THAT CATER TO ALL AGES, ADDRESSING ISSUES LIKE POST-EVENT STAGNANCY AND CLIMATE-INDUCED DISCOMFORT.
TO ENHANCE VISITOR EXPERIENCE AND UTILIZATION, IT AIMS TO ENHANCE ENVIRONMENTAL SUSTAINABILITY, IMPROVE WALKABILITY AND LIVABILITY.

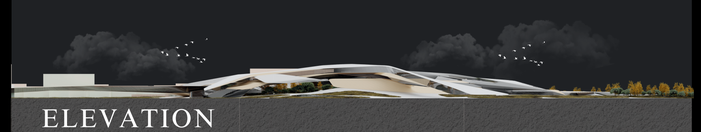
BACKGROUND

PLANS



GROUND FLOOR | FIRST FLOOR | SECOUND FLOOR

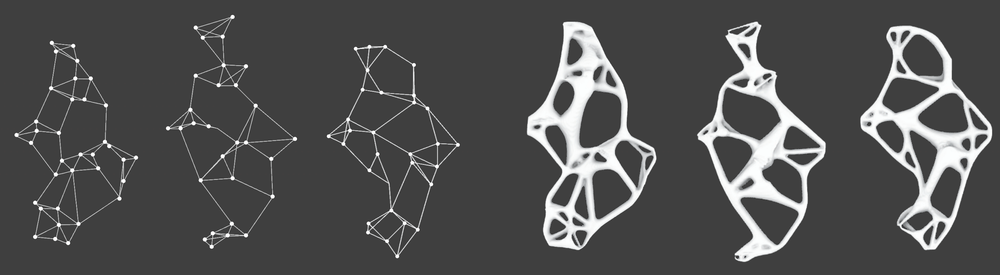
SECTION



ELEVATION

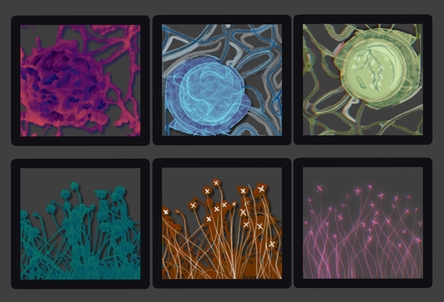
THEORY

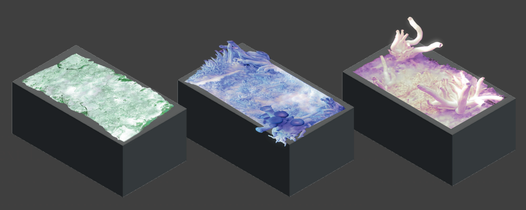
USING PYTHON CODE, THE PROJECT CREATES THE SHORTEST WALKABLE PATHS BETWEEN SPACES IN EXPO CITY DUBAI, LINKED BY RAMPS FOR SEAMLESS ACCESSIBILITY, ENSURING A PERPETUALLY ENJOYABLE EXPERIENCE FOR ALL VISITORS.



SHORTEST DISTANCE LINK VARIATIONS

SETUP, EXPERIMENTAL

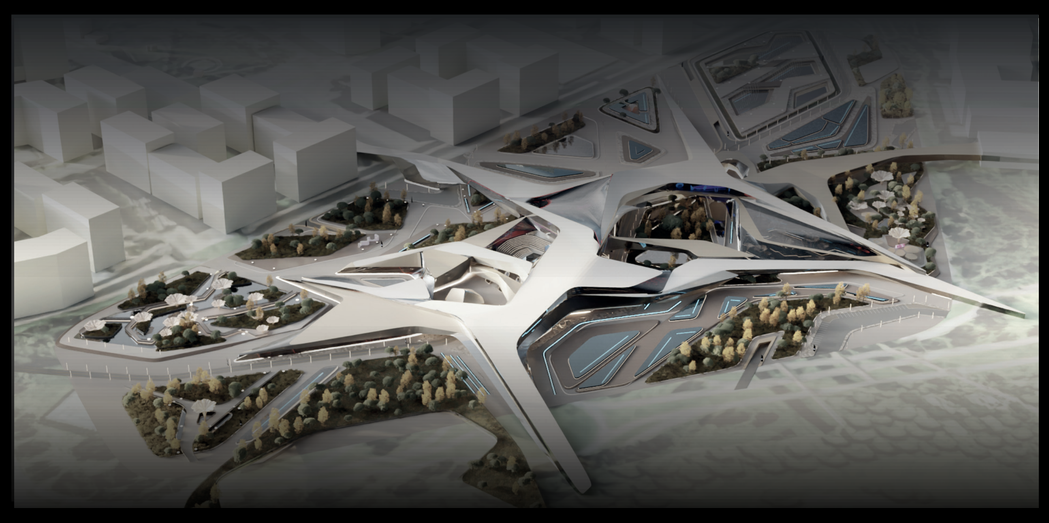


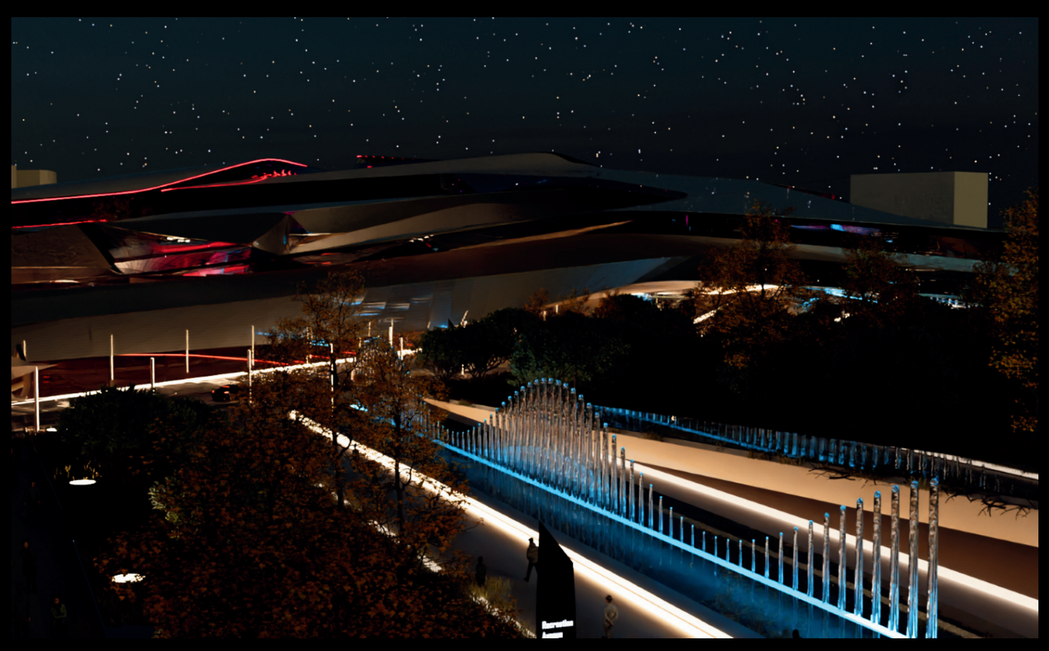


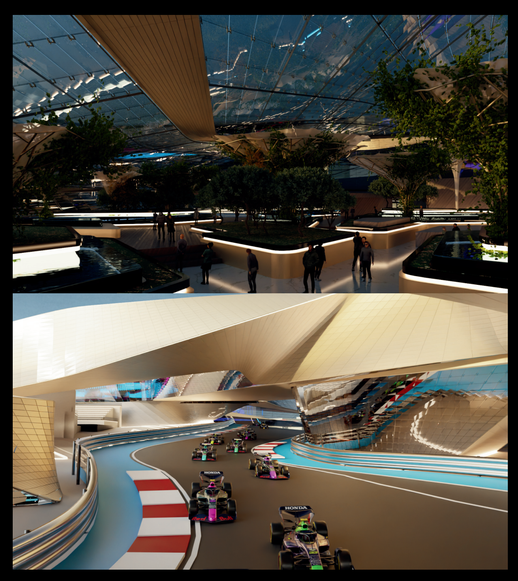
MYCELIUM BRICK GROWTH PROCESS

OUR EXPERIMENTATION WITH BOTH SPORES AND FUNGUS IN MYCELIUM-BASED BRICK PRODUCTION YIELDED DIVERSE RESULTS, SHOWCASING VARIATIONS IN STRENGTH, DURABILITY, AND ECOLOGICAL IMPACT, GUIDING OUR MATERIAL SELECTION PROCESS.

RESULTS

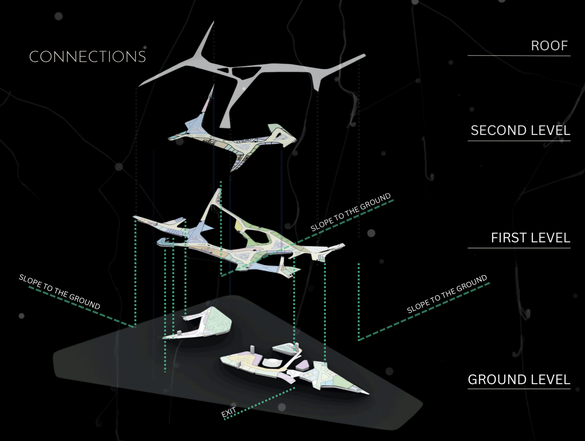


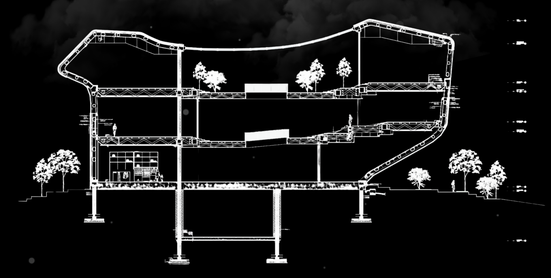




DISCUSSIONS

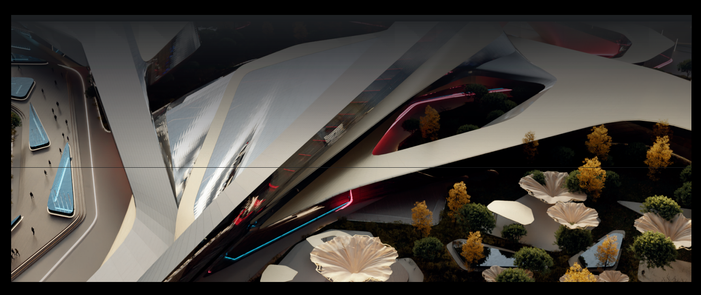
"THE LINK" FOCUSES ON REVITALIZING THE AREA WITH THREE SPECIALIZED ZONES—RECREATIONAL, EDUCATIONAL, AND SOCIAL—TO BOOST COMMUNITY ENGAGEMENT, LEARNING, AND SOCIAL INTERACTION. TO ENHANCE SUSTAINABILITY, MYCELIUM BRICKS, AN ECO-FRIENDLY BUILDING MATERIAL, ARE UTILIZED THROUGHOUT THE CONSTRUCTION.





CONCLUSION

In conclusion, this project aims to transform Expo City Dubai into a vibrant, multifaceted hub by addressing challenges like post-event stagnancy and climate discomfort. Through the incorporation of walkable corridors, dynamic events, and sustainable design based on LEED guidelines, it seeks to attract a diverse audience and enhance the area's usability and appeal.



ACKNOWLEDGEMENT & REFERENCES

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Dr. Aseel Ali Hussien
Prof. Emad S. Mushtaha

Structure
Dr. Samir Mohammed Dirar

Mathematics
Dr. Firas Ghanim Ahmed
Eng. Alaa Hawarna

Expo City
Basil Kalaitzis
Dean Riley

Chemical Lab
Nemat Dek Al-Bab

Other Contributions
Dr.Aref Maksoud
Eng. Osama Hassan

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Wateen: Sculpting Khor Fakkan's Landscape into a Multi-Zonal Tourism Destination

Students: Sarah Isam Alawneh | Farah Mahdy Al Mayahy

Supervisor: Dr. Aref Maksoud

Introduction:

Human civilization, though a mere fraction of Earth's age, has continually evolved, innovating and adapting to its surroundings. From the humble beginnings of Prehistoric hunting societies to the intricate cultures of today, our relationship with nature has shaped our existence. In this context, Wateen seeks to redefine and modernize mountainous sites, particularly within the scenic bounds of Khor Fakkan, Sharjah, UAE. By leveraging advancements in technology and design principles, including computational techniques and artificial intelligence, the research aims to reconceptualize large-scale mixed-use applications in mountainous terrains. Embracing Islamic-local architectural styles and utilizing natural, locallysourced materials, the project strives to fuse cultural authenticity with sustainable architectural innovation. This endeavor not only enhances the tourism potential of the region but also serves as a pioneering example of usercentered design and sustainable development in the UAE.

Wateen

Sculpting Khor Fakkan’s Landscape into a Multi – Zonal Tourism Destination Through AI Tools and Cutting-Edge Design Techniques

Sarah Isam Alawneh , Farah Mahdy Al Mayahy

Supervised by Dr. Aref Maksoud

جامعة الشارقة
UNIVERSITY OF SHARJAH
كلية الهندسة
COLLEGE OF ENGINEERING

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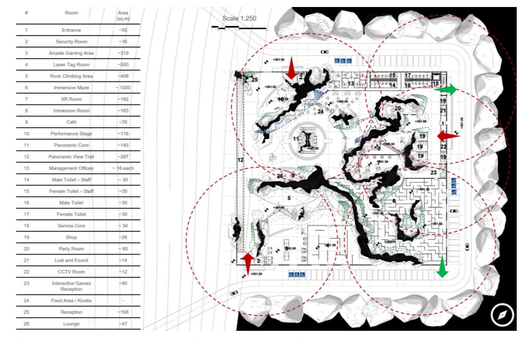
Architectural Design

Hirz – *Recreational and Accommodation Zone*

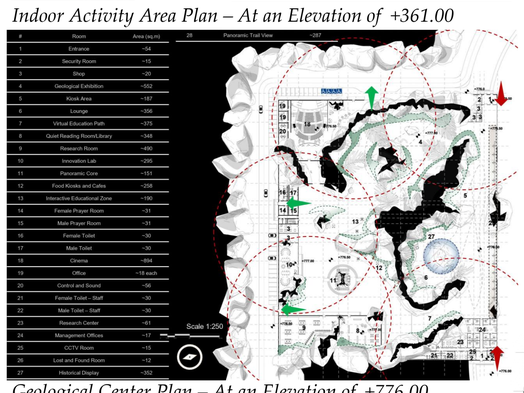
Miškāh – *Educational Zone*

I'rth – *Commercial Zone*

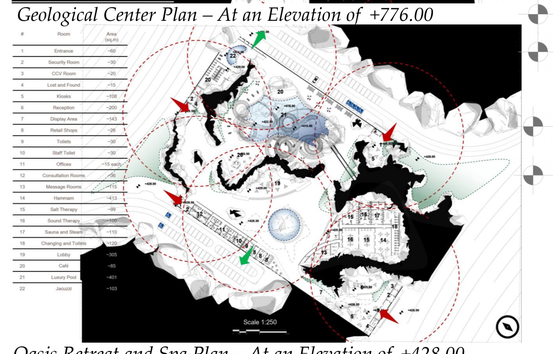
Nabḍ – *Fitness and Wellness Zone*



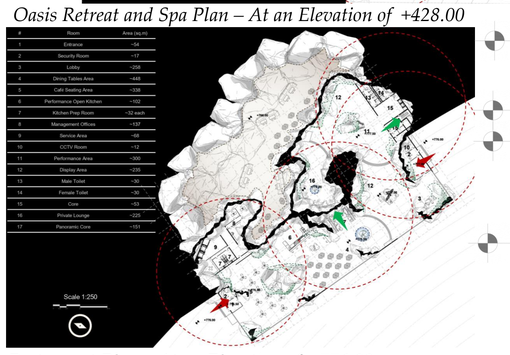
Indoor Activity Area Plan – At an Elevation of +361.00



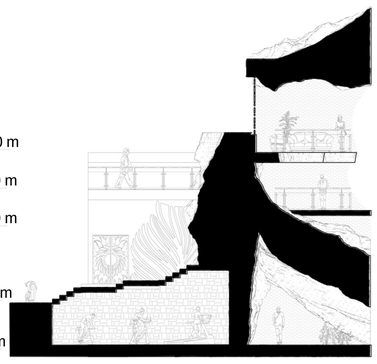
Geological Center Plan – At an Elevation of +776.00



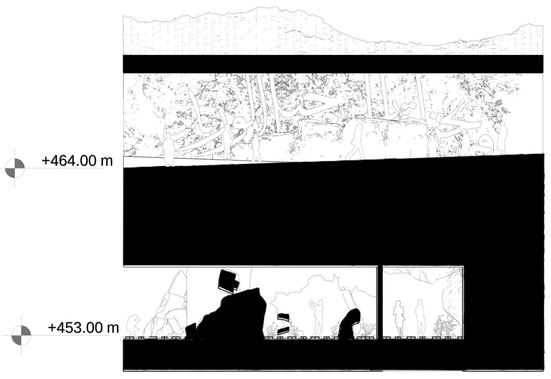
Oasis Retreat and Spa Plan – At an Elevation of +428.00



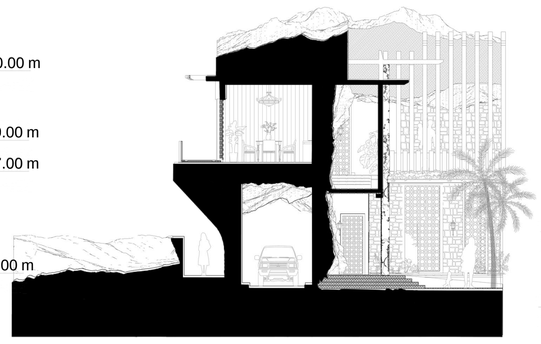
Restaurant Plan – At an Elevation of +776.00



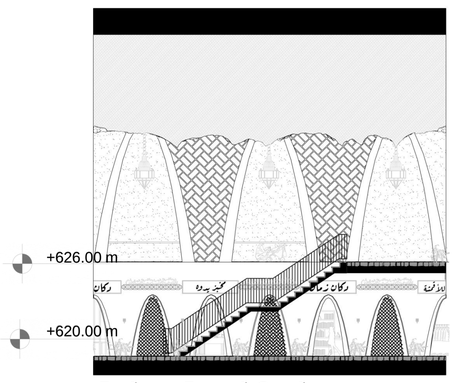
Meditation Center
Section



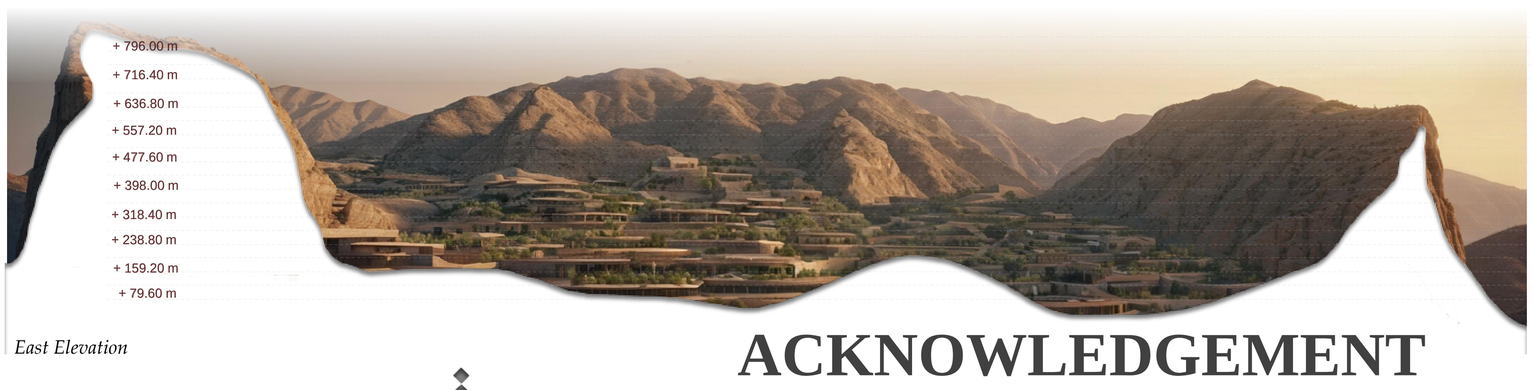
Arabic Calligraphy Exhibition
Section



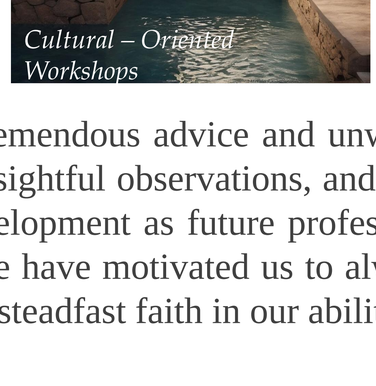
Sarab – Accommodation Local Villa
Section

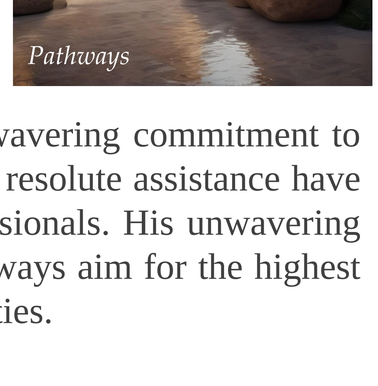


Indoor Local Souk
Section



East Elevation





ACKNOWLEDGEMENT

We are incredibly grateful to Dr. Aref Maksoud for his tremendous advice and unwavering commitment to our senior project. Dr. Maksoud's outstanding guidance, insightful observations, and resolute assistance have been crucial in molding our project and fostering our development as future professionals. His unwavering dedication to our achievement and his desire for excellence have motivated us to always aim for the highest standards. We sincerely appreciate all of his hard work and steadfast faith in our abilities.

Civil & Environmental Engineering

INTRODUCTION

Since its establishment in 1997, the Civil and Environmental Engineering (CEE) Department has become a regional leader in Civil Engineering education. The CEE Department strives to remain at the forefront of modern Civil Engineering education in the City of Sharjah, the cultural capital of the Arab world. To balance the current and emerging needs of [illegible] both locally and internationally.

The Bachelor of Science in CEE degree is a 135-credit program and is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org, and by the UAE Ministry of Higher Education and Scientific Research. The Master of Science in Civil Engineering degree is a 33-credit program with a strong emphasis on research related to local and regional

VISION

The Civil and Environmental Engineering Department aspires to be a regional leader in Civil Engineering education, research, and community service with special focus on the needs of the United Arab Emirates.

MISSION AND GOALS

The Civil and Environmental Engineering Department is to support the needs of the UAE community and the region [illegible] contributing to the discovery and application of knowledge through [illegible] Engineering profession.
[illegible] of Sharjah will produce graduates who:

Are prepared to practice the civil engineering profession responsibly for the benefit of the community.	Will achieve, upon few years of practice, levels of technical knowledge and professional expertise necessary for career advancement and assuming leadership positions in the Civil Engineering profession.	Will pursue scientific inquiry and lifelong learning opportunities, such as self- directed learning, graduate studies, participation in professional activities, and continuing education.

PROGRAMS OFFERED

- Bachelor of Science in Civil Engineering
- Master of Science in Civil Engineering
- Doctor of Philosophy in Civil Engineering
- Master of Science in Environmental Science and Engineering

STUDENTS' ACTIVITIES

Table of Content

Interchange Over Al-Dhaid Road (E88) (University City Sharjah – SAIF Zone)

Feasibility Study: Remote Sensing & PTV Vissim Analysis

Students: Abdalla Alshamsi | Mohamed Kawde | Yousef Ibrahim

Supervisor:Dr. Muamer Abuzwidah | Prof. Rami Al-Ruzouq

WINNER

Introduction:

This project uses state-of-the-art software and application to analyze and propose an overpass over road E88 Al-Dhaid with design elements that follow standards set by local authorities, to provide better access to Sharjah International Airport - Saif Zone and ease traffic flow in surrounding areas.

Interchange Over Al-Dhaid Road (E88)

(University City Sharjah – SAIF Zone)

Feasibility Study: Remote Sensing & PTV Vissim Analysis

Abdalla Alshamsi[1], Mohamed Kawde[1], & Yousef Ibrahim[1]

[1]Trans M1-2 Dept. of Civil & Environmental Eng., University of Sharjah, UAE

Supervisors: Dr. Muamer Abuzwidah & Prof. Rami Al-Ruzouq

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BACKGROUND

Traffic simulation involves mathematical modeling of transportation systems, such as freeway junctions, arterial routes, and roundabouts, using computer software. It aids in planning, designing, and operating transportation networks by simulating traffic behavior and flow patterns1. The field has evolved from early macroscopic models to more detailed microscopic approaches, allowing for precise analysis of individual vehicle behaviors and environmental impacts

DISCUSSIONS

The three alternatives have been discussed below the results.
The recommended option, ***Alternative III - Bridge with Roundabouts***, stands out due to its ***safety features***, ***minimal environmental impact***, and ***shorter commuting distance***. Addressing aesthetic concerns through thoughtful design could enhance its overall acceptance.

CONCLUSION

The senior design project has effectively utilized advanced modeling and simulation tools to propose viable transportation solutions.

Long-term benefits in traffic management, safety improvements, and community development should guide the successful implementation of this project, contributing to the sustainable development of Sharjah's transportation infrastructure.

Limitations

- Simulation does not consider ***actual traffic*** condition of surrounding intersections and traffic facilities.
- Only ***general*** solution is suggested, other restrictions such as land use may apply.
- ***Experienced*** personnel may suggest better solutions, as those mentioned here are based on assumptions and .

METHODOLOGY

Study Area

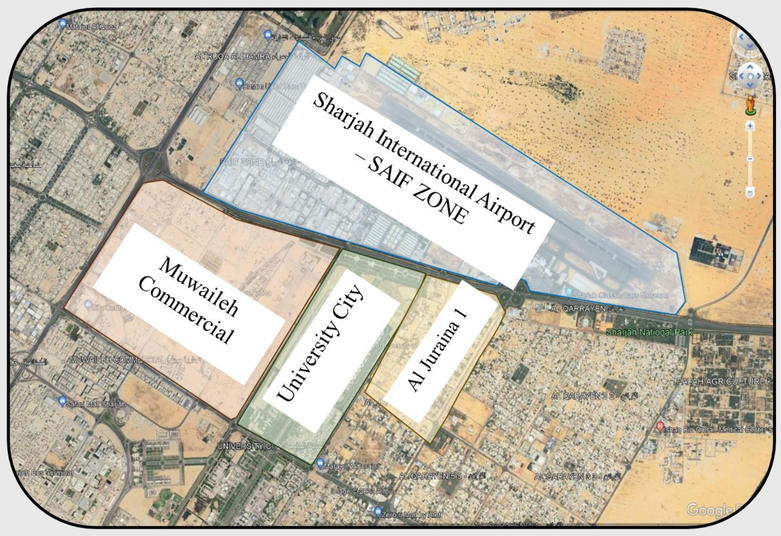
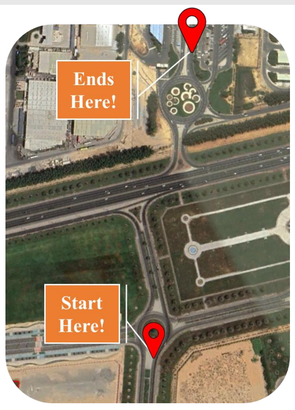


Figure 1. ***E88 Al-Dhaid***, Sharjah, United Arab Emirate.

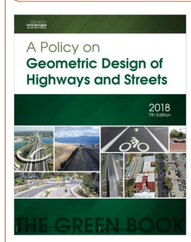


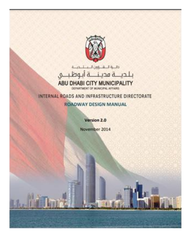
Simulation Assumptions

- **Default** PTV Vissim settings
- Lane widths: **3.60 m**
- Measure between **same two points**
- Peak Hour Volume: **2000 vph**

	Level of Service	Traffic Volume (Average Vehicles) Per Lane Per Hour
Urban	C-E	1400-2000
Rural	C-D	1000-1200

Design Manuals





Google Earth
PTV VISSIM
Google Forms
ArcGIS Pro
USGS science for a changing world

Safety Impact

- Determined by number of Conflict Points
- Determined by distance travelled

Environmental Impact

- Determined by estimated green areas affected
- Determined by total time travelled

Economic Impact

- Comparing to price of constructing similar project.

Social Impact

- Whether it provides possible pedestrian facility
- Perspective of commuters from field survey
- Overall aesthetic appearance and impact.

RESULTS

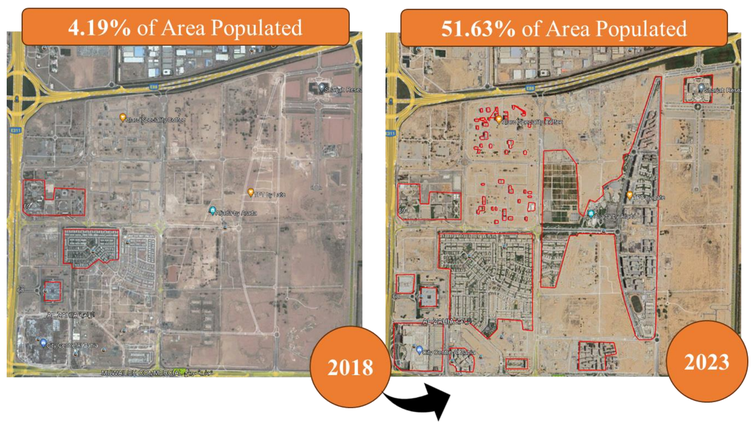


Figure 2: Existing Situation - Simulation

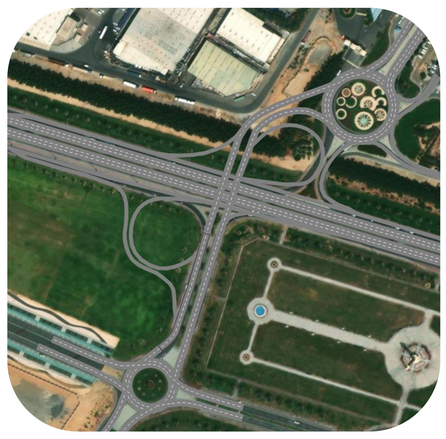


Figure 3: Alternative I – Partial Cloverleaf

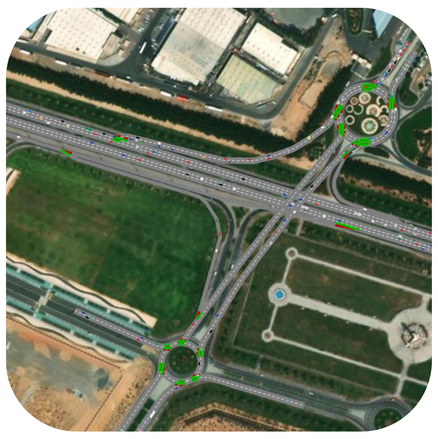


Figure 4: Alternative III – Bridge with roundabouts

Figure 5: Alternative II – Single Lane Bridges

Table 1. Existing Situation Results

Existing Situation Simulation Results		
	To SAIF ZONE	From SAIF ZONE
Distance	6378 m	9227 m
Traffic Volume	Travel Time	
2000 vph / lane	10.00 min	17.32 min

Table 2. Alternative I Results

Alternative I - Simulation Results		
	To SAIF ZONE	From SAIF ZONE
Distance	800 m	730 m
Traffic Volume	Travel Time	
2000 vph / lane	1.73 min	53 s

Table 3. Alternative II Results

Alternative II - Simulation Results		
	To SAIF ZONE	From SAIF ZONE
Distance	2200 m	2190 m
Traffic Volume	Travel Time	
2000 vph / lane	4.17 min	2.77 min

Table 4. Alternative III Results

Alternative III - Simulation Results	
	To/From SAIF ZONE
Distance	633 m
Traffic Volume	Travel Time
2000 vph per lane	55 s

Alternative I - Partial Cloverleaf Interchange

- Robust option with improved traffic flow and safety.
- Considerable environmental impact due to its large footprint.
- Moderate safety impact with (**22**) conflict points.
- Estimated cost: **260** million dirhams.
- Aesthetically challenging for **53**% of survey respondents.

Alternative II - Single Lane Bridges

- Targets traffic congestion by segregating left-turn traffic.
- Highest number of conflict points (**28**) and longest travel distance (2200 m).
- Promotes economic development and local property values.
- Estimated cost: **93.5** million dirhams.
- Socially acceptable and environmentally modest.

Alternative III - Bridge with Roundabouts

- Best environmental impact (green area: 28911.8 m²) and shortest commuting time (1 minute).
- Safest option with (**20**) conflict points (10 merging, 10 diverging).
- Aesthetically less appealing but may accommodate pedestrian facilities.
- Estimated cost: **200** million dirhams.

Analyzing and Improving Traffic Operations at the Intersection of Road S116 and S112

Students: Bashayer Ahmed | Amina Fall | Alya Alsuwaiji | Reed AlOtaiba

Supervisor: Dr. Muamer Abuzwidah

Introduction:

This Senior Design Project analyzes Maleha Street in Sharjah, UAE, focusing on the intersection of roads S116 and S112. The study employs technologies and scientific methods to enhance the planning, operation, and management of transportation systems, ensuring safety, efficiency, and sustainability. It involves extensive data collection and uses tools like Google Earth, Earth Explorer, ArcGIS, and PTV VISSIM to assess road conditions and manage congestion.

Analyzing and Improving Traffic Operations at the Intersection of Road S116 and S112

Bashayer Ahmed U20105547, Amina Fall U20200520, Alya Alsuwaiji U20101209, Reed AlOtaiba U20200024

Supervisors: Dr. Muamer Abuzwidah

Dept. of Civil & Environmental Eng., University of Sharjah, UAE

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BACKGROUND

Traffic simulation uses mathematical models of transportation systems—like freeway junctions, arterial routes, and roundabouts—through computer software. It supports planning, designing, and operating transportation networks by simulating traffic behaviors and flow patterns. The discipline has progressed from early macroscopic models to detailed microscopic approaches, enabling precise analysis of individual vehicle behaviors and environmental impacts.

DISCUSSIONS

Traffic data from 2019, 2024, and 2025 shows worsening conditions. Average delays per vehicle, and vehicle demand rose significantly indicating a growing gap between demand and capacity. Queue lengths and travel times at intersections also increased, suggesting longer crossing durations for vehicles despite short distances.

CONCLUSION

After thorough examination of the intersection between Road S116 and S112, where traffic bottlenecks are most pronounced, it is a must to mitigate this issue. Two solutions have been proposed to mitigate this issue. Farther study is highly recommended for the construction cost of either a bridge or an underpass.

Limitations

Traffic simulation employs mathematical models of transportation systems like freeway junctions and roundabouts through software to plan, design, and operate networks. It has evolved from macroscopic to microscopic models, allowing detailed analysis of individual vehicle behaviors and environmental impacts.

METHODOLOGY

Study Area

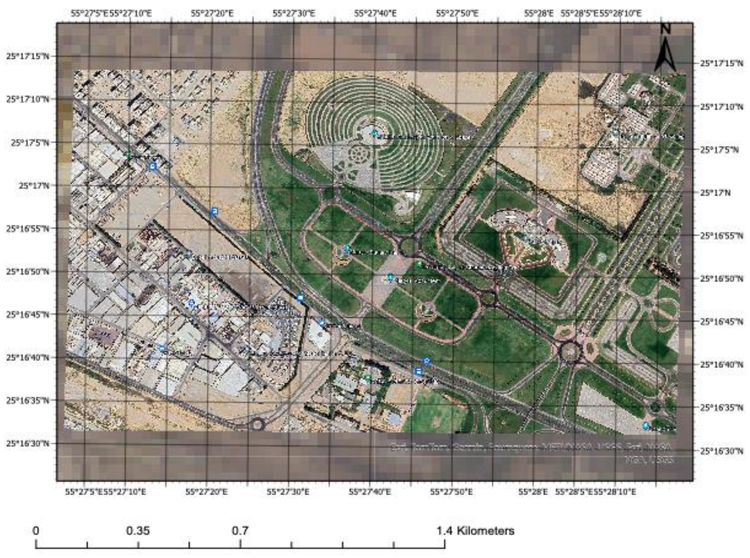
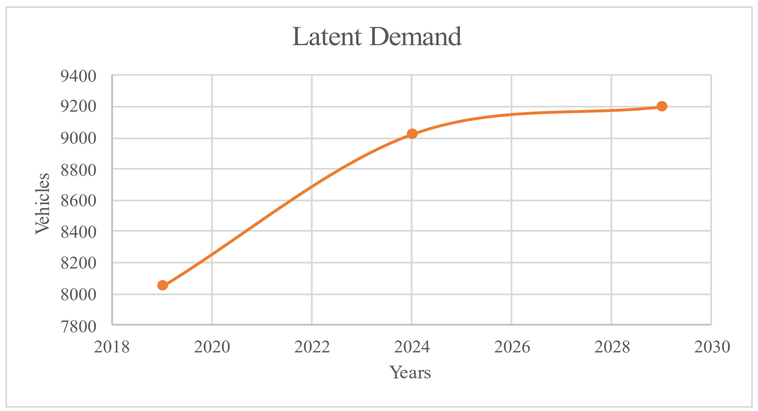


Figure 1: Study Area

RESULTS



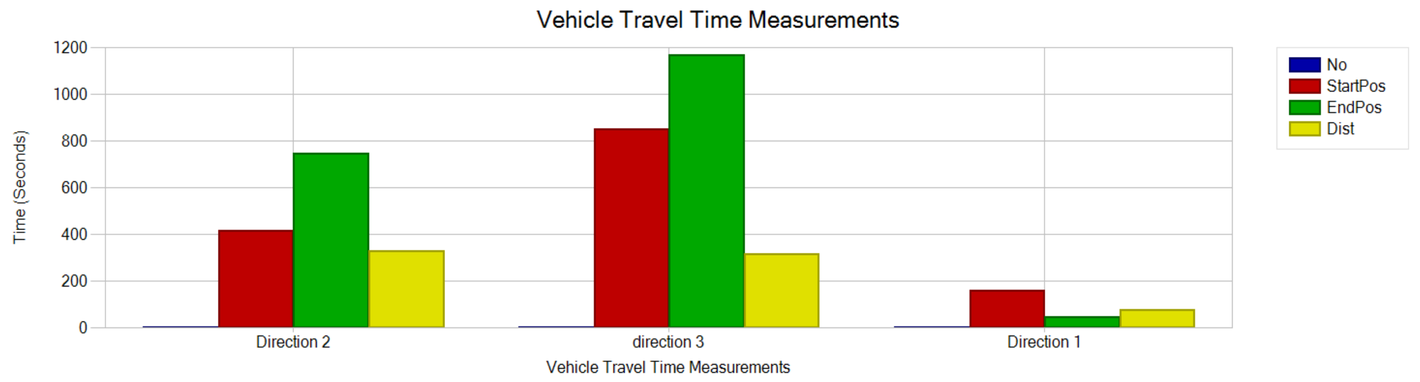
Graph 4 : Latent demand over the Years

Data Collection

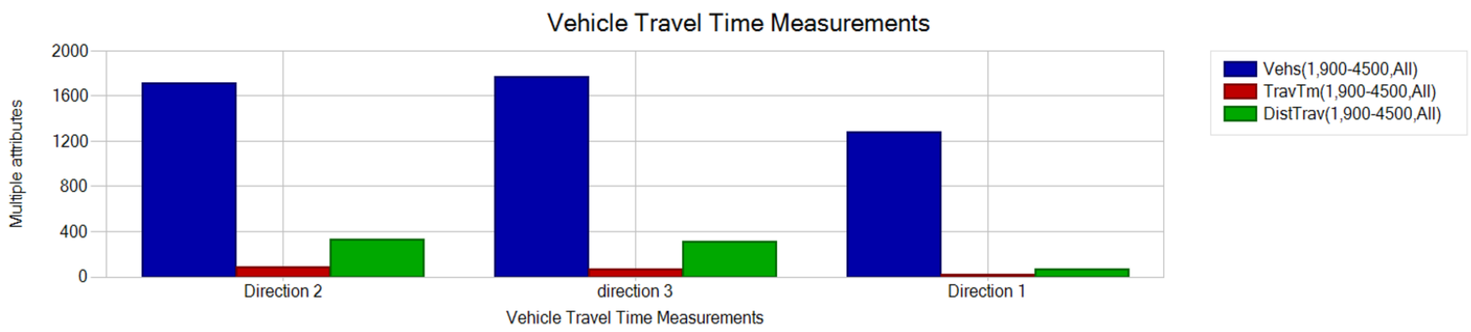
Figure 2: Intersection Signals

Figure 3: Pavement Condition at Intersection of S112 and S116

Graph 5: PTV VISSIM designed Area



Graph 6: Vehicle Travel Time Results (Current)



Graph 7: Vehicle Travel Time Measurements Results (Future)

Enhancing Asphalt Pavement Performance with Styrofoam and Reacted and Activated Rubber (RAR) Additives

Students: Maadh Al falahi | Rashid Al shamsi | Abdullah Al faihan | Salah Mahdi | Abdullah Al Ali

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

Introduction:

This research project aims to enhance asphalt pavements in the UAE by optimizing the use of Reacted and Activated Rubber (RAR) and Styrofoam additives. By experimenting with different proportions of these additives, the study seeks to develop asphalt formulations that improve durability and performance, tailored to the UAE's specific infrastructure challenges.

Enhancing Asphalt Pavement Performance with Styrofoam and Reacted and Activated Rubber (RAR) Additives

Maadh Al falahi, Rashid Al shamsi, Abdullah Al faihan, Salah Mahdi, and Abdullah Al Ali

Supervisor(s): : Prof. Ghazi Al-Khateeb & Dr. Waleed Zeiada

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INTRODUCTION

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OBJECTIVES

Investigation of Additive on the Performance of Asphalt Binder:

- Evaluate the current use of Styrofoam and RAR technologies in UAE asphalt mixtures.
- Explore the capability of Styrofoam and RAR additives to improve UAE asphalt pavement performance.
- Focus on parameters such as durability, flexibility, resistance to aging, and environmental sustainability.

Optimization of Additive Percentages:

- Conduct experiments to optimize the percentages of Styrofoam and RAR additives in asphalt binder.
- Determine the most effective combinations for enhancing asphalt binder properties and performance.

Customization for UAE Conditions:

- Customize research methodologies to align with UAE's specific climatic, traffic, and environmental conditions.
- Ensure that optimized asphalt formulations meet the region's infrastructure needs effectively.

BACKGROUND

Asphalt is a major component of the hot mix asphalt (HMA) used for road construction. Globally, asphalt production exceeds several hundred million tons annually, with over 90% of roads surfaced with asphalt pavement.

The global asphalt market continues to grow, driven by urbanization, infrastructure development, and transportation projects.

Innovative additives like Reacted and Activated Rubber (RAR) and Styrofoam are used to enhance asphalt binder properties and performance.

THEORY / METHODS

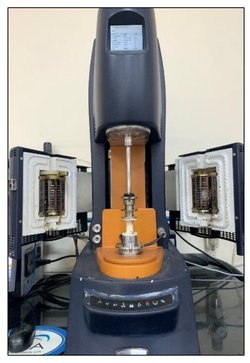
A binder containing 0% of RAR and Styrofoam will be tested to establish a baseline for comparison. Subsequently, a series of asphalt mixtures will be prepared, each containing varying percentages of RAR and/or Styrofoam additives. These percentages include 5%, 10%, and 15% of RAR combined with 0%, 0.05%, and 0.2% of Styrofoam, respectively.

High-Shear Mixer

IPC Controls Pivot Automatic Penetrometer

Anton Paar Softening Point Test Instrument

Brookfield Viscometer



Dynamic Shear Rheometer (DHRIII by TA Instruments)

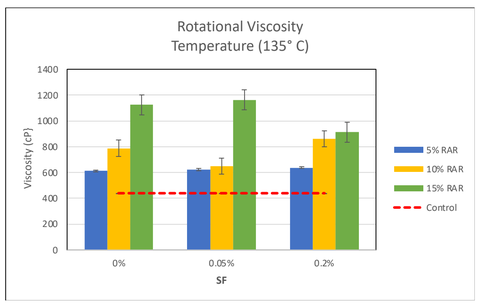
RESULTS

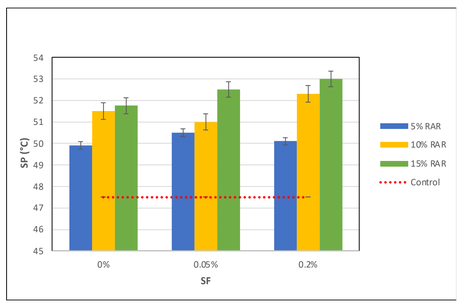
Increasing Reacted and Activated Rubber (RAR) concentration enhances stiffness, deformation resistance, thermal stability, and recovery capability of asphalt binder under various stress conditions.

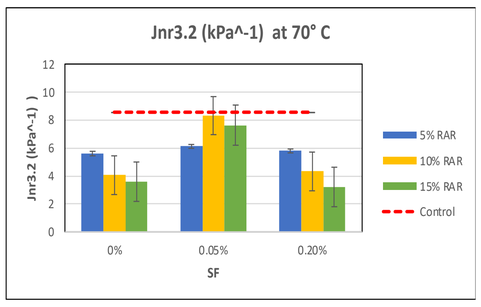
Combining Styrofoam (SF) additives with RAR further enhances asphalt binder properties, especially at higher SF concentrations.

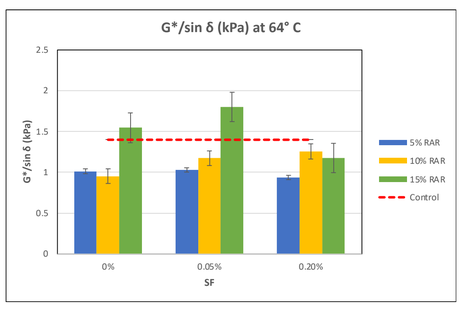
Optimal improvement in strength and durability observed with 5% RAR and 0.2% Styrofoam mix.

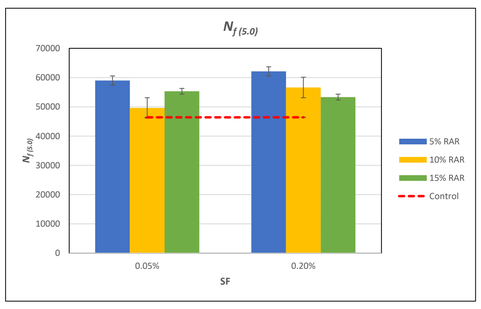
Least effective in mitigating rutting and fatigue found in the mix containing 10% RAR and 0.05% Styrofoam.

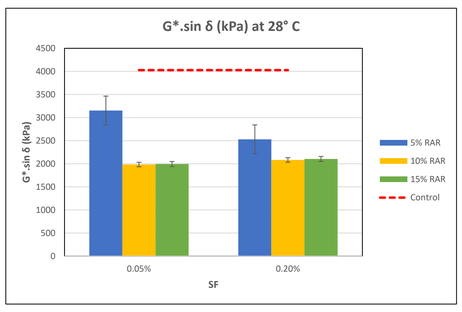












MSCR

1	0.2% SF 15% RAR
2	0.2% SF 10% RAR
3	0.2% SF 5% RAR
4	0.05% SF 5% RAR
5	0.05% SF 15% RAR
6	0.05% SF 10% RAR

Binder	Rutting	Fatigue	Total
0.05% SF 5% RAR	4	2	6
0.05% SF 10% RAR	6	6	12
0.05% SF 15% RAR	5	4	9
0.2% SF 5% RAR	3	1	4
0.2% SF 10% RAR	2	3	5
0.2% SF 15% RAR	1	5	6

LAS

1	0.2% SF 5% RAR
2	0.05% SF 5% RAR
3	0.2% SF 10% RAR
4	0.05% SF 15% RAR
5	0.2% SF 15% RAR
6	0.05% SF 10% RAR

FINDINGS

Increasing RAR concentration generally decreases penetration values.
Addition of SF alongside RAR decreases penetration further, particularly at higher SF concentrations.

Higher RAR concentration increases softening point values, indicating improved resistance to deformation at high temperatures.
SF addition enhances this effect, further increasing softening points.

Increasing RAR concentration improves stiffness and elastic behavior at elevated temperatures.
SF addition influences stiffness, particularly at higher concentrations.

Higher RAR concentration enhances binder's recovery capability under low and high stress levels.
SF addition affects recovery capability depending on temperature and concentration.

Higher RAR concentration enhances stiffness and resistance to deformation.
SF addition shows nuanced effects on stiffness, influenced by concentration and temperature.

Increasing RAR concentration improves resistance to deformation and viscoelastic behavior.
SF addition enhances these properties, particularly at higher concentrations.

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- Ramadan, K. Z., Al-Khateeb, G. G., & Taamneh, M. (2019). Mechanical properties of styrofoam-modified asphalt binders. International Journal of Pavement Research and Technology, 13(2), 205–211. https://doi.org/10.1007/s42947-019-0102-4

Headwear Detection System for Construction Safety

Students: Abdullah Monif | Ahmed Msallam | AbdelRahman Almadani | Omar Touba

Supervisor: Dr. Ram Kumar | Dr. Saleh Abu Dabous

Introduction:

Helmet detection using webcam technology has potential applications in various fields, including construction site safety monitoring and remote worker identification. However, the accuracy of such systems can be significantly impacted by real-world conditions. This study investigates the performance of a webcam object detection algorithm for helmet recognition across a diverse set of scenarios. We evaluate the algorithm's effectiveness under varying lighting conditions (well-lit, dim, bright), resolutions (high, low), and presence of factors that might hinder detection such as occlusion, multiple people, movement, and different helmet types.

Headwear Detection System for Construction Safety

Abdullah Monif U20103675, Ahmed Msallam U20102587, AbdelRahman Almadani U20106208 **and** Omar Touba U18105155.
Dept. of Civil & Environmental Eng., University of Sharjah, UAE
Supervisor(s):Dr.Ram Kumar & Dr.Saleh Abu Dabous

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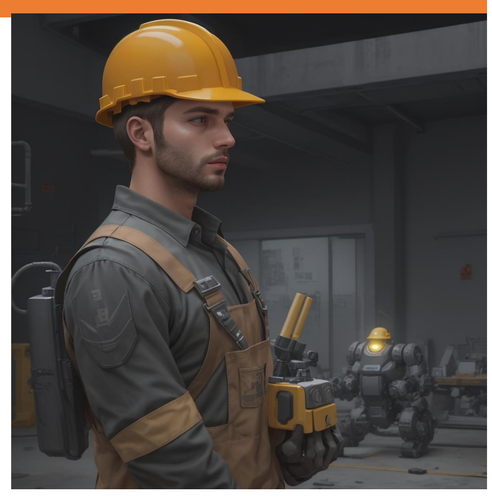
Introduction



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We evaluate the algorithm's effectiveness under varying lighting conditions (well-lit, dim, bright), resolutions (high, low), and presence of factors that might hinder detection such as occlusion, multiple people, movement, and different helmet types.

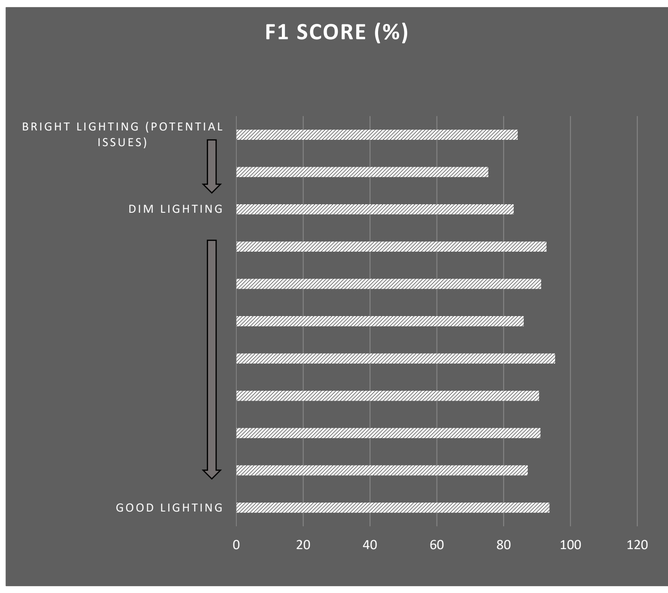

Figure 1.F1 score related to lighting

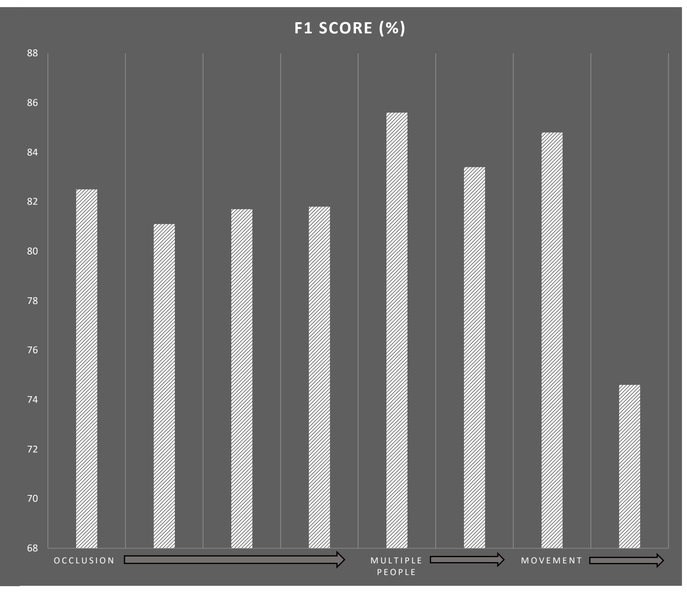

Figure 2.F1 score with different distortions

Data Analysis, and Results

Trial	Scenario (Webcam)	Precision	Recall	F1 Score
1	Well-lit room, person sitting directly facing webcam	95.40%	92.10%	93.70%
2	Dimly lit room, person working at a desk with webcam, helmet on	86.20%	79.80%	83.00%
3	Room with window light, person wearing helmet while holding tools, lit by webcam	89.90%	84.50%	87.20%
4	Room with overhead fluorescent lights, person putting on helmet, lit by webcam	92.70%	89.30%	91.00%
5	Person wearing a helmet with a reflective visor in a room (webcam struggles with reflections)	79.50%	85.70%	82.50%
6	Person wearing a construction helmet tilted back while working on a shelf, lit by webcam	83.90%	78.50%	81.10%
7	Person wearing a baseball cap partially obscuring a bike helmet, lit by webcam	86.80%	76.90%	81.70%
8	Low-resolution webcam footage, person walking through a room with a helmet	81.00%	76.20%	78.50%
9	High-resolution webcam, person standing still in a room, helmet on a table, lit by webcam	91.10%	87.40%	89.20%
10	Multiple people in a room, some wearing helmets and some not, captured by webcam	88.30%	82.90%	85.60%
11	Person wearing a helmet while sitting at a computer, partially obscured by monitor, lit by webcam	84.50%	79.20%	81.80%
12	Person on a stationary bike trainer wearing a helmet, lit by webcam	92.40%	88.80%	90.60%
13	Person sitting on a couch, facing the webcam, helmet on.	96.70%	94.10%	95.40%
14	Person walking with a helmet in a room with cluttered background, captured by webcam	87.60%	82.20%	84.80%
15	Person with a beard, good lighting conditions in a room, lit by webcam	88.70%	83.40%	86.00%
16	Person with a beard, low-resolution webcam footage in a dimly lit room	78.10%	72.80%	75.40%
17	Person wearing a helmet with a dark visor in a brightly lit room, lit by webcam	80.20%	88.50%	84.2%
18	Person wearing a brightly coloured helmet with lights in the background, lit by webcam	92.60%	89.90%	91.20%
19	Multiple people in a workshop, some wearing helmets and some not, captured by webcam	86.10%	80.70%	83.40%
20	Person wearing a motorcycle helmet	83.70%	81.00%	82.30%
21	Person walking by with a helmet in a hallway, captured by a webcam with good lighting	94.20%	91.40%	92.80%
22	Person moving around a room, wearing a helmet (webcam might struggle with movement)	77.80%	71.50%	74.60%

Table 1. Summary of data

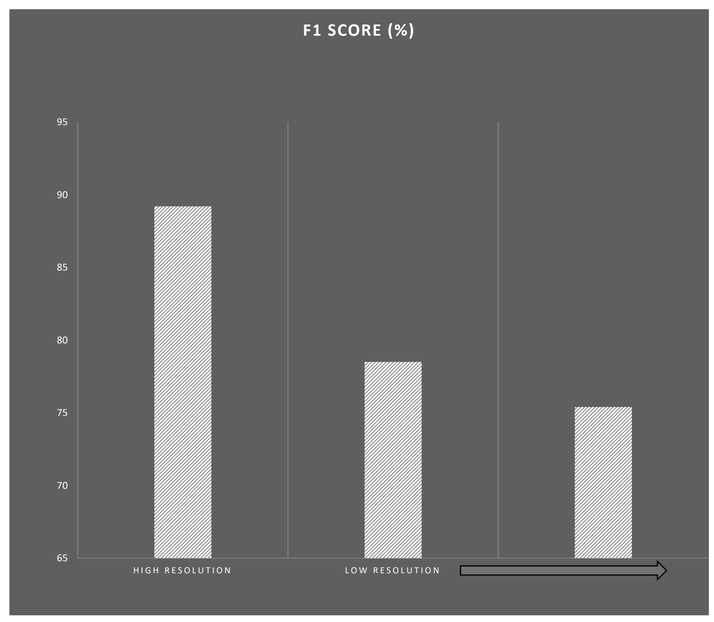

Figure 3.F1 score in relation to resolution

```
StartCamera()

While True:
    frame = CaptureFrame()

    Convert frame to grayscale
    gray_frame = ConvertToGrayscale(frame)

    Detect faces
    detected_faces = DetectFaces(gray_frame)

    Count people with helmets
    people_with_helmets = 0

    Iterate over detected faces:
        Check if face is wearing a helmet:
            Increment people_with_helmets counter

    Show results on frame
    ShowResults(frame, people_with_helmets, TotalDetectedFaces(detected_faces))

    Check for exit command
    if ExitCommandDetected():
        break

StopCamera()
```

Figure 6. pseudo code

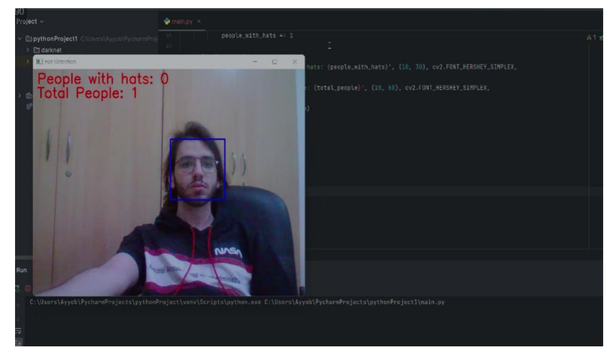

Figure 4.EXAMPLE:not wearing anything

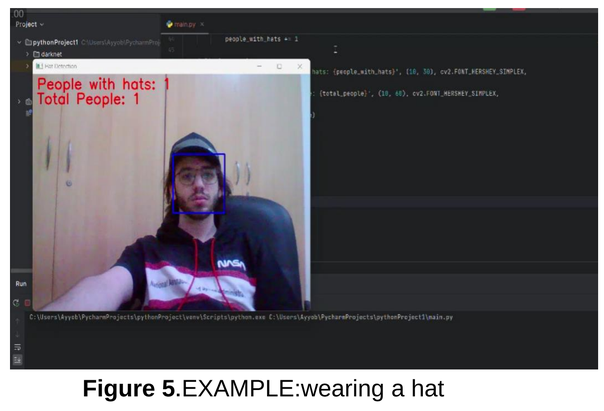

Figure 5.EXAMPLE:wearing a hat

Summary and Conclusions

Key Findings:

- Lighting: Overall, well-lit environments yielded the best performance (average F1 score above 90%). Dim lighting conditions and bright lighting with potential reflections (e.g., dark visor) resulted in lower scores (around 80% F1 score).
- Resolution: High-resolution video footage led to slightly better results compared to low-resolution footage (around a 4% difference in F1 score).
- Occlusion, Multiple People, Movement: Scenarios with occlusions (e.g., tilted helmet), multiple people, or significant movement generally resulted in lower performance (F1 score below 85%).
- Helmet Type: The type of helmet itself didn't seem to have a major impact on detection accuracy, with scores ranging from 82% to 92% F1 score across different helmet types

Overall:

The study demonstrates that the webcam object detection algorithm performs well in controlled environments with good lighting and minimal obstructions. However, its effectiveness decreases when encountering real-world challenges like dim lighting, movement, and occlusions.

Integration of Titanium Oxide Nanoparticles and Carbon Nanotubes for Enhancing Asphalt Binder Properties

Students: Sara Eid | Malak Gaddah | Reem Ali | Aisha Alaskar

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

Introduction:

This Project Investigates The Impact Of Incorporating Multi-wall Carbon Nano Tubes (MWCNT) And Titanium Oxide Nanoparticles (Nano-tio2) On The Properties Of Asphalt Binders.

Integration of Titanium Oxide Nanoparticles and Carbon Nanotubes for Enhancing Asphalt Binder Properties

Department of Civil & Environmental Engineering
Senior Design Project II - (Spring 2023/2024)
Sara Eid, Malak Gaddah, Reem Ali, & Aisha Alaskar
Supervisors: Dr. Waleed Zeiada and Prof. Ghazi Al-Khateeb

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INTRODUCTION

This Project Investigates The Impact Of Incorporating Multi-wall Carbon Nano Tubes (MWCNT) And Titanium Oxide Nanoparticles (Nano-tio2) On The Properties Of Asphalt Binders.

OBJECTIVES

- Examine how Multi-wall Carbon Nano Tubes (MWCNT) and Titanium Oxide Nanoparticles (Nano-TiO2) affect the physical properties of a 60/70 base asphalt binder.
- Analyze the combined effects of nanoparticles on the asphalt binder when using both conventional and Superpave testing methods.
- Explore the effectiveness of MWCNT and Nano-TiO2 in improving the asphalt binder's resistance to rutting, particularly in regions like the UAE .

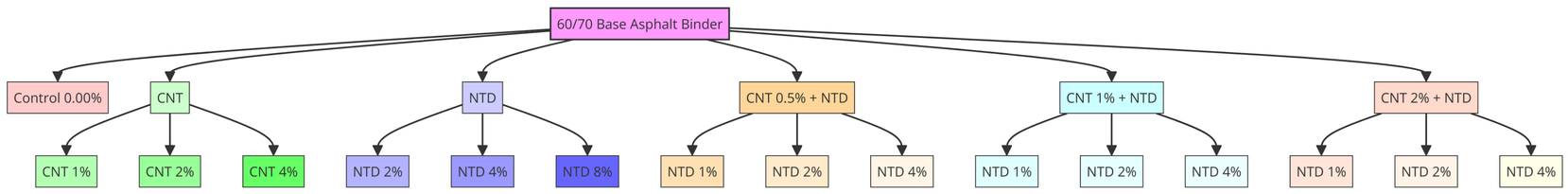
FINDINGS

- The sample with 2% CNT and 1% NTD exhibited the highest G*/sin δ value, indicating superior resistance to rutting at 64°C.
- The sample with 2% CNT and 2% NTD displayed the lowest G*sin δ value, indicating enhanced resistance to fatigue cracking at 28°C.
- In the MSCR Test, 8% NTD was classified as "Heavy Traffic" according to standards, sustaining a strain of 3.2 KPa at 70°C, which indicates excellent resistance to traffic loading and rutting at high temperatures.

CONCLUSION

The study on Nano-Modified Asphalt Binder with Carbon Nanotubes (CNT) and Nano Titanium Dioxide (NTD) has led to notable findings. Mixes have greatly enhanced high-temperature performance and rutting resistance, such as 2% CNT and 1% NTD. As well as fatigue enhancement through the mix 2% CNT and 2%. In addition, AASHTOWare results revealed that 2% CNT and 1% NTD can extend the life span of the pavement by 4.75 years. In summary, nano-modification with CNT and NTD enhances asphalt binder performance in warm climates but requires careful balance with application challenges and temperature adaptability.

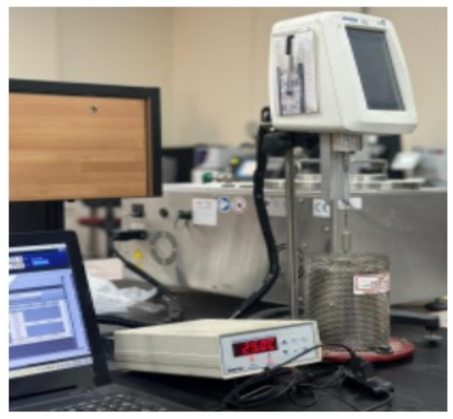
Binder Mixes



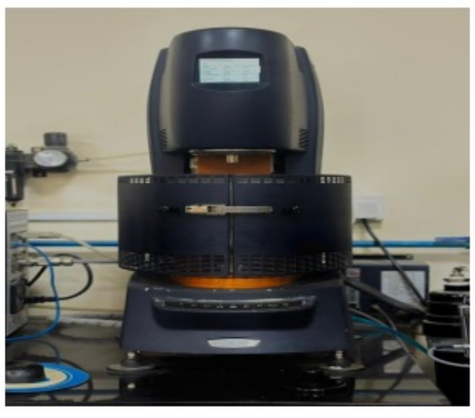
Apparatus

Penetration Test ASTM D5/D5M – 20

Softening Point Test ASTM D36/D36M – 14



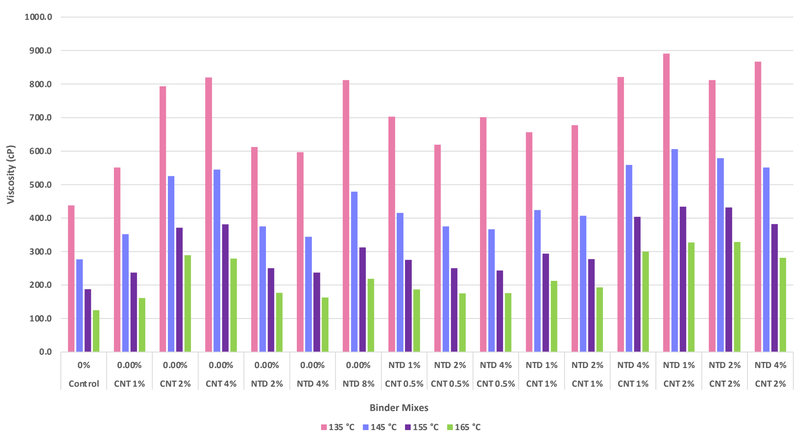
Rotational Viscometer Test ASTM D4402/D4402M – 15

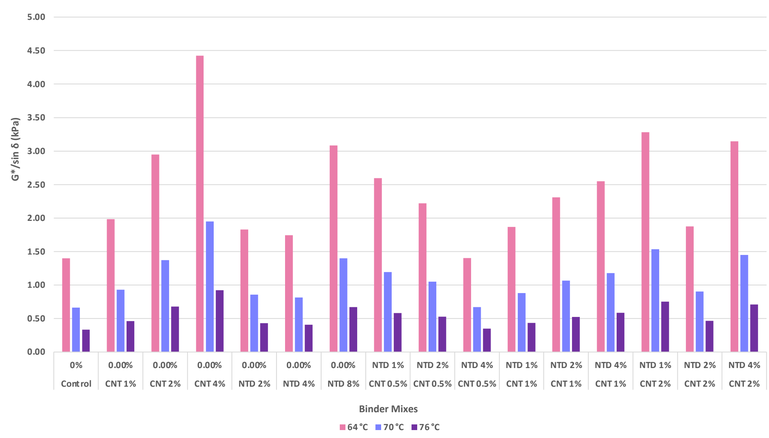


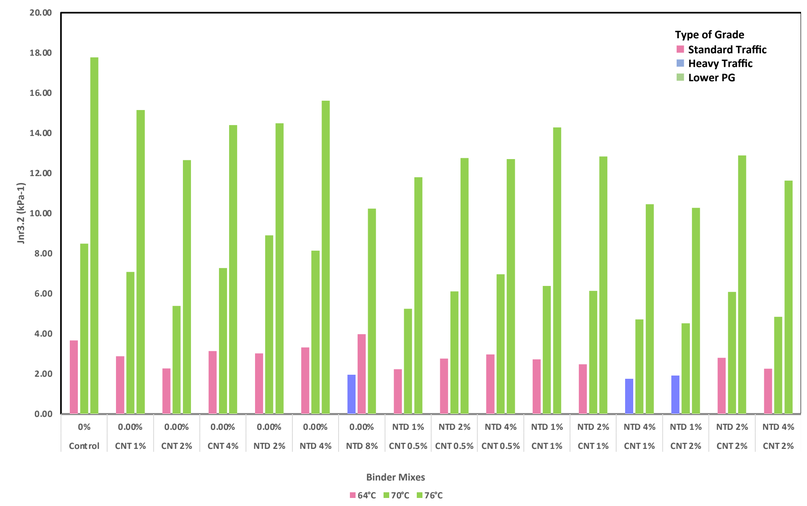
Dynamic Shear Rheometer ASTM D7175 – 15

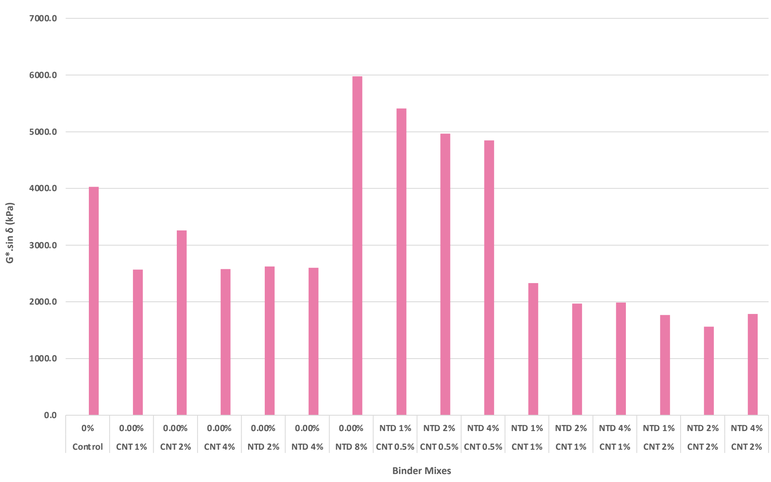
Bending Beam Rheometer ASTM D6648

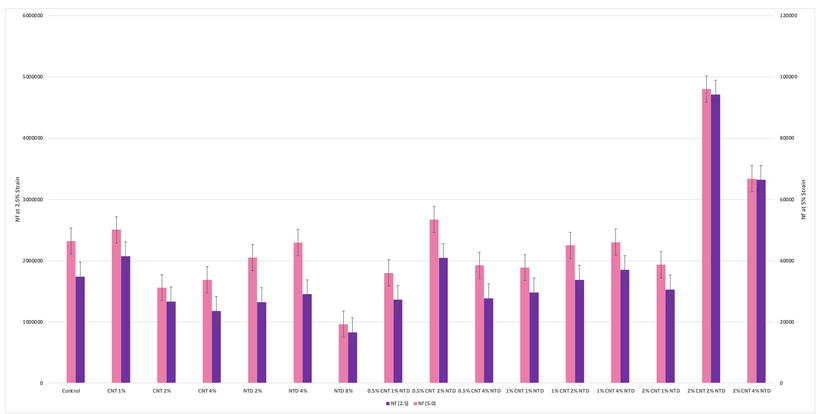
RESULTS

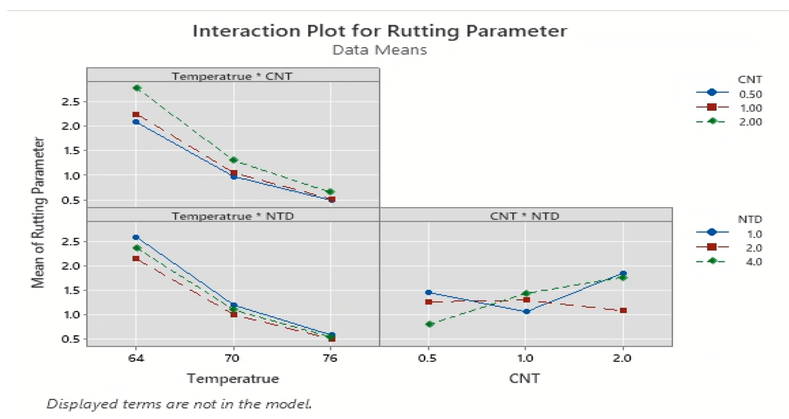












Investigate the Synergistic Effect of the Nano Materials on Asphalt Binder

Students: Ahmad Ez Eddin | Mohammed Tayeb | Omar Kardousha | Ibrahim Diyab

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

Introduction:

This projects main idea is to study the possible changes and improvements in different performance parameters of nanomodified asphalt binder, using 60/70 Shell Control Binder, and Carbon Nano Tubes (CNT) and Nano Aluminum Trioxide (NAT) as the nano modifiers of interest.

Investigate the Synergistic Effect of the Nano Materials on Asphalt Binder

Ahmad Ez Eddin, Mohammed Tayeb, Omar Kardousha, and Ibrahim Diyab

Dept. of Civil & Environmental Eng., University of Sharjah, UAE

Senior Design Project (2), Spring 2023 - 2024

By Supervision Of Dr. Waleed Zeiada and Prof.Ghazi Al-Khateeb

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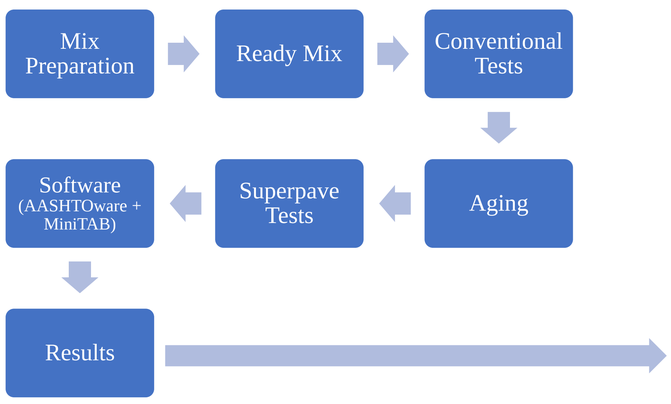
OBJECTIVES

- Explore the synergistic effects of CNT and NAT in varying proportions and assess their collective impact on the overall performance of asphalt binders.
- Execute all conventional and superpave tests to examine the rheological properties of the modified binder, comparing it with the control.
- Determine the best combination of CNT and NAT percentages that yields the most significant enhancements in asphalt binder properties and rutting and fatigue cracking resistnace

TESTING FLOWCHART



Test Category	Test	Aging Condition		
		Unaged	Short-Term Aged (RTFO)	Long-Term Aged (PAV)
Conventional Tests	Penetration	✓		
	Softening Point	✓		
Superpave Tests	Rotational Viscosity (RV)	✓		
	Performance Grade (G*)/(Sin(δ))	✓		
	Multiple Stress Creep Recovery (MSCR)		✓	
	(G*)(Sin(δ))			✓
	Linear Amplitude Sweep (LAS)			✓
	Bending Beam Rheometer (BBR)			✓

PROJECT WORK PLAN

Binder	Carbon Nano Tubes (CNT) %	Nano Aluminum Trioxide (NAT) %	Status
1	0	0	Done
2	1	0	Done
3	2	0	Done
4	4	0	Done
5	0	2	Done
6	0	4	Done
7	0	8	Done
8	0.5	1	Done
9	0.5	2	Done
10	0.5	4	Done
11	1	1	Done
12	1	2	Done
13	1	4	Done
14	2	1	Done
15	2	2	Done
16	2	4	Done

APPARATUS

The penetration test is a needle with a 100g weight that penetrates the binder for 5 seconds, the test result is the amount of penetration in 0.1mm, can be an indication for binder stiffness

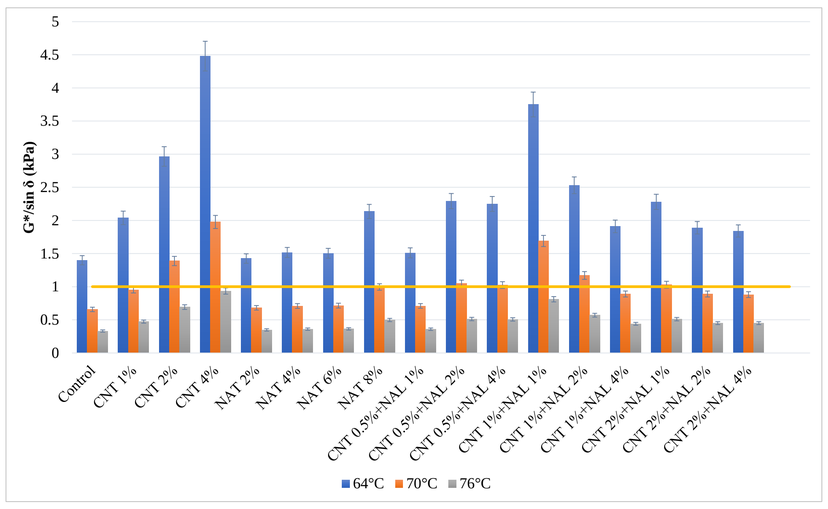
The softening point test finds out the temperature at which the binder is at 13,000poise, or in other word soft enough to melt

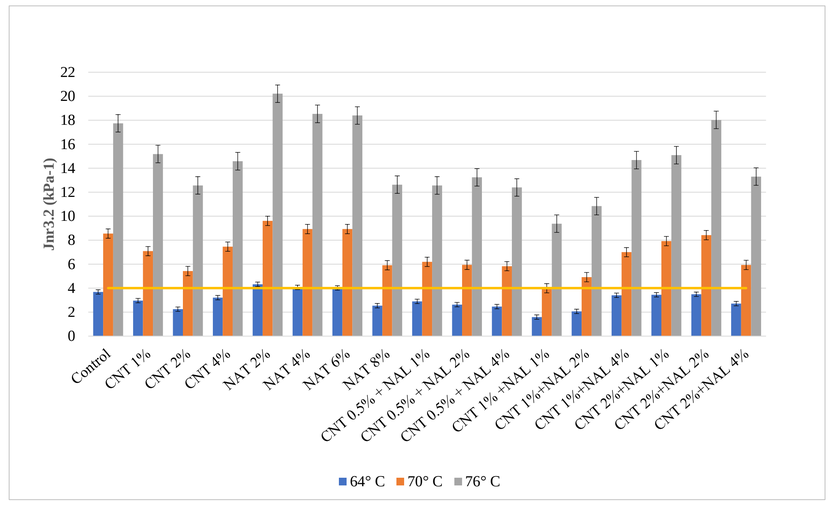
The Bending Beam Rheometer (BBR) test evaluates the low-temperature flexibility and relaxation properties of asphalt binders, crucial for assessing their performance in cold climates. A prismatic asphalt beam is loaded at its midpoint and monitored for deflection over 240 seconds at a specified temperature. Parameters like stiffness and deflection slope determine the binder's resistance to cracking. Meeting both stiffness and slope criteria is essential for passing the test, ensuring suitability for use in cold conditions.

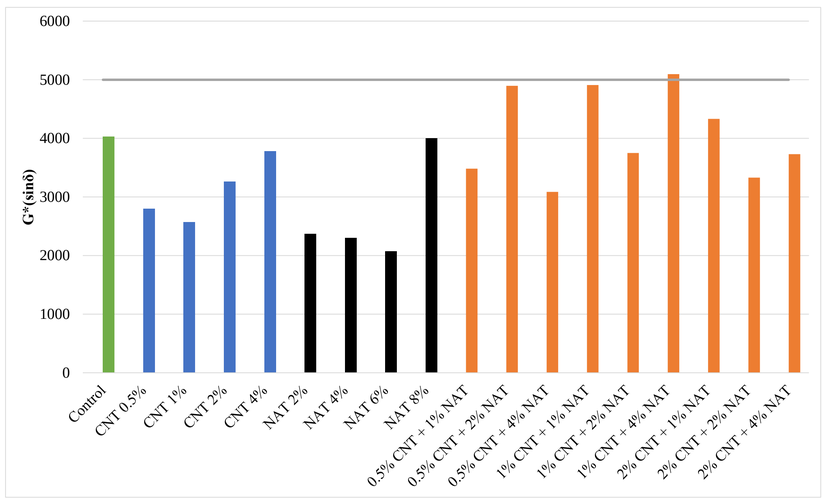
The Rotational Viscosity test apparatus is an apparatus that measures the viscosity of a binder mix for a given temperature range, using torque and a spindle, so that when the spindle requires more torque this means the binder is more viscous

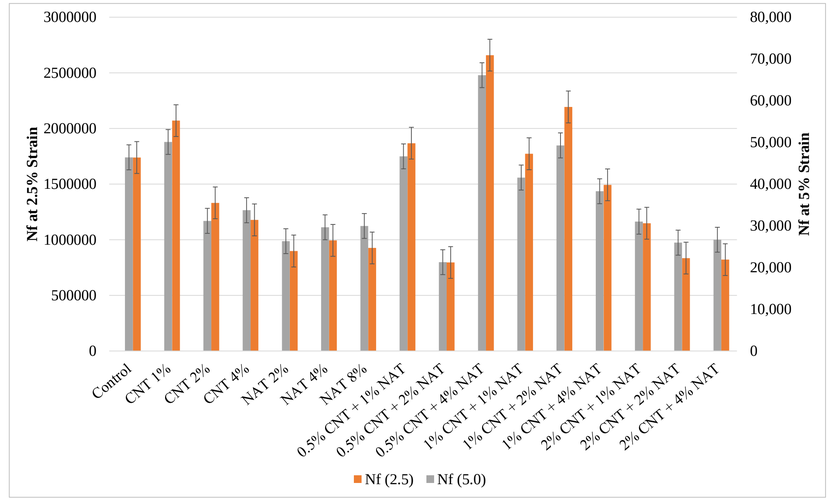
The DSR apparatus is where all superpave tests are done, including Performance Grading test, Multiple Stress Creep Recovery (MSCR) , G*(Sin(δ)) Parameter test and Linear Amplitude Sweep Test (LAS), 2 specimens' sizes are used which are 25mm and 8mm as shown to the side

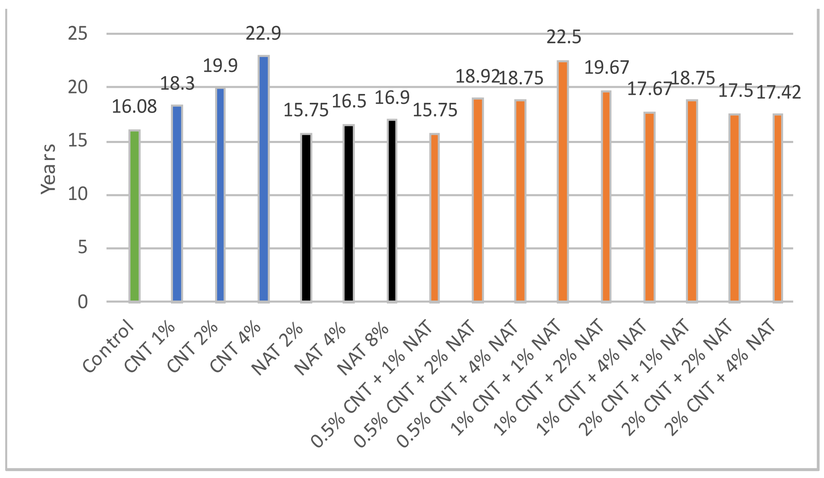
RESULTS

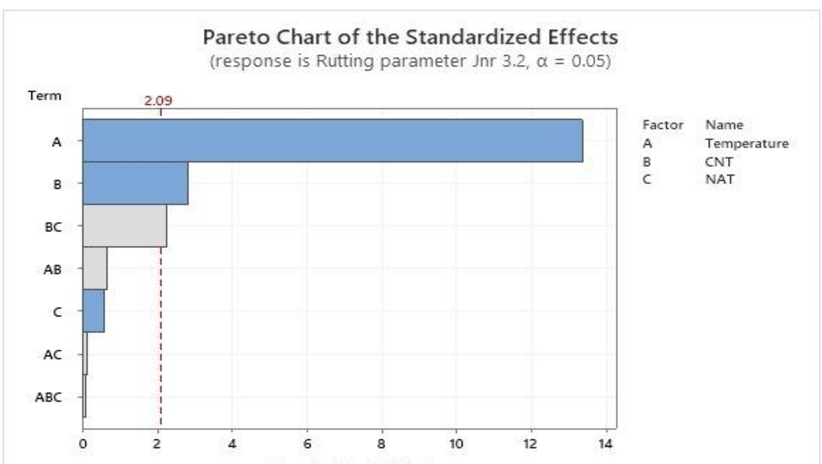












FINDINGS

- Using Carbon Nano Tubes (CNT) and Nano Aluminum Trioxide (NAT) in asphalt binder has a positive impact on performance up to a certain level.
- (0.5%CNT + 4% NAL) modified mix outperforms in fatigue resistance, while (1%CNT + 1%NAT) excels in rutting resistance
- All mixes fail to pass 70°C in MSCR, whereas (1%CNT + 1% NAT) modified binder passes with a standard traffic load rating
- Notably, only negative synergy can be observed among all tests, apart from LAS and BBR with a very small positive synergy

CONCLUSION

This report explores the impact of carbon nanotubes (CNT) and Nano Aluminum Trioxide (NAT) on asphalt binder, focusing on rutting and fatigue cracking. Various tests, including standard and Superpave tests, were conducted at different temperatures. The mix of (1% CNT + 1% NAT) showed the best rutting resistance, while (0.5% CNT + 4% NAT) performed better in fatigue parameters. Statistical analysis revealed CNT's significant influence on binder performance, with limited synergy between CNT and NAT. The (1% CNT + 1% NAT) mix demonstrated the longest pavement life according to AASHTOware software. Overall, CNT showed superior effects on binder performance compared to NAT.

Electrical Engineering

Table of Content

Baby-Haven: Controlled Enhanced Care – Smart AI Incubator for preemies

Students: Aisha Alzarooni | Khawla Saleh | Noora Albannai
Supervisor: Dr. Raouf Fareh | Mentor: Eng. Noor ul Misbah Khanum

WINNER

Problem Statement:

The birth of a premature baby necessitates a series of special care due to their vulnerability. According to the World Health Organization (WHO), every year, approximately 15 million babies are born prematurely, and nearly 1 million don’t survive. This reality shows the urgent needs for progress in neonatal care. Sometimes, conventional incubators that are designed to provide a secure environment for these infants don’t fully ensure their safety, because there were incidents of death due to technical fault in the incubator. These accidents happened due to the continuous need for manual adjustments and supervision by healthcare professionals, which are both physically demanding and vulnerable to human mistakes.

Baby-Haven: Controlled Enhanced Care – Smart AI Incubator for preemies

Senior Design Group: Aisha Alzarooni, Khawla Saleh, Noora Albannai
Supervisor: Dr. Raouf Fareh, Mentor: Eng. Noor ul Misbah Khanum
Examination Committee: Dr. Mahmoud Albreem, Dr. Sofiane Khadraoui
College of Engineering, Department of Electrical Engineering.

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Technical Background

Ensuring the well-being of premies during their critical early days of life requires a delicate balance of medical attention and environmental control, which is provided by our incubator. It's structured around three central subsystems: a control system, a monitoring system, and an AI-based baby-cue interpretation system. The control system regulates critical environmental factors within the incubator. The Real-Time Monitoring System, empowered by biosensors, offers continuous oversight of the newborn's vital signs. By complementing these features, our AI Baby-Cue Interpretation System is a pioneering advancement. It uses AI to analyze preemies' cues to determine their emotional state. Together, these subsystems ensures a safe environment for premies.

Future Developments

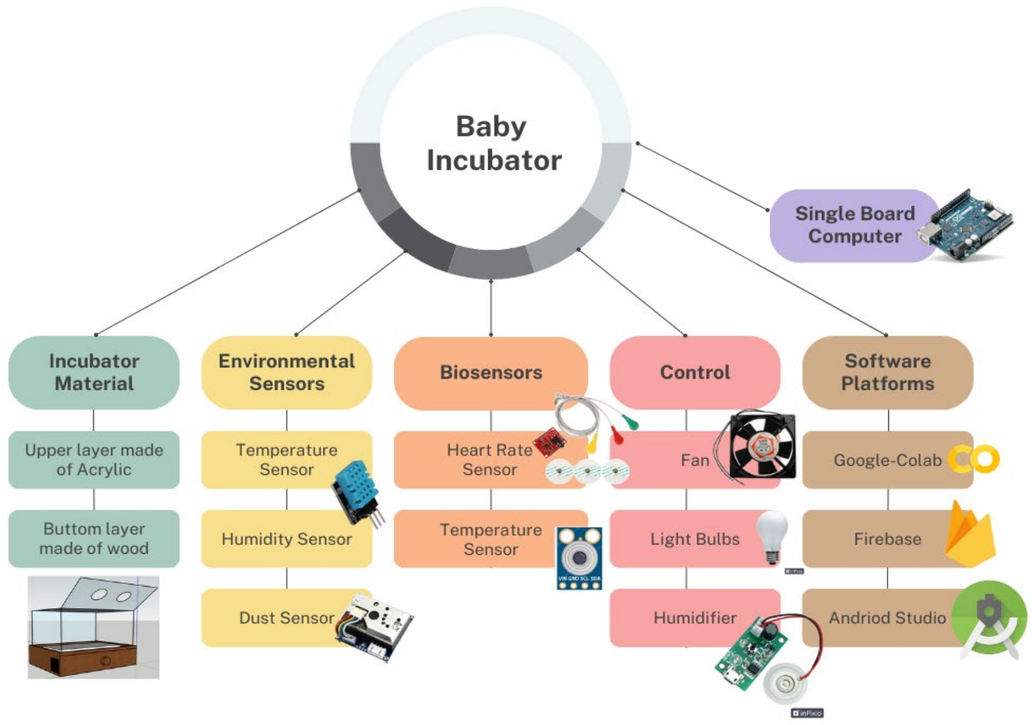
Our project marks a humble beginning in infant care advancements, but further adjustments are needed for development.

- Application of a reliable type of control, rather than ON-OFF Control, to maintain accurate results.
- Extend the AI-based system to not only listen and understand the reasons for babies' cries but also respond to their needs.
- Explore adding features for baby-family communication.

Conclusion

Our project represents a pivotal step forward in enhancing neonatal care, with a focus on the well-being of both infants and healthcare providers, it has the potential to significantly reduce infant mortality rates by minimizing human errors in care procedure. Our design aims to complement rather than a replacement in the essential human element in neonatal care. Through this poster, we outlined our aims, design process, and anticipated outcomes, to showcase the significant impact our project could have in the future of infant care.

System Overview



Methodology

1. Design/build a smart incubator featuring control and real-time monitoring systems.
2. Create an AI-based System for Baby-Cue Interpretation.
3. Obtain a method for efficiency storing collected data.

Proposed Design

The proposed design is made up of a series of interconnected phases. Our incubator is composed of four distinct sections. First, the design and build section focuses on the physical construction of the incubator which includes designing the structure and selecting suitable materials. The design should support the incubator's goal, in addition to the following sections. Moving on the software aspect is crucial for controlling and monitoring the incubator's functions. It involves programming Arduino, Google-Colab, Firebase and Android Studio to manage different parameters and ensure the smooth operation of the incubator and user-friendly interaction through a real-time and all-time monitoring display. Building on the previous aspect, sensors play a vital role in gathering real-time data to create informed decisions. This section includes different sensors that feed data to software that enables timely and precise adjustments in the incubator's environment. Shifting the focus to the last section, the hardware covers the physical components that interface with the software and sensors to control and manage the incubator's functions and environment.

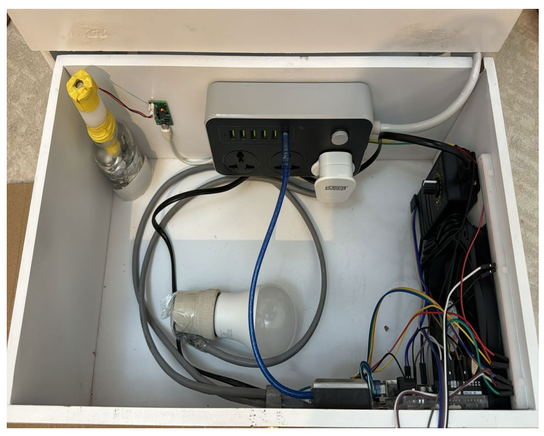
Results

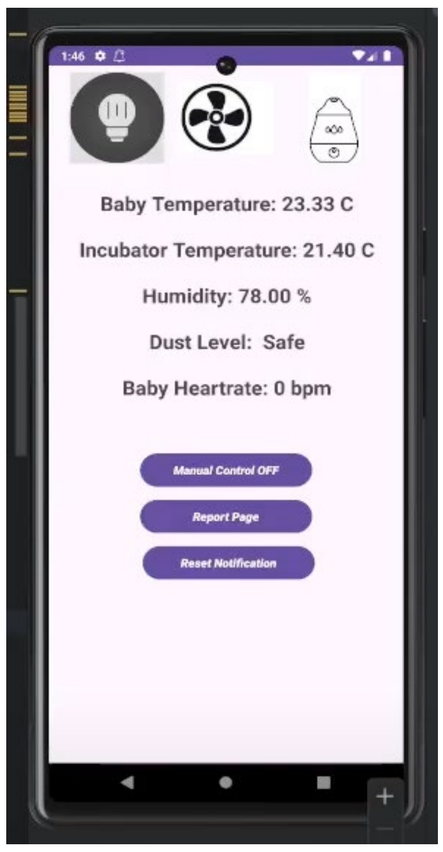
Through the use of both Platforms Firebase and Android Studio, our BabyMonitorApp is utilized, which provides healthcare professionals with a reliable data and accurate readings of both real-time and all-time data of environmental conditions and baby's vital signs. Furthermore, we integrated an AI model that interprets baby cries, through convolutional neural network (CNN) were features are extracted from spectrograms, classifying them as hungry, sleepy, discomforted, in pain, or requires burping.

```
# Define the path to the audio file for inference
audio_file_path = '/content/cry/Discomfort/10A40438-09AA-4A21-83B4-8119F03F7A11-1430925142-1.0-f-26-dc.wav'

# Get class labels
class_labels = ['Burping', 'Discomfort', 'Hungry', 'Pain', 'Tired-Sleepy']
```

```
1/1 [==============================] - 0s 97ms/step
Predicted class: Discomfort
```





Supervisor

Examiners

Design and Implementation of an Electric Vehicle

Students: Khalil Ibrahim Qashmar | Rakan Maher Sadaka | Bara Mahdi Masoud

Supervisor: Dr. Ali Ahmed Adam Ismail | Mentor: Eng. Mohammad Saad Suleiman

Problem Statement:

In this project, we designed and implemented an electric vehicle, as such vehicles play a crucial role in enhancing air quality by reducing the demand for gasoline. In an electric vehicle, pressing the accelerator pedal activates a controller, which then transfers electricity to the motor. These vehicles contain rechargeable batteries that store energy. They can contribute to lessening pollution and creating a cleaner environment because they are more efficient due to having fewer moving parts. We're taking this action because conventional cars have a negative impact on the environment. They deplete resources, pollute the atmosphere, and release greenhouse gases., and release greenhouse gases.

Design and Implementation of an Electric Vehicle

Senior Design Group: Khalil Ibrahim Qashmar, Rakan Maher Sadaka, Bara Mahdi Masoud
Supervisor: Dr. Ali Ahmed Adam Ismail, Mentor: Eng. Mohammad Saad Suleiman
Examination Committee: Prof. Ramesh Bansal, Dr. Venkata Chandu
Collage of Engineering, Electrical and Electronics Engineering

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Technical Background

The majority of electric cars (EVs) consist of several parts; however, regardless of the type of EV, all must include three essential components. The electric motor, which converts electrical energy into mechanical motion, serves as the engine of the electric vehicle. Typically, electric motors used in EVs can be classified as AC or DC. Some EVs utilize multiple motors for increased efficiency and performance. Power electronics are employed in electric vehicles (EVs) to regulate the amount of electricity sent from the battery to the electric motor. This includes converters and inverters that control voltage and current to ensure peak motor performance. The battery pack acts as the energy source for an electric car's motor by storing electricity. These lithium-ion batteries are designed for maximum energy density, security, and lifespan. Depending on the EV, the battery pack may be positioned under the floor for a lower center of gravity.

The mechanical structure of the electric vehicle includes the wheels, chassis, suspension system, steering system, and differential.

Conclusion

To sum up, we have designed and implemented an electric vehicle. Given the widespread use of fossil fuels in various industries and transportation sectors worldwide, and the depletion of fossil fuel reserves, it's imperative to transition to greener energy sources like electric power. With this goal in mind, we have developed a car that operates solely on electric batteries and a DC motor. Our testing has shown that our EV is stable, safe, and suitable for everyday use as a vehicle.

THEORY / METHODS

In this project, both software and hardware implementations were part of the design. In the hardware part, we designed a drive controller for a BLDC motor, which consists of optocouplers that isolate the low voltage side from the high voltage side, a DC to DC converter to step up the voltage from 5V to 15V so that the IGBT of the inverter can be used as a switching component. The BLDC motor has hall sensors that detect the position of the rotor. Moreover, in the mechanical part, we will create an effective design based on calculations for the frame of our EV that depend on the weights of the components. In the software part, we used an Arduino microcontroller to control the speed of the motor by regulating the speed of the switches in the inverter circuit according to the input voltage coming from the accelerator pedal.

SETUP, EXPERIMENTAL

First of all, we began by designing the gate driver. At this stage, we utilized KiCad software to design our gate driver PCB. We installed all the required electrical components of the gate driver, including the optocoupler, DC to DC converter, resistors to limit the current, and finally capacitors to smooth out the output voltage. The IGBT switches operate according to the PWM signal coming from the driver circuit. Whenever the 15V from the driver circuit is applied to the gate of the IGBT switch, it operates as a short circuit. Our motor is a BLDC motor that has 3 hall sensors to determine the position of the rotor. Based on the hall sensor sequence, the microcontroller will control the switching of the inverter. We used 4 batteries, each 12V connected in series, to create a 48V and 55AH battery pack as our power supply.

RESULTS

We used the LAB VOLT to test our system. Initially, we employed a resistive load just to check the switching sequence of the inverter. We obtained a very efficient output signal, quasi-square wave. This output signal from the inverter would be connected to the BLDC motor to drive it. After testing our controller and connecting it to the actual BLDC motor, we were able to drive the motor at various speeds using the accelerator pedal to control the input reference speed. The final step was installing all the electrical components onto the electric vehicle's chassis. A 48V rechargeable battery pack of 55AH has been connected to power the BLDC motor, and front lights, back lights, and reverse sensors have been added to the electric vehicle as well.

Figure 1 Electric Vehicle

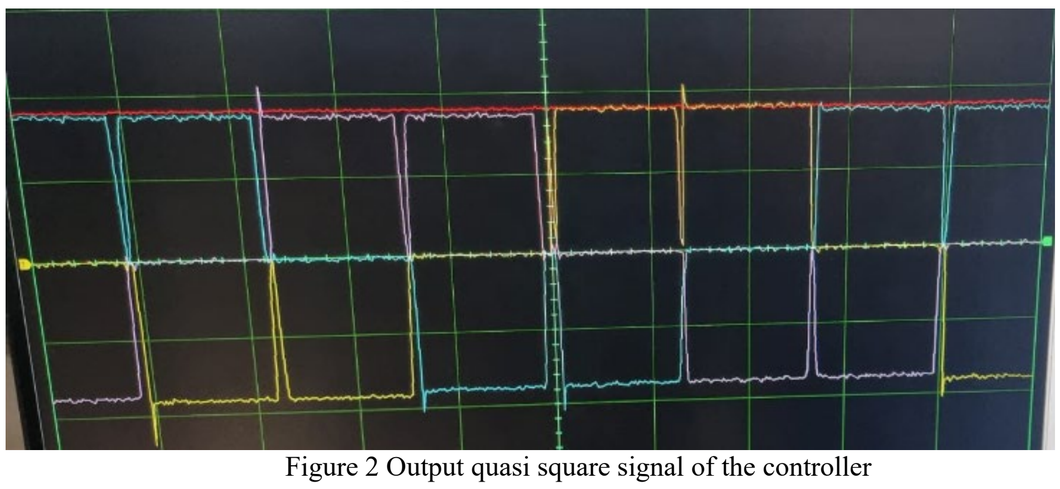


Figure 2 Output quasi square signal of the controller

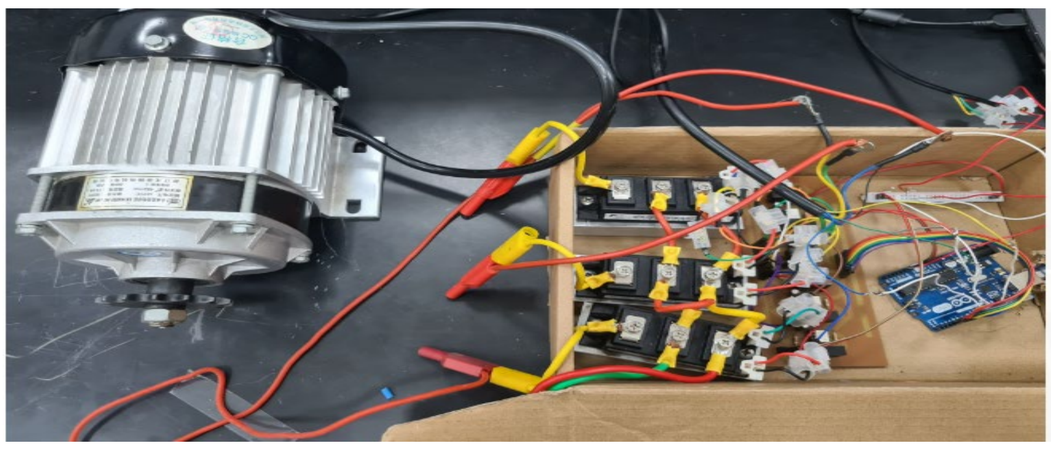
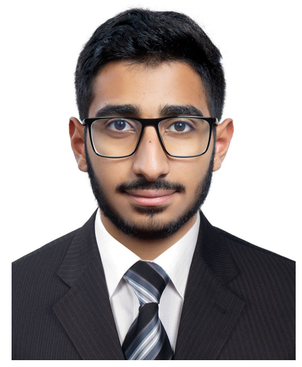


Figure 3 BLDC Motor Controller

DISCUSSIONS

After designing and building our electric vehicle, we were able to drive the BLDC motor connected to the vehicle and control its speed using the accelerator pedal to adjust the input speed. To minimize costs, we opted for lead-acid batteries. However, had we used lithium-ion batteries, the charging time would have been shorter and the losses would have been reduced. Compared to existing electric cars, our vehicle is lighter and constructed of high-strength steel and aluminum to ensure passenger safety.

Senior Design Group:



Design and Implementation of Hospital Nursing System for Self-Medical Check

Students: Shaima Ahmed Alzarouni | Lamia Ali Almarzooqi | Maryam Abdulsalam Aljasmi

Supervisor: Prof. Anwar Hasan Jarndal | Mentor: Eng. Alya Yousif Alhammadi

Problem Statement:

The pre-appointment check-up is a crucial procedure for patients visiting hospitals, providing health information through measurements like body temperature, blood pressure, heart rate, pulse oximetry, weight, and height recorded by nurses. However, hospitals often face challenges due to limited nursing staff, causing delays in patient care. Reducing waiting time for these check-ups is crucial to enhance overall patient experience. This project is addressing this problem by designing a unit that combines the registration process and measuring of vital signs, which will be done independently by the patients in a short time through integrated sensors within the unit. The collected data will be submitted to the E-health system, so the doctor can possess the health information of the patient.

Design and Implementation of Hospital Nursing System for Self-Medical Check

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Examination Committee: Prof. Abir Jaafar Hussain, Dr. Ali Ahmed Adam Ismail
Affiliation: College of Engineering, Department of Electrical and Electronics Engineering

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Technical Background

The following technical background provides a better understanding of the system:

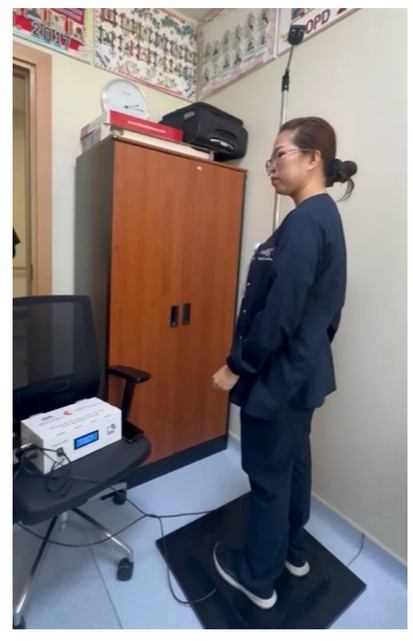
- **Ultrasonic Sensor**: The ultrasonic sensor functions by emitting sound waves and detecting their reflections to measure distances between objects. In our unique system, we utilized this sensor to measure height.
- **Load Cell:** A load cell A transducer that converts applied force into a measurable electrical output. In our system, we integrated four load cells to accurately measure weight.
- **MLX90614 Sensor:** The MLX90614 sensor is designed to convert the intensity of infrared energy emitted by an object into a digital temperature reading. We employed this sensor to measure body temperature within our system.
- **MAX32664 Sensor:** A hub sensor equipped with two LEDs and a photodetector. It functions by measuring the light emitted by these diodes and detecting how this light is absorbed by the finger while the finger is placed within the finger clip. Using specific algorithms, the sensor analyzes these absorption variations to determine vital signs such as blood pressure, heart rate, and oxygen saturation (SPO2).

METHODOLOGY

1. ***Collecting Data:*** We began by researching similar projects to understand how they implemented their systems. Then, we learned about the functionality of each sensor.
2. ***Planning & Design:*** We started by sketching the prototype and determining the appropriate size for the acrylic sensors box, wood bases, 3D printed parts and stainless-steel stand.
3. ***Programming Sensors:*** Each sensor was programmed and tested for accuracy. This included the Ultrasonic, weight sensor (load cell), temperature sensor, and HUB Sensor (BP, SPO2, HR).
4. ***Preparing Instructions and Display:*** We prepared the sounds used for instructions and configured the LCD display.
5. ***Sensor Integration:*** All sensors were integrated into the Arduino Mega in the correct order.
6. ***RFID Integration:*** The RFID ID and its wireless reader were programmed using Arduino Uno.
7. ***System Integration:*** The Arduino Mega was integrated with the Arduino Uno to function as one system.
8. ***Wireless Data Transmission:*** The Node MCU was programmed to wirelessly send data to an online dashboard (Adafruit).
9. ***Testing the feasibility and collecting feedback:*** We planned for a visit to the University of Sharjah Hospital to test the accuracy of the device and observe how patients interacted with it.

EXPERIMENTAL SETUP

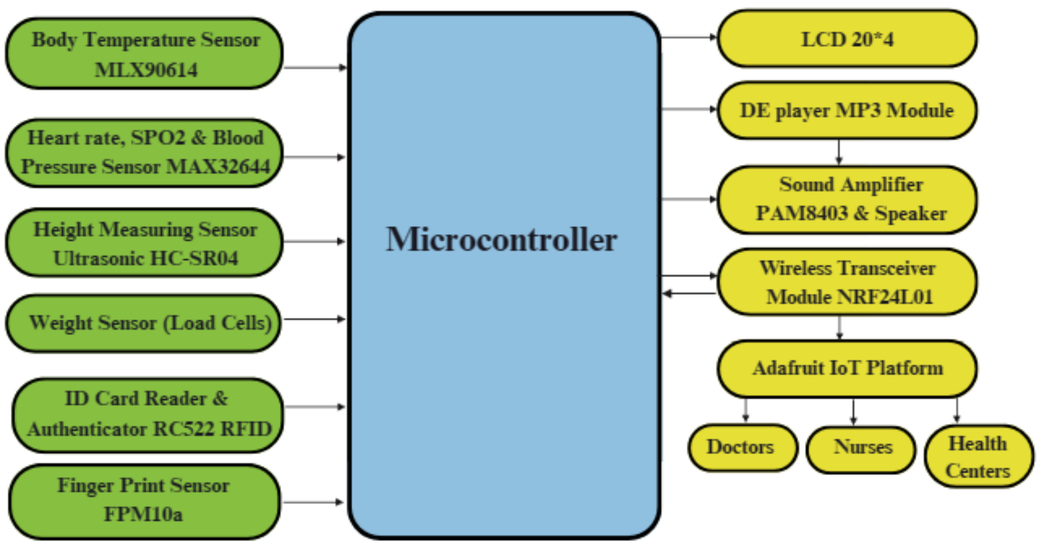
The project involves setting up hardware components to collect and process data. This includes connecting sensors to microcontrollers and sending data to an Adafruit dashboard. Thorough testing is done to ensure accuracy. Finally, everything is assembled into a unified unit with a designed enclosure and user interfaces for data visualization. This makes data handling and analysis efficient through IoT communication.



RESULTS

1. We conducted testing of the system at University Hospital in Sharjah. This included initial testing on the medical staff to ensure accuracy and reliability, focusing on the main vital signs measurements.
2. We proceeded to test the system on available patients at the hospital. Patient feedback was positive overall, with 95% satisfaction, although older patients required assistance due to system complexity.
3. Our system allowed patients to independently measure their vital signs, reducing wait times significantly from 15 to 3 minutes. This improvement enhanced patient experience and healthcare efficiency.
4. The hospital's nursing department director, Mohammed Hani, praised our technology as "the future nurse", affirming our commitment to revolutionizing healthcare.

System Block Diagram

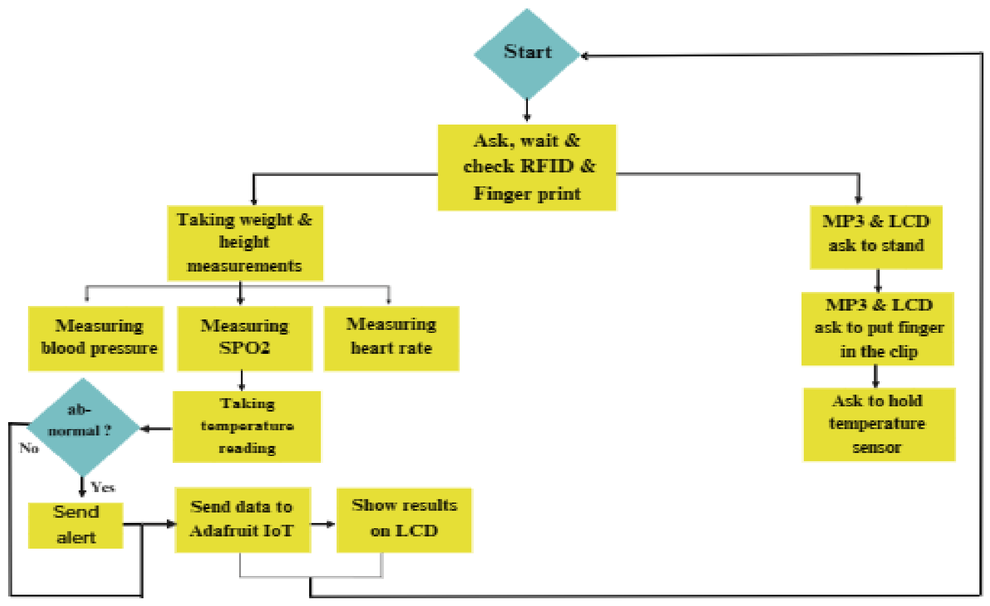


Final Design

Conclusion

Our system aims to revolutionize pre-appointment check-ups by integrating registration and vital sign assessments into an independent process for patients, reducing delays caused by nursing staff shortages. The system securely transmits collected data to the hospital's E-health system for doctor review and long-term medical history storage. Overall, our device promises to improve patient experience, marking a significant advancement in smart nursing and monitoring systems with potential future development and widespread adoption.

System Flow Chart



Future Improvements

- Incorporating AI into our system will enhance its diagnostic capabilities and predictive analytics.
- Ensuring compatibility with other hospital systems and electronic health record platforms.
- Expanding our reach through partnerships with healthcare providers worldwide will facilitate broader deployment of our system.

Software:

ARDUINO TINKERCAD adafruit

Smart Waste Collection System

Students: Mona Nadhari | Alya Alshamsi | Mariam Alqaydi

Supervisor: Prof. Ahmed Elwakil, Mentor: Eng. Noor Ul Misbah

Problem Statement

- In the modern world, most municipalities struggle with properly and productively managing waste.
- Waste management is essential as it reflects on the quality of living in a country.
- More waste is produced because of the population growth, unproductive scheduling of waste collection, and overflowing containers. This results in issues that include pollution, spread of germs, pests and unwanted odors, a visually unappealing and unsanitary environment.
- Clever solutions are needed to maintain a waste management system that is both economical and effective.

Smart Waste Collection System

Senior Design Group: Mona Nadhari – Alya Alshamsi – Mariam Alqaydi
Supervisor: Prof. Ahmed Elwakil, Mentor: Eng. Noor Ul Misbah
Examination Committee: Prof. Amr Elnady, Prof. Hissam Tawfik
College of Engineering, Department of Electrical and Electronics Engineering

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- Clever solutions are needed to maintain a waste management system that is both economical and effective.

Technical Background

The design of this project consists of four separate parts: inputs, outputs, power unit, and the process unit.

1. Inputs: The inputs in this project consist of two weatherproof ultrasonic sensors, a MQ-2 smoke sensor and a HC-05 Bluetooth module. Each of these components can detect certain occurrences that can then relay a message through the microcontroller and deliver and output.
2. Outputs: The output data is represented by signals sent by the microcontroller such as:
   SIM 808, a GSM and GPS module that has data to send an SMS of the exact location.
   L298 Dual Channel Motor Driver and Actuator, a device that controls the actuator to open the lid through the Arduino by managing voltage levels.
   LED screen, a display screen used for advertisements.
3. Power Unit: Consisting of three parts, this unit is what powers the entire project. The solar panel is what charges the battery through the charger circuit which helps in monitoring and regulating the process.
4. Process Unit: The process unit is the Arduino Mega that manages all the processes and synchronizes the system.

Conclusion

- The project is a successful fully automated waste management system.
- It is powered by solar energy and can detect fullness level and smoke to alert the user. The lid opens automatically, and an LED screen displays advertisements. Additionally, all mentioned information is saved on a cloud to predict future trends.
- It is a project that is user-friendly, energy efficient, cost efficient, and can be implemented anywhere.

METHODOLOGY

The system will operate as follows:

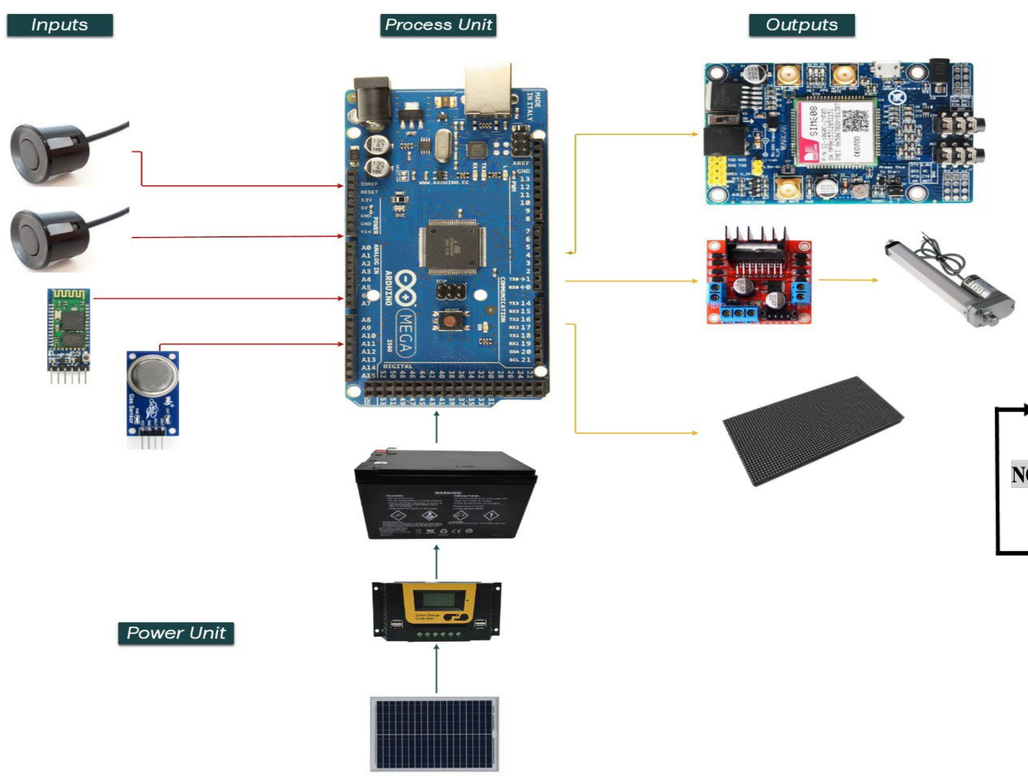
1. All components will be powered by a solar panel, charger circuit and a 12V rechargeable battery.
2. The system will collect data from the sensors and sends them to the microcontroller.
3. The microcontroller (Arduino Mega) will process the data and instruct the outputs to operate as required.
4. The outputs will be prompted to show the functionality of the system. (e.g., display an LED advertisement, open the lid, receive a message)

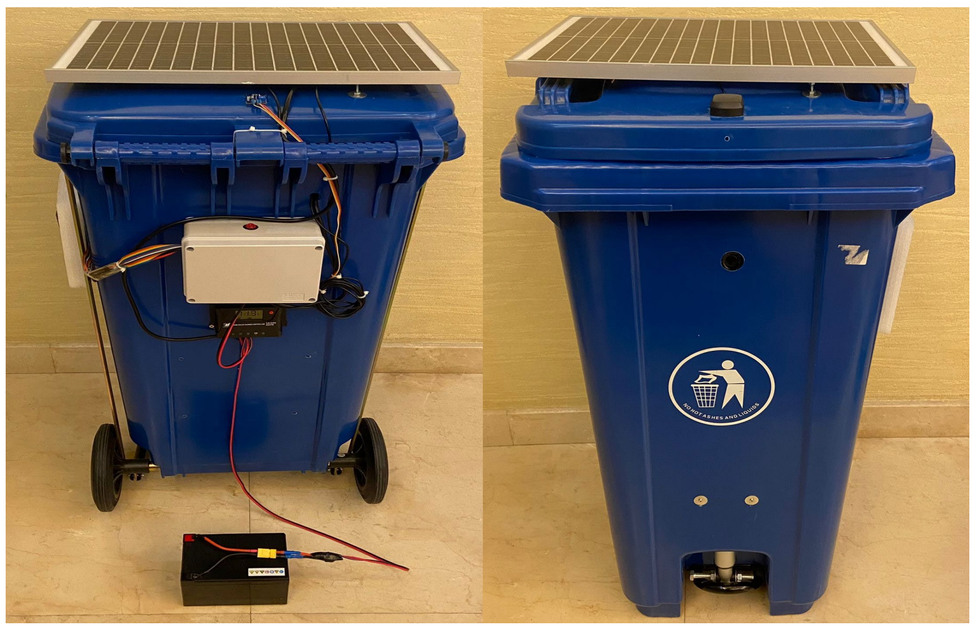
EXPERIMENTAL SETUP

The hardware of the project consists of two parts: one that transmits and another that receives. Sensors transmit signals to the microcontroller that inform it of the status of the container, smoke level, and whether it requires to be opened. Once the microcontroller receives the signal and reads the status, it causes the actuator to open the lid and a notification is sent through the GSM/GPRS module to alert of the status and provide its location. The LED screen displays notices that are coded onto the microcontroller. The software of the project is represented by a C language code that is stored on the microcontroller. This language is compatible with the Arduino IDE software and offers error-detection and essential tools and libraries making it user-friendly with easy code verification.

RESULTS

- The first ultrasonic sensor successfully connects to the GSM and GPS which sends a SMS with the accurate fullness level and location of the container.
- The second ultrasonic sensor detects when someone is in front of the container and opens the lid by a linear actuator. It automatically closes after 20 seconds if nothing is detected.
- The lid can also be opened remotely through an app that is connected via Bluetooth.
- A smoke sensor is installed to prevent flames or hazardous materials in the container.
- The system is connected to a server where data surrounding the conditions of the container is collected on the cloud and saved on a website.
- An LED screen is mounted on the side of the container to display advertisements and is available for rent.



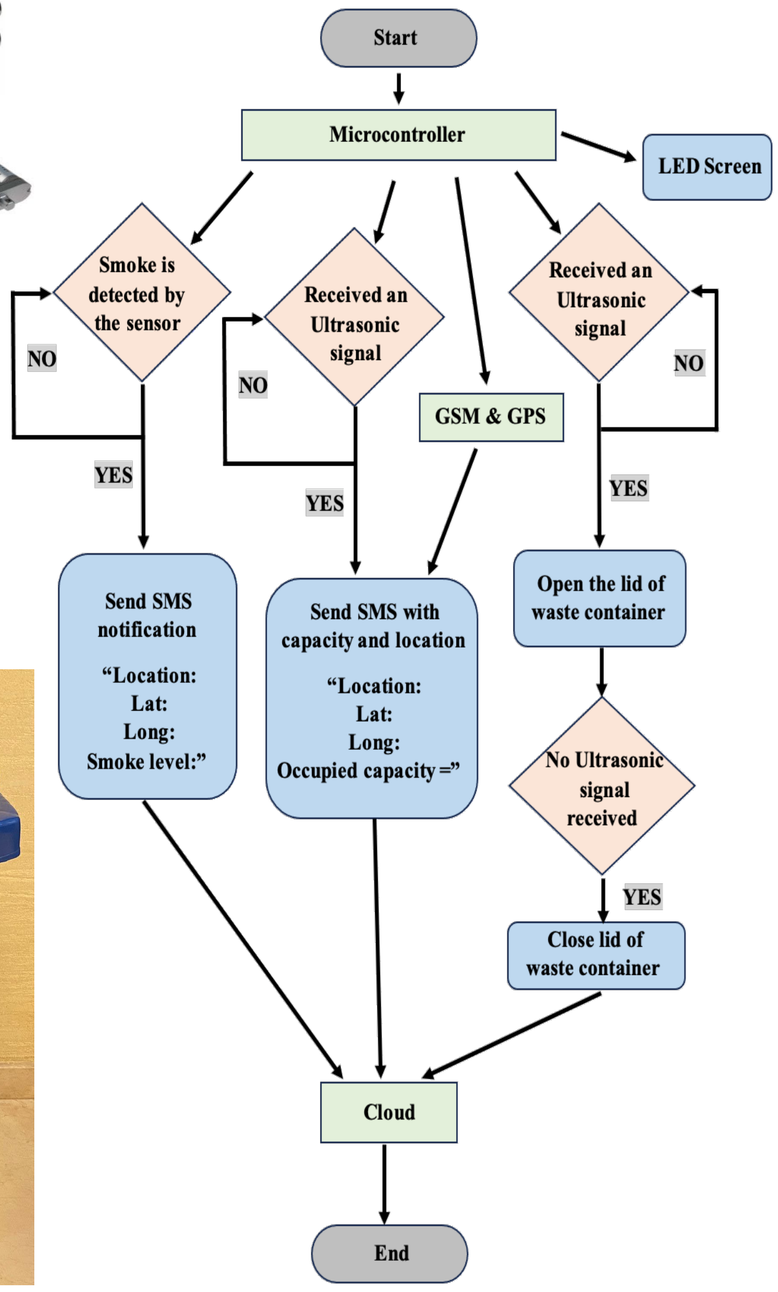


Future Developments

This project has great potential in becoming more advanced and helping build cleaner and more environmentally aware communities.

- **Using a battery that can withstand extreme heat such as a car battery.**
- **Adding a temperature sensor to detect extremities and make waste collection more frequent.**
- **In the night, an automatic light that is activated by a sensor can be added to increase visibility.**
- **A sensor that can detect hazardous waste thrown into the container and prevent the mixture of hazards with regular waste.**

Flowchart:



Solar based smart lot city air-pollution and waste container monitoring system

Students: Maryam Abdulla Q Alblooshi | Maha Hassan Al-Ali | Alia Ali Saeed Al-Shamsi

Supervisor: Dr. Venkata Chandu | Mentor: Eng. Obaida Abu Bader

Problem Statement:

Modern urban garbage disposal and air pollution prevention present significant challenges that require creative solutions. Rapid expansion, population increase, and industrial activity have caused two interconnected problems: waste generation and air pollution. Current waste management solutions often waste resources, increase operational costs, and harm the environment. Lack of air quality monitoring prevents prompt observations and proactive air pollution mitigation efforts, posing severe health risks to urban people. To address these serious issues, a complete and sustainable solution that maximizes garbage collection efficiency and monitors air quality in real time is needed. Conventional garbage disposal methods are ineffectual and environmentally harmful, and poor air quality harms the public.

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Examination Committee: Dr. Ali Adam | Mr. Mahmoud Abu Shammeh

College of Engineering | Department of Electrical Engineering

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Technical Background

A Solar-Based Smart IoT City Air-Pollution and Waste Container Monitoring System is a sophisticated urban infrastructure solution that integrates various technologies to address two critical challenges faced by modern cities: air pollution and inefficient waste management. The system's key components and functionalities can be described as follows:

1. Solar-Based
2. Smart IoT (Internet of Things)
3. City-Wide Air Pollution Monitoring
4. Waste Container Monitoring
5. Data Collection and Analysis
6. Wireless Connectivity
7. Centralized Control and Monitoring
8. Alerts and Notifications
9. User Access and Engagement
10. Environmental Impact

Conclusion

In conclusion, the setup of a smart waste management system utilizing Internet of Things (IoT) technology leaves the city in a better condition to become increasingly intelligent. By leveraging IoT technology, municipalities can monitor and manage waste collection more efficiently. We could say that the implementation of IoT-equipped smart trash systems is a wise choice among other innovations in waste management in smart cities. In this way, cities can utilize data and connectivity to drive more efficient operations, adhere to sustainability principles, and make the cities cleaner and healthier, offering better conditions to their present and future residents.

THEORY / METHODS

When designing a Solar-Based Smart IoT City Air-Pollution and Waste Container Monitoring System, it's essential to consider several design criteria to ensure its effectiveness and practicality. To complete building the system, we require specific criteria to be achieved such as:

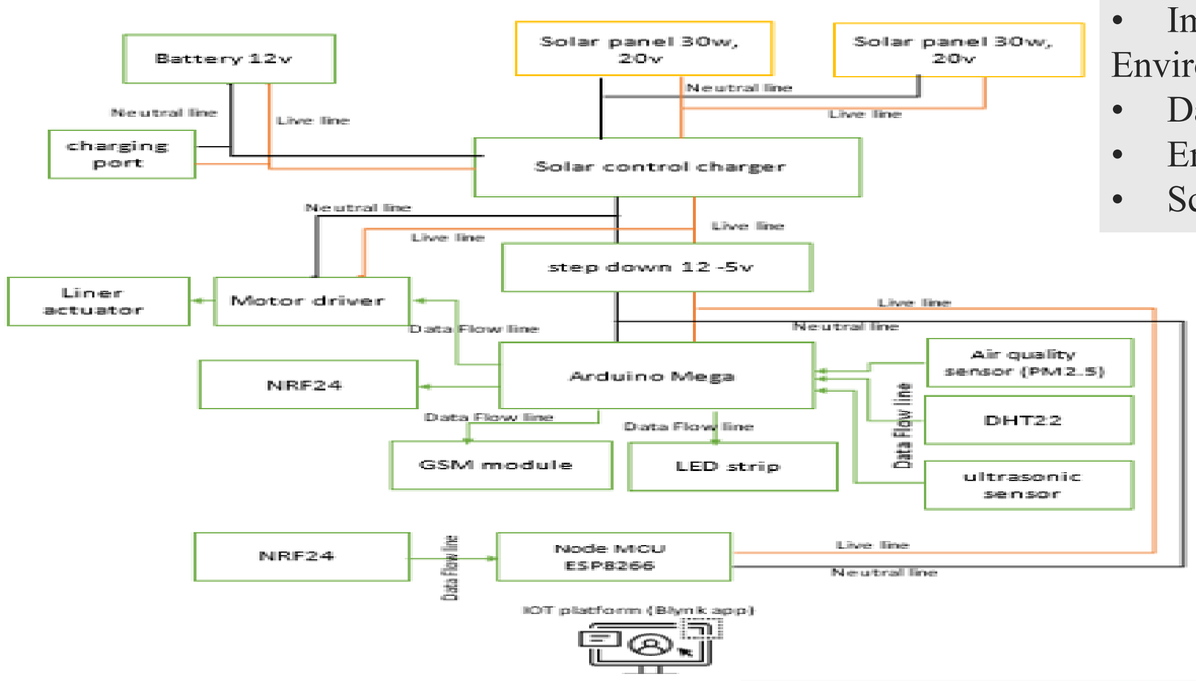
- Ease of use
- Portability,
- Expandability
- Cost
- Total power consumption
- Parts availability

SETUP, EXPERIMENTAL

In our design, a combination of hardware and software components were employed. The hardware includes a microcontroller, connected to various sensors and other related components. Specifically chosen air pollution sensors to measure air quality parameters accurately, as well as ultrasonic sensor attached to the waste container for real-time fill level tracking. To ensure sustainability, solar panels will capture sunlight to generate energy. Wi-Fi connectivity will enable data transmission to online servers. On the software side, we utilized the C-language for programming, a highly compatible choice with Arduino microcontrollers. An IDE software is utilized for the code development and uploading. The software aspect involved integrating the system with an online server (BLYNK) for data storage and real-time visualization.

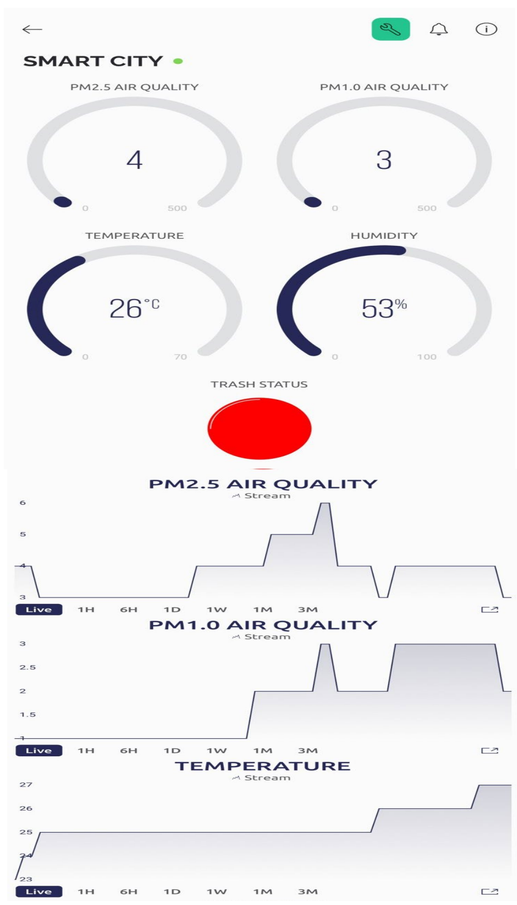
RESULTS

As a result, An efficient waste management system that minimizes the need for manual intervention operates sustainably with the help of strategically positioned solar panels that harness renewable energy. A communication module facilitates real-time data transmission, while a rechargeable battery stores excess solar-generated energy to ensure uninterrupted operation. Using a linear actuator and a notification system would help minimize waste collection by sending notifications when the waste container is full. This helps in waste disposal processes, reduces overflow of the waste, and potentially less air pollution within the city, it's a great way to unite engineering and environmental sustainability.



Trash is full

Trash is empty



DISCUSSIONS

The setup of a smart waste management system utilizing Internet of Things (IoT) technology leaves the city in better condition to become increasingly intelligent By leveraging IoT technology, municipalities can monitor and manage waste collection more efficiently, leading to several advantages:

- Optimized Waste Collection
- Improved Public Health and Environment
- Data-Driven Decision Making
- Enhanced Citizen Engagement
- Scalability and Adaptability

Air quality parameter :

- 0~35 µg/m^3
- 116~150 µg/m^3
- 151~251 µg/m^3

Temperature parameter :

- Below < 18°C
- 20°C~25°C
- Above 28 °C

Humidity parameter :

- Below 40%
- 40% ~ 60%
- Above 60%

Industrial Engineering & Engineering Management

Table of Content

Streamlining Warehouse Operations With Lean: A Case Study at Aramex

Students: Taima Abu Shawish | Baylasan. Baida | Nadia Abuhantash

Supervisor: Prof. Hamdi Bashir

WINNER

Abstract:

This report details the work done to apply lean principles to one of Aramex's warehouses, Initial value stream mapping revealed a process cycle efficiency (PCE) of 55.65% across various warehouse processes, which fell short of the organizational benchmark of 60%. The study identified the picking process as the primary bottleneck, with a PCE of only 27%. A major source of this inefficiency was found to be the travel distance, which accounted for about 54% of the picking time. To address this issue, five routing strategies—transversal, return, midpoint, largest gap, and composite—were introduced and tested through ten replications to ensure consistent results. Analysis with ANOVA and Tukey's test identified the composite strategy as the most effective, significantly outperforming other strategies at a 95% confidence level. Implementing the composite strategy resulted in a reduction in non-value-added time by 10.5 minutes in the picking process. This led to an 8.27% increase in the picking process's PCE and an overall improvement in the warehouse PCE from 55.65% to 60%. These findings demonstrate that applying lean principles can lead to substantial efficiency gains and cost reductions, ultimately benefiting both the company and its customers.

Streamlining Warehouse Operations With Lean: A Case Study at Aramex

Group Code: 23-24F02
Group Members: Taima Abu Shawish U20100319, Baylasan. Baida U20103907, Nadia Abuhantash U20102531
Supervisor: Prof. Hamdi Bashir

ABSTRACT

This report details the work done to apply lean principles to one of Aramex's warehouses, Initial value stream mapping revealed a process cycle efficiency (PCE) of 55.65% across various warehouse processes, which fell short of the organizational benchmark of 60%. The study identified the picking process as the primary bottleneck, with a PCE of only 27%. A major source of this inefficiency was found to be the travel distance, which accounted for about 54% of the picking time. To address this issue, five routing strategies—transversal, return, midpoint, largest gap, and composite—were introduced and tested through ten replications to ensure consistent results. Analysis with ANOVA and Tukey's test identified the composite strategy as the most effective, significantly outperforming other strategies at a 95% confidence level. Implementing the composite strategy resulted in a reduction in non-value-added time by 10.5 minutes in the picking process. This led to an 8.27% increase in the picking process's PCE and an overall improvement in the warehouse PCE from 55.65% to 60%. These findings demonstrate that applying lean principles can lead to substantial efficiency gains and cost reductions, ultimately benefiting both the company and its customers.

BACKGROUND

Lean principles have been increasingly adopted in the manufacturing sector over recent decades, and their application has recently expanded from production to warehousing. A growing body of research indicates that lean warehousing, a relatively new concept, can significantly reduce logistics costs and delivery times, leading to higher customer satisfaction. Warehouses are vital in the supply chain, managing inventory and orders efficiently. They offer value-added services, evolving from traditional storage to strategic assets. With technology, they optimize transportation and adapt to market changes. In e-commerce, they're essential, needing swift operations. Advanced technology, like management systems, addresses challenges. Overall, warehouses ensure smooth flow from production to consumption. Lean warehousing maximizes efficiency and minimizes waste using principles from lean manufacturing. It optimizes processes, reduces inventory, streamlines workflows, and empowers employees. Data-driven decision-making and performance metrics drive continuous improvement. Adopting lean warehousing practices enhances agility, saves costs, and boosts customer satisfaction, maintaining high standards of quality and efficiency.

AIM & OBJECTIVES

The aim of this project was to streamline operations at one of the Aramex warehouses by achieving the following objectives:

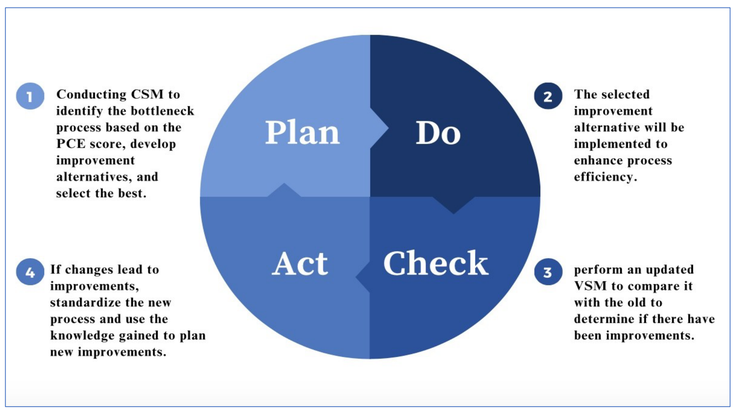
- To Visualize Operations to Identify Areas for Improvement: Map out the flow of operations for selected processes to pinpoint inefficiencies.
- To Generate Improvement Alternatives: Propose different solutions to address the identified bottleneck process and improve overall process cycle efficiency (PCE).
- To Evaluate and Select the Best Improvement Alternative: Assess the proposed alternatives to determine the most effective approach for streamlining operations.

CONCLUSION

The case study effectively demonstrates the use of lean warehousing tools and the PDCA methodology to increase PCE at an Aramex warehouse. By identifying and addressing bottlenecks in the picking process, the adoption of the composite routing strategy, validated by ANOVA and Tukey's test, resulted in a significant reduction in non-value-added time. This strategic change improved the PCE of the picking process by 8.27% and increased the overall warehouse PCE to meet the organizational standard of 60%, alongside a 30.74% increase in picking capacity. To sustain these improvements, it is recommended to conduct thorough training programs to ensure all warehouse staff are skilled in using lean tools and the newly implemented routing strategies, and implement a robust system to monitor processes, ensuring sustainability of the improvements and identifying further areas for enhancement. By integrating these recommendations, the warehouse can preserve its current efficiency levels and lay the groundwork for perpetual advancement and innovation in its operations. The positive outcomes of this project suggest a strong case for Aramex to consider wider implementation of our recommendations across all warehouse processes. By doing so, Aramex could potentially realize similar efficiency improvements on a larger scale, thereby reinforcing its competitive edge in the logistics industry.

METHODOLOGY

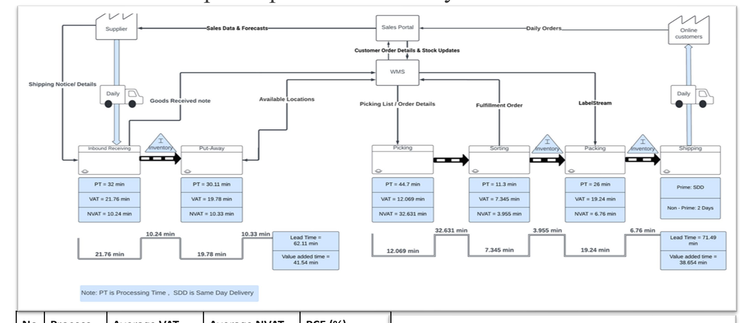
The study aims to improve warehouse processes by reducing non-value-added time and enhancing process cycle efficiency through lean tools. After conducting our literature review, we have found that the PDCA cycle is the most appropriate method for continuously reducing waste to increase the efficiency of the client being studied. We will follow the steps represented to achieve our objectives.



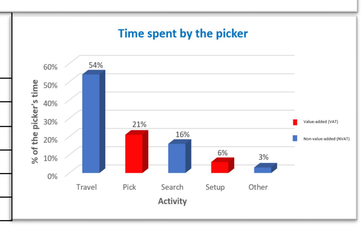
RESULTS

Plan Phase

A current VSM was conducted to classify activities into value-added and non-value-added to identify the most inefficient process. Followed by calculations for the process efficiency cycle (PCE). The current process cycle efficiency of the warehouse is estimated at 55.65%, which is below the organizational target of 60%. the picking process is the primary bottleneck that contributes to this inefficiency, with a PCE of only 27%. To find out why this is happening, we analyzed the time spent by the picker and identified the areas with the highest NVAT. we found that a significant portion of NVAT (54% of the total time) is consumed by travel time. Therefore, our focus was on reducing travel distance to minimize travel time and improve process efficiency.

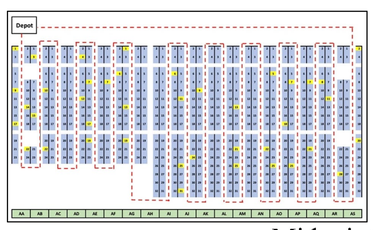


No.	Process	Average VAT (min)	Average NVAT (min)	PCE (%)
1	Receiving	21.76	10.24	68%
2	Put Away	19.78	10.33	65.7%
3	Picking	12.069	32.631	27%
4	Sorting	7.345	3.955	65%
5	Packing	19.24	6.76	74%
Total		**80.194**	**63.916**	**55.65%**

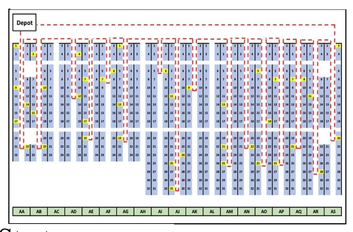


Improvement Alternatives Development

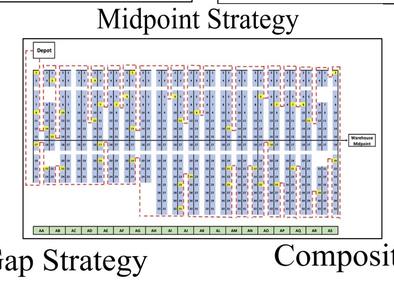
Transversal Strategy



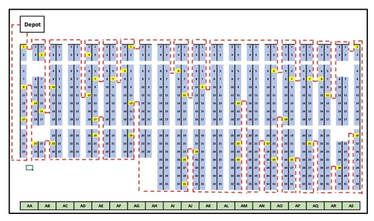
Return Strategy



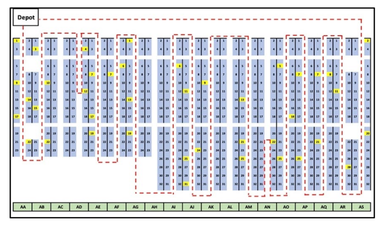
Midpoint Strategy



Largest Gap Strategy

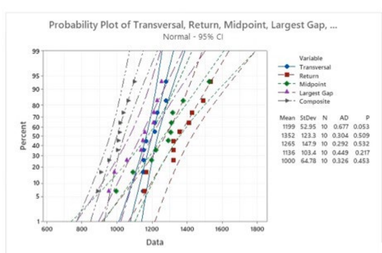


Composite Strategy



Alternatives Evaluation

Ten replications were conducted for each routing strategy and ANOVA was used to compare their performance in terms of travel distance. The null hypothesis was rejected, indicating that not all strategies are similar. Tukey's test showed that the Composite strategy is significantly different and outperforms all others at a 95% confidence level.



Grouping Information Using the Tukey Method and 95% Confidence

Factor	N	Mean	Grouping
Return	10	1351.5	A
Midpoint	10	1265.2	A B
Transversal	10	1199.4	B
Largest Gap	10	1135.6	B
Composite	10	1000.3	C

Means that do not share a letter are significantly different.

Method

Null hypothesis	All means are equal
Alternative hypothesis	Not all means are equal
Significance level	α = 0.05

Equal variances were assumed for the analysis.

Factor Information

Factor	Levels	Values
Factor	5	Transversal, Return, Midpoint, Largest Gap, Composite

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Factor	4	707831	176958	16.15	0.000
Error	45	493032	10956		
Total	49	1200863			

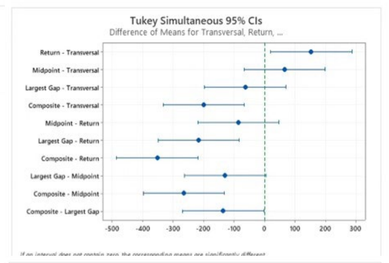
Model Summary

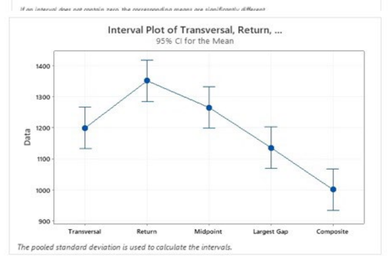
S	R-sq	R-sq(adj)	R-sq(pred)
104.672	58.94%	55.29%	49.31%

Means

Factor	N	Mean	StDev	95% CI
Transversal	10	1199.4	52.9	(1132.8, 1266.1)
Return	10	1351.5	123.3	(1284.8, 1418.2)
Midpoint	10	1265.2	147.9	(1198.6, 1331.9)
Largest Gap	10	1135.6	103.4	(1069.0, 1202.3)
Composite	10	1000.3	64.8	(933.6, 1066.9)

Pooled StDev = 104.672



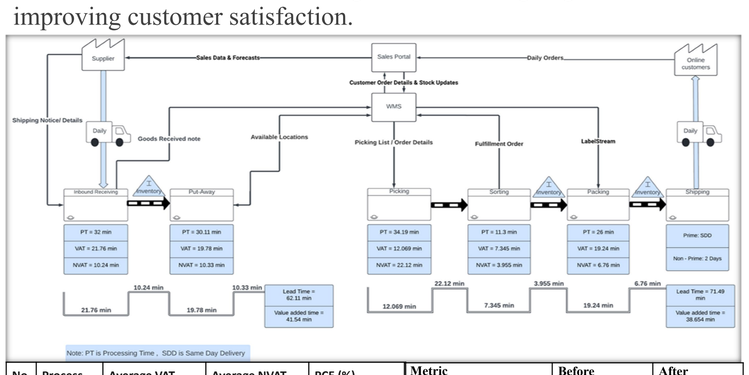


Do Phase

In the Doing phase, the composite strategy which combine both transversal and return strategies is implemented during the picking process since it significantly outperforms all other routing strategies. This is done for five observations to update the picking process in the previous VSM.

Check Phase

To check for improvements, the picking process is updated it in the previous VSM after implementing the composite strategy, As a result, there was a noticeable improvement in the PCE percentage. The average non-value-added time for the picking process has been reduced by 10.5 minutes, resulting in an 8.27% improvement in the PCE of the picking process. This, in turn, has led to an overall warehouse PCE improvement from 55.65% to 60%. This achievement aligns with the organizational goal of reaching a 60% PCE, underscoring the effectiveness of the implemented strategy. It is worth noting that an 8.27% improvement in the PCE of the picking process will lead to an increase of 30.73% in the picking capacity per shift. This enhancement not only streamlines the picking process but also contributes to the overall goal of reducing logistics costs and improving customer satisfaction.



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4	Sorting	7.345	3.955	65%
5	Packing	19.24	6.76	74%
Total		**80.194**	**53.435**	**60%**

Metric	Before Improvement	After Improvement
Picking Time (for 60 items)	44.70 minutes	34.19 minutes
Picking Rate (items/hour)	80.54	105.29
Total Items Picked per Shift	1288.64 items	1684.64 items
Increased Percentage of Picking Capacity	**30.73%**	

Act Phase

During the act phase, it's important to implement a standardized composite strategy. This involves upgrading the picking devices to display the path for the composite strategy for each picklist. It's necessary to conduct thorough training programs for all warehouse staff to ensure they are skilled in using lean tools and the newly implemented routing strategies. Additionally, it's important to ensure the sustainability of the improvements and identify further areas for enhancement.

ACKOWLEDGEMENTS

We extend our heartfelt appreciation to Aramex for generously providing us with access to one of their warehouses, enabling us to conduct our project seamlessly within their organization. This invaluable opportunity has significantly contributed to the achievement of our project.

Revamping of a Fuel Cell System from Industry 2.0 to Industry 4.0: from Business Intelligence to Business Analytics

Students: Aissa Messaoudi | Abdallah Fareed | Ahmed Elsayed | Kareem Al Jaghbeer | Zeyad Mohamed

Supervisor: Dr Concetta Semeraro

Introduction:

Our project, “Revamping of a Fuel Cell System from Industry 2.0 to Industry 4.0: from Business Intelligence to Business Analytics," focuses on transforming a nonfunctional fuel cell system, initially built with industry 2.0 tools, into a new advanced system compatible with industry 4.0 standards. By revitalizing a neglected system within a laboratory environment, the aim is to demonstrate how outdated, non-functional systems can be upgraded to align with modern digital technologies. These technologies include data analytics, data monitoring, data extraction, and intelligent decision-making dashboards.

Revamping of a Fuel Cell System from Industry 2.0 to Industry 4.0: from Business Intelligence to Business Analytics

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23-24F07
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جامعة الشارقة
UNIVERSITY OF SHARJAH
كلية الهندسة
COLLEGE OF ENGINEERING

INTRODUCTION

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BACKGROUND

Our project contextualizes fuel cell technologies within the broader landscape of sustainable energy solutions and Industry 4.0, highlighting their high efficiency and low emissions crucial for transitioning to greener energy sources. We discuss the Fuel Cell System's applications in transportation and stationary power generation and explore the role of data-driven techniques like Formal Concept Analysis (FCA) and business intelligence tools such as Power BI in optimizing these systems for improved performance and predictive maintenance. This convergence of technology and analytics enhances operational efficiency, promotes renewable energy utilization, provides significant operational insights, and paves the way for future technological integration within the system

DISCUSSIONS

- The project met its objectives by revamping an outdated fuel cell system with advanced digital tools, highlighting both the efficacy of the approach and areas for further development.
- The Integration of new technologies with existing hardware and adapting data management practices for data analytics.
- Utilization of Power BI for creating dashboards, contributing to the body of knowledge in digital system enhancement and providing learning opportunities in data-driven decision-making.
- Reinforce the project’s alignment with sustainable practices and industry 4.0 standards, suggesting significant implications for the future of energy systems and industrial operations.
- The possibility of incorporating real-time data monitoring and additional sensors set a course for the continuous evolution of the system within the technological landscape of Industry 4.0.

CONCLUSION

The project revamped a fuel cell system from Business Intelligence to Business Analytics, showcasing improved sustainability and efficiency.. our project has achieved significant milestones, including operationalizing the system, optimizing it through data-driven approaches, and developing Power BI dashboards for improved operation. Moving forward, we recommend embracing Industry 4.0 by integrating advanced sensors and real-time data tools to further enhance the system's performance and capabilities.

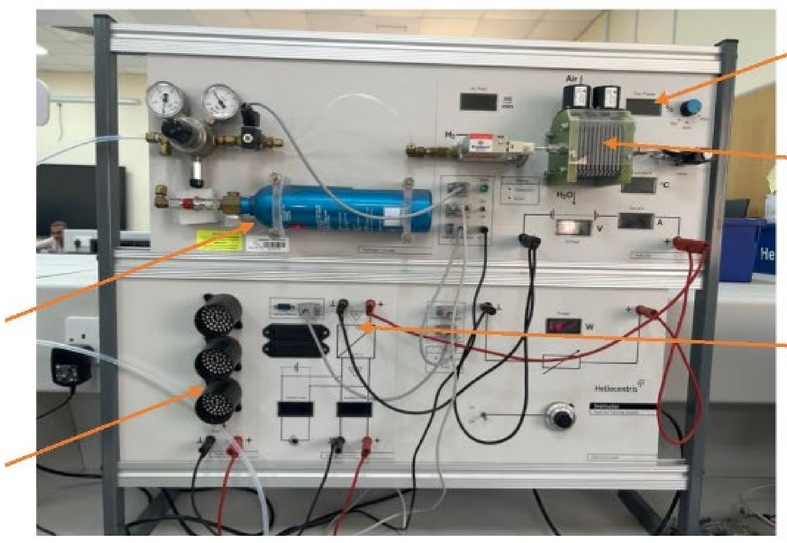
THEORY

This report delves into the innovative convergence of Fuel Cell System, Power BI, and data-driven techniques, heralding a new frontier in data analytics and sustainable energy solutions. It underscores the strategic importance of utilizing Business Intelligence to unlock insights and optimize the Fuel Cell System to Business Analytics. With Power BI's robust capabilities for analyzing complex datasets, and fuel cell environmentally-friendly energy solutions, projects highlights the immense potential of this integration. This synthesis aims to clarify the interactions between data-driven methodologies and fuel cell systems, identifying research avenues and propelling the fields of data analytics and sustainable energy technologies forward

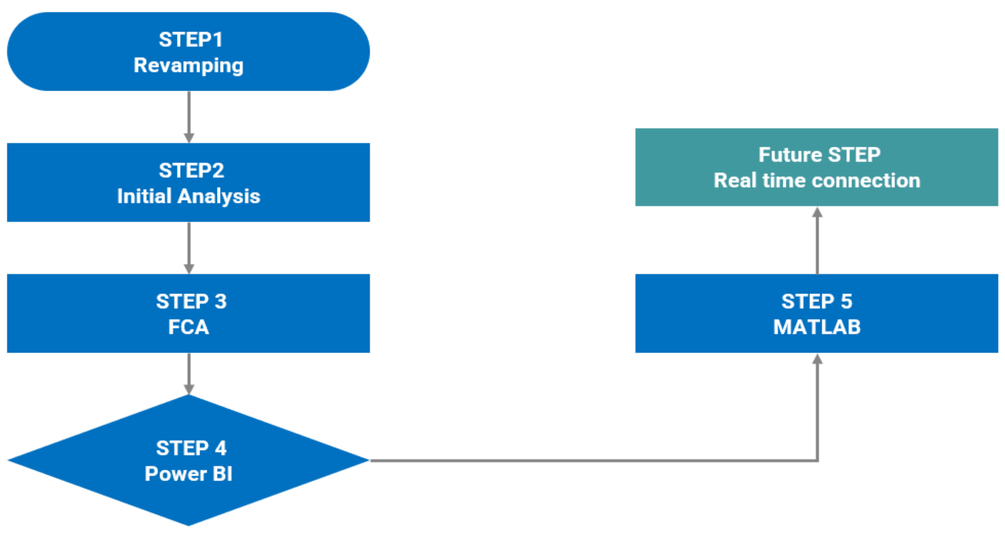
EXPERIMENTAL SETUP

In our project, we revamped an outdated fuel cell system, transforming it into a technologically advanced setup compliant with Industry 4.0. The process began with thorough diagnostics to repair the system, followed by strategic hardware upgrades. We then overhauled the data management from basic data files to a more structured system suitable for data analytics. This careful preparation enabled us to incorporate sophisticated software tools for business intelligence and analytics, allowing for significant operational insights and paving the way for future technological integration.

Fuel Cell System



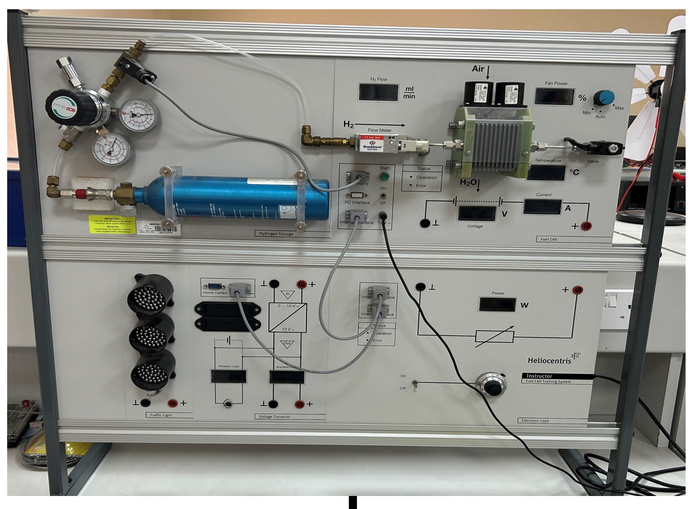
Fuel Cell System Architecture



CASE STUDY AND RESULTS

1. Revamped an outdated fuel cell system to align with Industry 4.0 technologies, enhancing efficiency and connectivity.
2. Business Intelligence Implementation Developed Power BI dashboards, translating complex data into actionable insights for system optimization.
3. Predictive Maintenance Applied machine learning algorithms to predict system performance, improving maintenance.
4. Performance Optimization Demonstrated the capability to optimize voltage output through careful analysis and adjustment of system parameters
5. Business Analytics enabled prescriptive maintenance for real-time data.

Revamped Fuel Cell System



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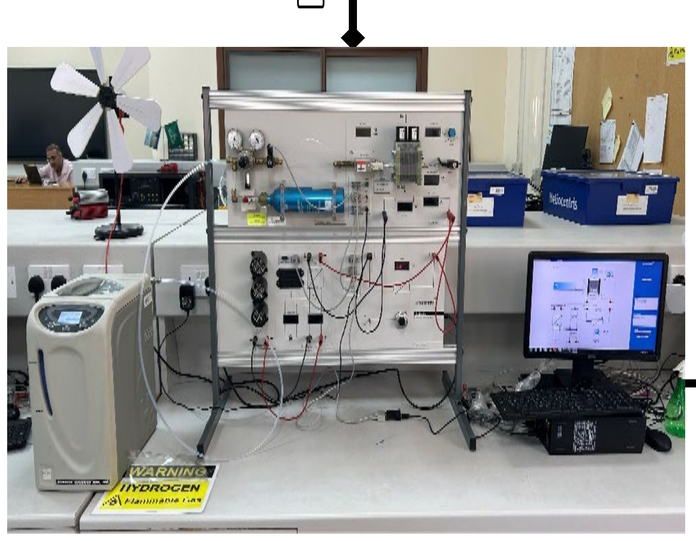
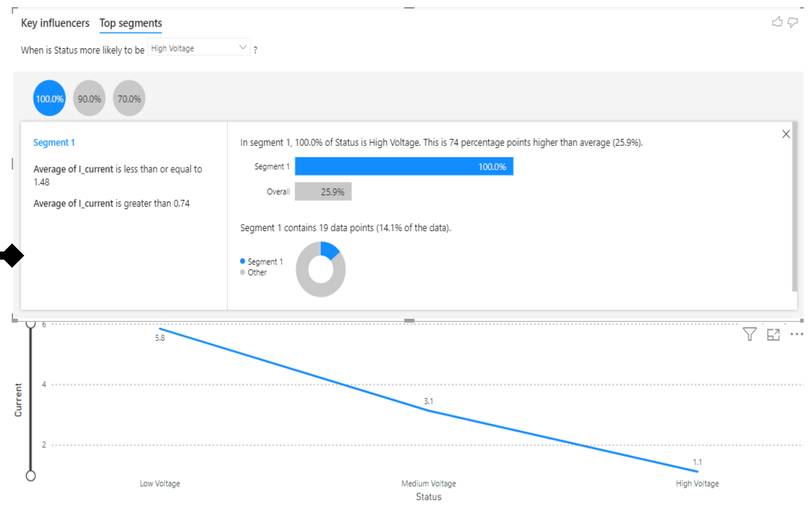
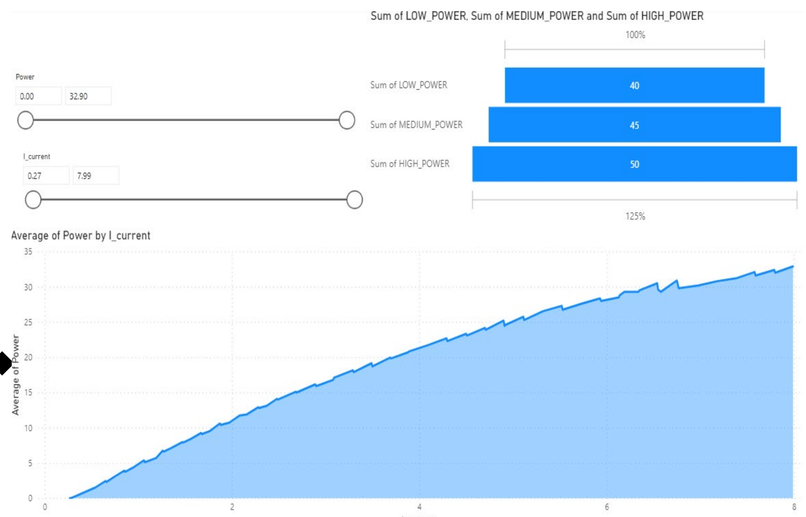


Full Revamped System: Through systematic repair, upgrades, and integration of modern technologies, we revamped the system.

2



Segmentation Dashboard: Each segment is accompanied by a confidence rating, and the targeted status can be adjusted accordingly.



Power Consumption by Current: The dashboard is designed to confirm that the Fuel Cell operates according to the planned parameters.

ACKNOWLEDGEMENT & REFERENCES

We express profound thanks to Dr. Concetta Semeraro for her mentorship, Eng. Abdalhakim for his collaboration, our department's faculty for their wisdom, and our families for their unwavering support. Our work is built upon key literature, including Semeraro et al. (2023) on digital twin design, Wark (2022) on BI tools for proactive reporting, and Wang et al. (2011) on PEM fuel cells, providing the academic foundation for our project

Design and Implement a Digital Twin Of a Compressed Air Energy Storage System for Real Time Optimization

Students: Ahd Maher Shoshaa | Layan Samer Ghannam | Nada Samy Moursy

Supervisor: Dr. Concetta Semeraro

Introduction:

CAES systems, essential for storing excess energy from renewable sources, operate by compressing air for later use. However, maintaining their efficiency and reliability poses significant challenges. This project seeks to address these issues by leveraging Digital Twin technology. By creating a virtual replica of CAES systems and integrating real-time monitoring and predictive analytics, we aim to optimize their performance and sustainability. Through tools like Amazon Forecast and MATLAB, past data is utilized to predict system behavior and enhance operational efficiency. Overcoming challenges such as data availability and software complexity is crucial for the successful implementation of digital twin in CAES systems, ultimately advancing energy storage technology for a more sustainable future.

Design and Implement a Digital Twin Of a Compressed Air Energy Storage System for Real Time Optimization

23-24F03: Ahd Maher Shoshaa U20101349
Layan Samer Ghannam U20103261
Nada Samy Moursy U20101128
Supervisor: Dr. Concetta Semeraro

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INTRODUCTION

CAES systems, essential for storing excess energy from renewable sources, operate by compressing air for later use. However, maintaining their efficiency and reliability poses significant challenges. This project seeks to address these issues by leveraging Digital Twin technology. By creating a virtual replica of CAES systems and integrating real-time monitoring and predictive analytics, we aim to optimize their performance and sustainability. Through tools like Amazon Forecast and MATLAB, past data is utilized to predict system behavior and enhance operational efficiency. Overcoming challenges such as data availability and software complexity is crucial for the successful implementation of digital twin in CAES systems, ultimately advancing energy storage technology for a more sustainable future.

BACKGROUND

In recent years, the concept of Digital Twins has surged in popularity across industries, reshaping conventional approaches to system monitoring, optimization, and maintenance. According to (Semeraro et al., 2021) Digital Twin is "A set of adaptive models that emulate the behaviour 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 change, to prescribe real time actions for optimizing and/or mitigating unexpected events observing and evaluating the operating profile system". Within the energy sector, Digital Twins offer compelling opportunities for bolstering efficiency, reliability, and sustainability. Among the array of energy storage solutions, Compressed Air Energy Storage (CAES) has emerged as a particularly promising technology, aimed at storing surplus energy generated from renewable sources to mitigate the inherent intermittency challenge.

CAES systems operate by compressing air during periods of low energy demand, storing it underground, and subsequently releasing it through turbines to generate electricity during peak demand periods.

DISCUSSIONS

- Digital Twin technology significantly improved CAES systems by utilizing past data and predictive modeling for real-time monitoring.
- Amazon Forecast, a cutting-edge predictive analytics tool, continuously refined predictions within the Digital Twin framework for CAES systems. Leveraging machine learning algorithms and historical data, it enabled stakeholders to anticipate system behavior accurately, optimizing proactive management strategies.
- Microsoft Excel emerged as the preferred platform for data analysis and problem-solving within the Digital Twin framework for CAES systems. Its user-friendly interface and powerful analytical functions facilitated the manipulation and interpretation of complex datasets, empowering stakeholders to make informed decisions and optimize system performance effectively.
- MATLAB, a versatile programming language and interactive environment, played a pivotal role in the continuous monitoring of CAES systems within the Digital Twin framework.. Through data visualization, analysis, and simulation, system could identify performance trends, detect anomalies, and optimize system operations in real-time, ensuring optimal efficiency and reliability.
- The experimental integration of Digital Twin technology with CAES systems demonstrated its feasibility and effectiveness in enhancing system efficiency and reliability. Leveraging advanced tools like Amazon Forecast, Microsoft Excel, and MATLAB, stakeholders developed predictive models, analyzed system behavior, and optimized operations in real-time. This collaborative framework showcased the transformative potential of Digital Twin technology in revolutionizing energy storage solutions and advancing sustainability initiatives.

CONCLUSION

This project explored Digital Twin technology's potential to enhance CAES systems, leveraging tools like Amazon Forecast, Excel, and MATLAB for real-time monitoring and prediction. Excel proved to be the best option, meeting project aims with its features for data analysis and proactive problem-solving. Its versatility improves operational efficiency, reduces downtime, and maximizes CAES system performance. The findings underscore the importance of historical data and advanced algorithms for optimized system performance. Future steps involve refining algorithms and fostering collaboration to advance energy storage technology.

THEORY

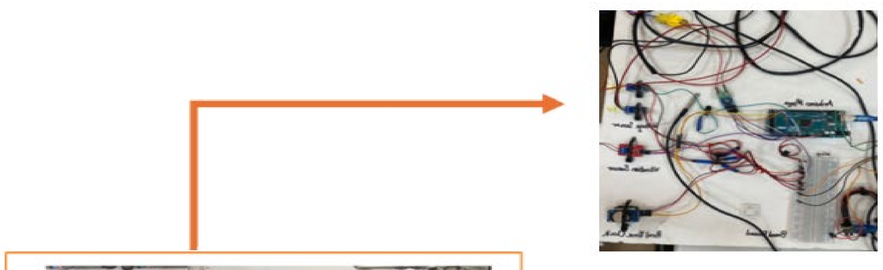
The project addresses challenges inherent in CAES systems by leveraging Digital Twin technology. Its primary objective is to develop innovative solutions enhancing the effectiveness and dependability of the CAES system through real-time monitoring, analysis, and optimization capabilities. A key focus involves obtaining real-time data from the physical system, with the digital system providing real-time feedback to enhance problem prediction and proactively address future issues. By utilizing historical data and predictive modelling, the aim is to improve operational efficiency, minimize downtime, ensure reliability, and optimize performance.

SETUP, EXPERIMENTAL

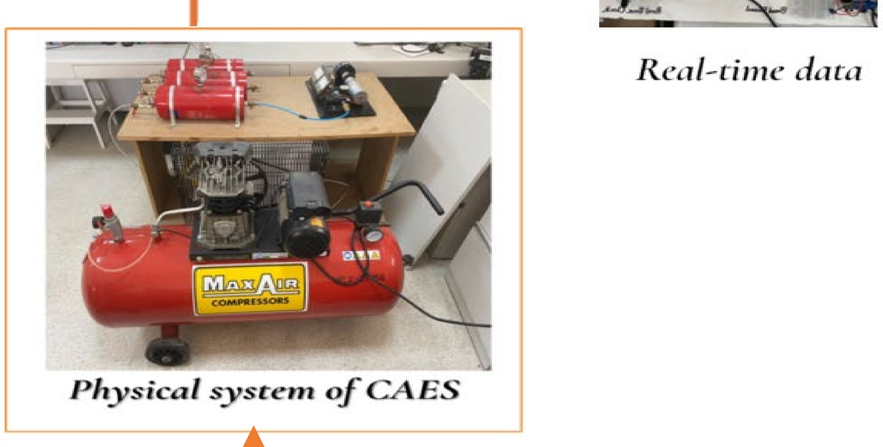
To realize the objectives outlined in this study, an experimental setup integrating Digital Twin technology with Compressed Air Energy Storage systems was devised. The Digital Twin framework was implemented to facilitate real-time monitoring, analysis, and optimization of the Compressed Air Energy Storage system's performance. Leveraging tools such as Amazon Forecast, Microsoft Excel, and MATLAB, historical data was collected and utilized to develop predictive models within the Digital Twin environment. The experimental setup involved continuous monitoring of key parameters such as air compression, storage, discharge, and energy production. Data from physical Compressed Air Energy Storage systems were fed into the Digital Twin, allowing for the generation of real-time feedback and predictive insights. Various software platforms were assessed for their suitability in the Digital Twin framework, with Microsoft Excel emerging as the optimal choice due to its robust data analysis features and versatility in proactive problem-solving. The experimental setup aimed to demonstrate the feasibility and effectiveness of Digital Twin technology in enhancing the efficiency, reliability, and performance of Compressed Air Energy Storage systems.

RESULTS

The Digital Twin technology improved Compressed Air Energy Storage (CAES) systems by using past data and predictive modeling for real-time monitoring. Analysis with tools like Amazon Forecast, Microsoft Excel, and MATLAB showed that Excel was most effective for data analysis and problem-solving. We set up a feedback loop using Excel and Amazon Forecast to improve predictions and used MATLAB to monitor system performance with historical and real-time data. This setup allowed continuous monitoring of CAES system phases like air compression, storage, discharge, and energy production, giving stakeholders real-time insights for proactive management. Excel's features helped boost operational efficiency and reduce downtime. Overall, Digital Twin technology proved effective in enhancing Compressed Air Energy Storage system performance, demonstrating



Real-time data



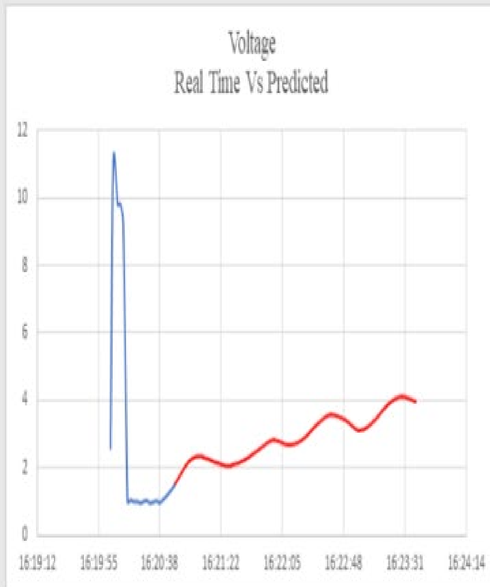
Physical system of CAES

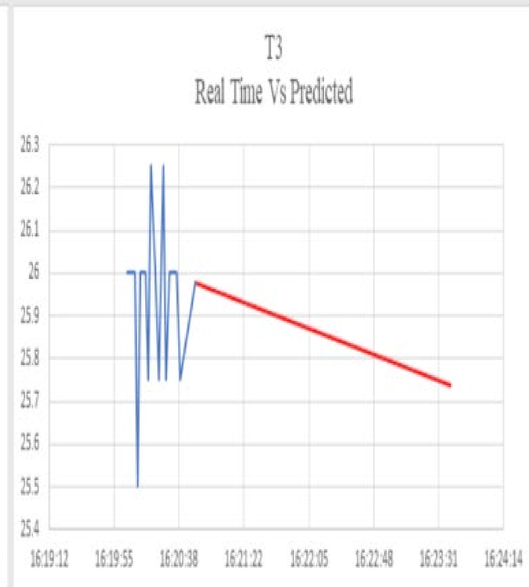
Digital twin of CAES

Feedback

CAES System Dashboard

Real Time				Prediction			
Time	Voltage	T3	Status	Time	Voltage	T3	Status
16:31:36	2.6	24.5	F2	16:32:09	0.19218	27.3529	F2
16:31:38	0.18	24.25	HS	16:32:19	0.19033	28.7445	F2
16:31:39	0.23	24.5	F2	16:32:29	0.18847	30.1361	F2
16:31:41	0.2	24	HS	16:32:39	0.18662	31.5276	F2
16:31:42	0.2	24.5	F2	16:32:49	0.18476	32.9192	F2
16:31:44	0.2	24.25	HS	16:32:59	0.18291	34.3108	F2
16:31:45	0.18	24.5	F2	16:33:09	0.18105	35.7024	F2
16:31:47	0.2	24.25	HS	16:33:19	0.1792	37.094	F2
16:31:48	0.15	24.25	HS	16:33:29	0.17734	38.4855	F2
16:31:50	0.18	24.25	HS	16:33:39	0.17548	39.8771	F2
16:31:51	0.15	24	HS	16:33:49	0.17363	41.2687	F2
16:31:53	0.2	24.25	HS	16:33:59	0.17177	42.6603	F2
16:31:54	0.2	24.25	HS	16:34:09	0.16992	44.0519	F2
16:31:56	0.18	24	HS	16:34:19	0.16806	45.4434	F2
16:31:57	0.18	24.25	HS	16:34:29	0.16621	46.835	F2
16:31:59	0.18	24.25	HS	16:34:39	0.16435	48.2266	F2





ACKNOWLEDGEMENT & REFERENCES

We are grateful to Allah (subhanahu wa ta'ala) for the opportunity to study at the University of Sharjah. Special thanks to our supervisor, Dr. Concetta, for her invaluable guidance in our senior design project. We also thank our parents for their enduring support, Professor Abdul Hai Al-Alami for allowing us to use his CAES system, Engineer Rawnaq for collaboration, and our friends for their encouragement. Lastly, we extend our thanks to ourselves for our dedication and perseverance.

Reference:

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Mechanical & Nuclear Energy Engineering

Table of Content

Design and Fabricate a Solar Thermal System for Brine Recovery

Students: Metraf Alteneiji | Ramez Badawieh | Khalfan Alkindi | Awadh Altamimi

Supervisor: Prof. Mutaz Ali | DR. Mohammed Kamil

WINNER

Introduction:

Desalination, a process to turn salty water into freshwater, helps, but it creates a new problem: salty waste called brine. Getting rid of brine can harm the environment. Our research is about using the power of the sun to solve this problem. The proposed solar thermal system aims to address these challenges by leveraging the principles of solar energy conversion and thermal desalination. Through the integration of solar collectors, heat exchangers, and evaporation chambers, the system will harness solar radiation to generate heat, facilitating the evaporation of water from the brine solution.

Title: Design and fabrication a solar thermal system for brine recovery.

Metraf Alteneiji, Ramez Badawieh, Khalfan Alkindi, Awadh Altamimi

Supervised by: Prof. Mutaz Ali, DR. Mohammed Kamil

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INTRODUCTION

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BACKGROUND

Background:

The increasing global demand for fresh water and concerns regarding water scarcity and environmental sustainability have prompted the exploration of innovative water treatment methods. Brine, a highly concentrated salt solution produced as a byproduct of various industrial processes like desalination, mining, and chemical production, poses a significant challenge due to its high salinity and potential environmental harm if not properly managed. Conventional methods of brine disposal, such as ocean discharge or evaporation ponds, carry environmental risks and waste valuable resources.

Theory:

The theoretical foundation guiding the design and development of a solar thermal system for brine recovery revolves around harnessing solar energy to facilitate thermal desalination processes. Key theoretical concepts include:

1. Heat Transfer Mechanisms
2. Evaporation and Condensation Processes
3. Thermal Desalination Techniques

CONCLUSION

In conclusion, the design and fabrication of a solar thermal system for brine recovery represent a promising avenue for addressing water scarcity challenges and mitigating environmental impacts associated with brine disposal. By harnessing the abundant and renewable energy of the sun, these systems offer a sustainable and economically viable solution for separating freshwater from brine solutions generated by various industrial processes.

THEORY / METHODS

The design and fabrication of a solar thermal system for brine recovery revolve around harnessing solar energy to facilitate the separation of freshwater from saline solutions.
Key theoretical principles include:
1- Solar Energy Utilization. 2- Evaporation and Condensation & 3- Thermal Desalination Techniques.

Methods: 1- System Design. 2- Material Selection. 3- Fabrication & 4- Testing and Validation

SETUP, EXPERIMENTAL

Setup:

1. Solar collector array positioned for optimal sunlight absorption.
2. Integration of heat exchangers for efficient heat transfer.
3. Design of evaporation chamber and condensation system.

Experimental Approach:

1. Optimize system operation for maximum efficiency.
2. Evaluate long-term durability and reliability.
3. Validate performance in real-world conditions.

RESULTS

The design and fabrication of the solar thermal system for brine recovery yielded promising results, demonstrating its potential effectiveness in addressing water scarcity challenges and mitigating environmental impacts associated with brine disposal. Key findings from the experimental testing and analysis include:

1. Water temperature.
2. Inlet temperature of heat exchanger.
3. Outlet temperature of heat exchanger.
4. Temperature of brine.

In the test we did in our project it was double pipe heat exchanger and the system was able to desalinate 1 Liter in 10 Minute.

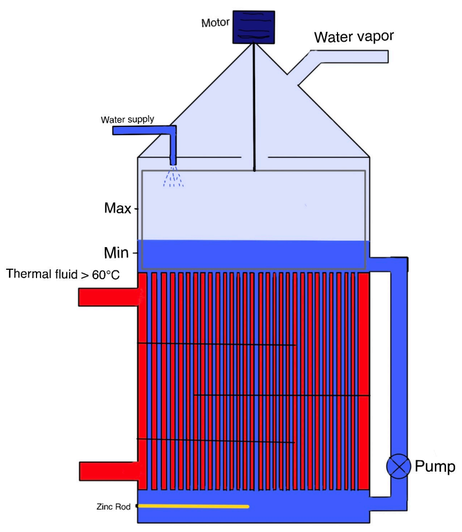


Figure 1 Boiler - for 1000 L / hr

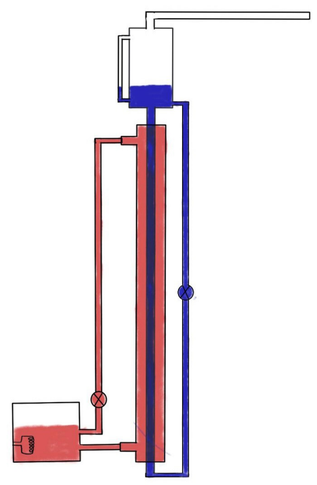


Figure 2 Double pipe heat exchanger

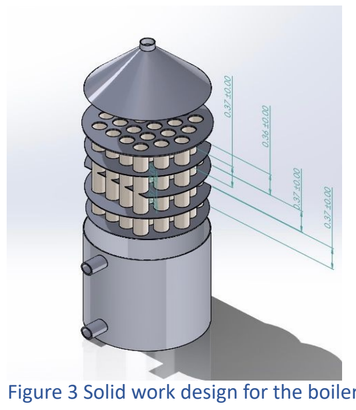


Figure 3 Solid work design for the boiler

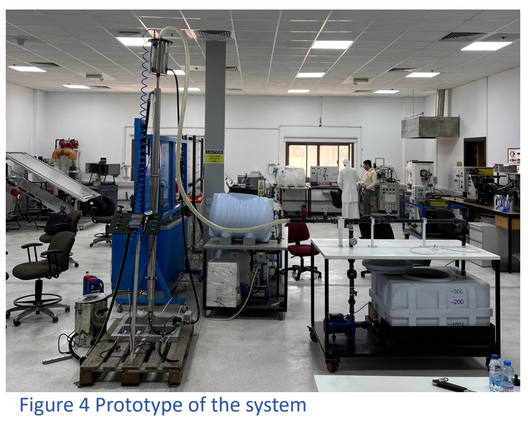
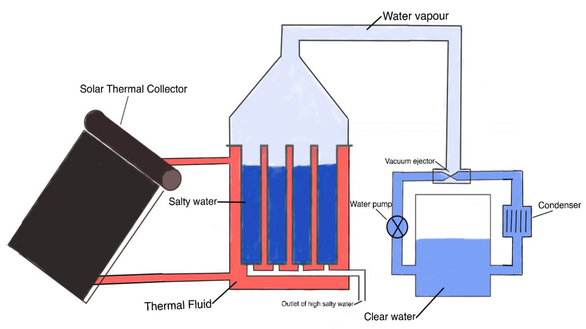


Figure 4 Prototype of the system



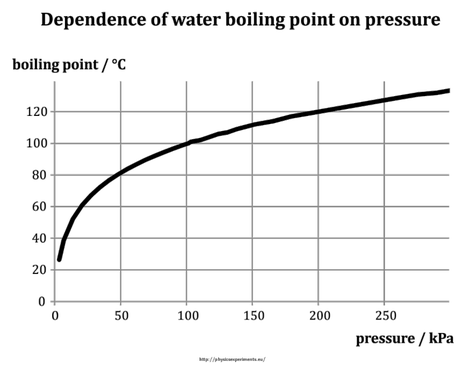


Figure 5 Work principle of the system

DISCUSSIONS

Designing and fabricating a solar thermal system for brine recovery presents a promising solution to address water scarcity challenges and mitigate environmental impacts associated with brine disposal. This discussion delves into key considerations and analyses associated with the design and fabrication process:

1. **Real-world Validation and Deployment:**

- **Real-world validation through field trials and pilot-scale deployments is essential to validate system performance under actual operating conditions and assess practical challenges.**

2. **Environmental Impact:**

- **An environmental assessment is crucial to understand the potential environmental impacts associated with the operation of the solar thermal system, including greenhouse gas emissions, water usage, and ecosystem effects.**
- **Comparing the environmental footprint of the solar thermal system to conventional brine disposal methods enables informed decision-making regarding sustainability and environmental stewardship.**

ACKNOWLEDGEMENT & REFERENCES

We want to express our gratitude to Dr. Mutaz and Dr. Kamil for their continuous support and guidance throughout our senior design project. Their assistance at every step was invaluable, and we are truly thankful for their dedication.

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Designing a Racing Kart

Students: Aseel Atheer | Yousef Maqatef | Abdullah Zahid | Fares Al Ansari

Supervisor: Dr. Mohammad AlShabi

Introduction:

This project report presents a comprehensive analysis and design process for constructing an efficient and cost-effective go-kart, focusing on the chassis, steering system, and wheel balancing, as part of a senior design project. Our primary objective was to explore the feasibility of building a go-kart within a limited budget, aiming to achieve performance and efficiency comparable to higher-budget models. This investigation was motivated by the market gap, where the cost of homemade go-karts represents about 20% to 43% of the upper market cost, ranging from $150 to $2000.

Designing a Racing Kart

Senior Design Project

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Fares Al Ansari U17200066

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Introduction

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Theory / Methods

Our methodology involved a detailed study of existing go-kart designs, cost analysis, component sourcing, and a focused design approach on the chassis, steering, and wheel balancing. The design was developed in SolidWorks, and the analysis was conducted using ANSYS, ensuring a robust and reliable engineering process. The design analysis adhered to the maximum regulations for most adult karting venues, with an average weight limit of 150 kg and a height limit of 190 cm, and considered a target velocity of 40 km/h.

SETUP, EXPERIMENTAL

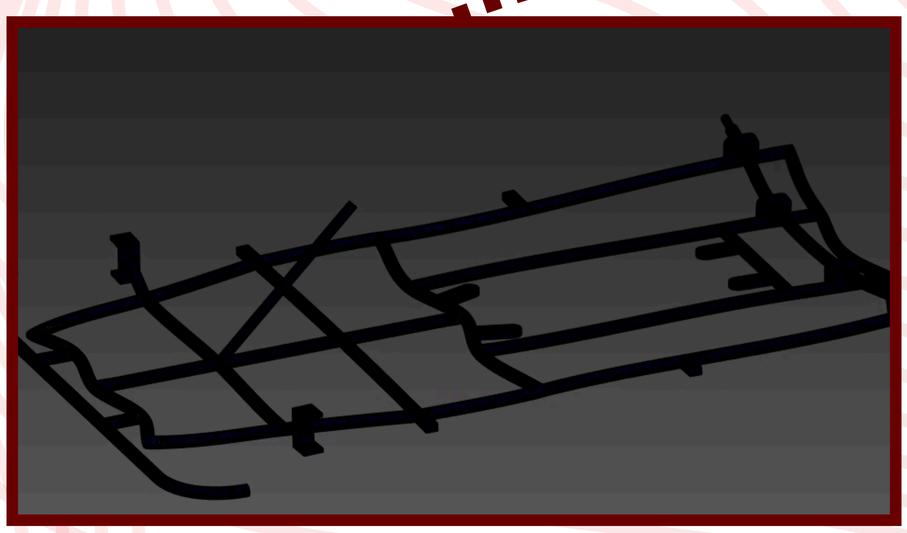
- Chassis & Material Selection: The Design and Conceptualization of the Chassis along with selecting the proper material for our application
- Design & Analysis: Designing the components on SolidWorks and doing the Finite Elements Analysis on Ansys.
- Steering Wheel Properties: Choosing the type of steering system fit to our budget and racing kart.
- Wheel balancing properties: Finding the correct type of wheels for our chassis.

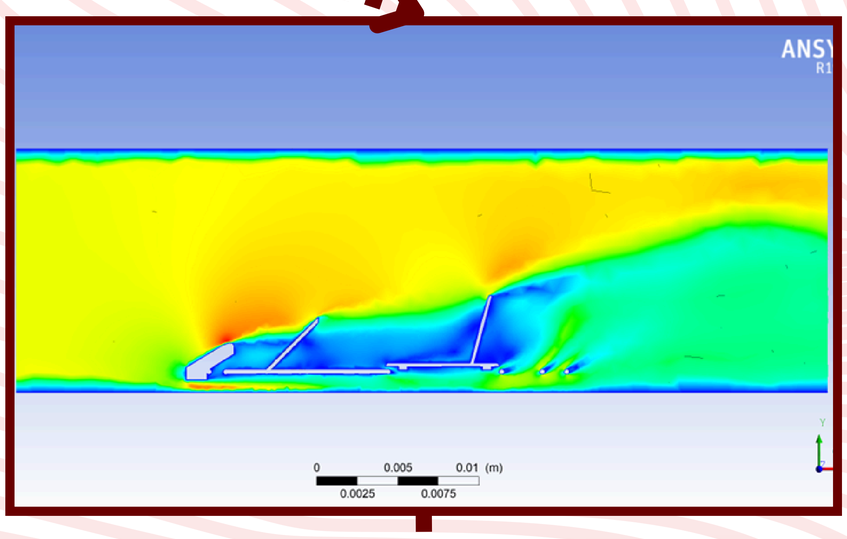
RESULTS

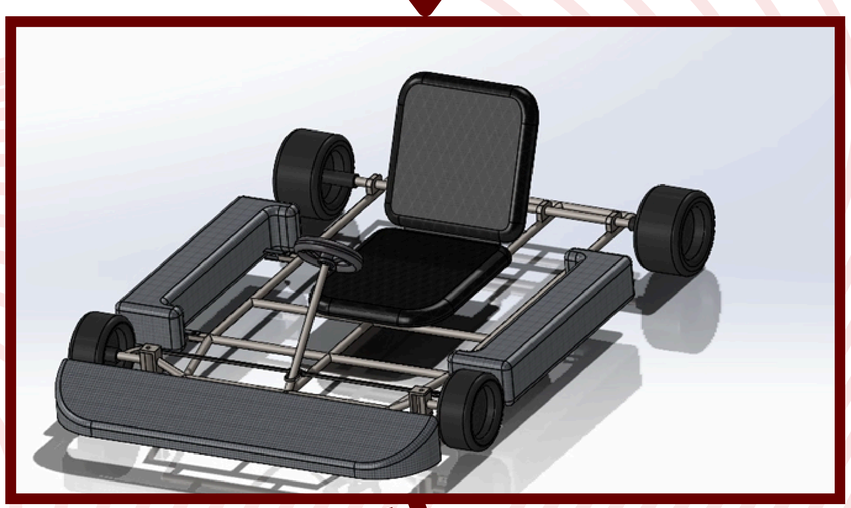
At the end of the project, we've reached our objectives which were to design the chassis, the steering system, and the wheel balancing within our requirements and budget. Below are images of the prototype on solidworks with it's different analysis along with the final product.

BACKGROUND

In the dynamic field of automotive design and engineering, particularly in the context of racing kart development, there exists a continuous pursuit of innovation and efficiency. This project on "Designing a Prototype Race Kart," lodged within the Automotive and Design specialization, aligns with the current state of the art in this area. The automotive industry has seen rapid advancements in technology, materials, and design philosophies, leading to the creation of vehicles that are not only faster but also safer and more reliable. In recent years, a significant emphasis has been placed on integrating cutting edge technology and sustainable practices into race kart design, reflecting a broader trend within the automotive industry towards environmental responsibility and technological advancement.







CONCLUSION

In the end, the racing kart senior design project was a culmination of everything we've learned practically and theoritically. We've applied all our experiences that we've gained in multiple courses which led to the final product we observe infront of us today. the satisfaction of turning a concept into a tangible, high-performance racing kart. This endeavor has not only been a learning experience but also a demonstration of capabilities as future engineers.

ACKNOWLEDGEMENT & REFERENCES

We extend our deepest gratitude to our advisor Dr. Mohammad Al Shabi, whose invaluable insights and guidance have been pivotal in shaping this project. We are also grateful to our family and colleagues who have pushed us to our greatest form to accomplish greatness. We are also thankful to Dr. Hussein Ali Hussein for his assistance with specific details that significantly enhanced our work and the many other instructors who shaped us throughout our university years to be able to attempt such a project.

Design of Heat Exchanger with Different Phases

Students: Hanna Yousef | Maryam M. AlShehhi | Jumana S. Ahmed

Supervisor: Mohammed Kamil

Introduction:

Heat transfer is crucial in industries such as power generation and automotive cooling, where inefficiencies and bulkiness often hinder performance. This project introduces a two-phase heat exchanger that utilizes cold air from an evaporative cooler and hot water from a water heater to tackle these challenges. Through detailed research, we designed, modeled, and analyzed the system using MS Excel, MATLAB Simulink, and SOLIDWORKS. We then constructed a prototype, conducted thorough testing, and evaluated its thermal and hydraulic performance by testing and CFD, significantly enhancing our expertise in thermo-fluid dynamics and the efficiency of heat exchange systems.

Design of Heat Exchanger with Different Phases

Authors: Hanna Yousef - Maryam M. AlShehhi – Jumana S. Ahmed
Supervisor: Mohammed Kamil, PhD
Examiners: Prof. Taher Laoui, Prof. Syarif Junaidi

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INTRODUCTION

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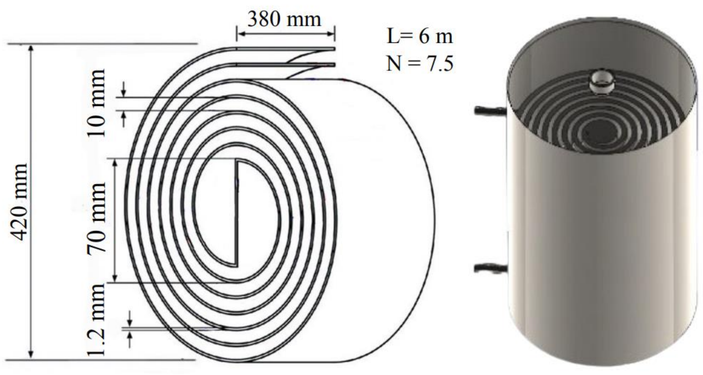
BACKGROUND

Heat exchanger's efficiency depends on factors such as flow rate, surface area, and material properties, while fouling requires regular maintenance. Heat exchangers can be arranged co-currently or counter-currently, with the latter often more efficient due to better temperature gradients. Spiral plate heat exchangers, notable for their compactness and efficiency, use two rolled sheets around a central rod to create an effective spiral flow path that boosts heat transfer and reduces fouling. This report focuses on optimizing a spiral plate heat exchanger for enhanced thermal and hydraulic performance in demanding industrial settings.

CAD Model & Simulation

For thermal and hydraulic performance testing, a CAD model was imported into Ansys Fluent and was compared with theoretical and experimental results.



CONCLUSION

In conclusion, the assessment of the two-phase spiral plate heat exchanger through steady state, transient, and hydraulic testing offers key insights into its varied performance. The alignment between CFD and experimental results validates the simulations, while deviations in theoretical predictions suggest areas for refinement. The data confirms the exchanger's efficiency in managing thermal loads and optimizing flow, making it ideal for precision-critical applications. This study highlights the potential of spiral plate heat exchangers to enhance thermal management solutions.

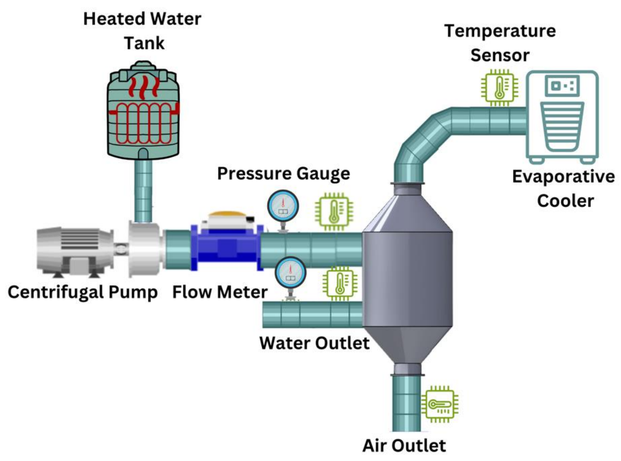
THEORY / METHODS

To design a versatile heat exchanger capable of handling different phases, we took the following steps:

- Research on spiral plate heat exchangers.
- Research on the design methodology of the spiral plate heat exchanger and the required equations.
- Constructing Microsoft Excel and MATLAB Simulink models to find optimal dimensions with add-ins and visual basic tools.
- Modifying our project, and reviewing and editing the dimensions
- Manufacturing our prototype and adding glass covers on the air inlets.
- Lab testing with steady-state, transient, and hydraulic experimentation.
- We analyzed our results using our theoretical model.
- We conducted CFD simulations with ANSYS Fluent.
- We studied the thermal and hydraulic performance of our heat exchanger and compared out results.

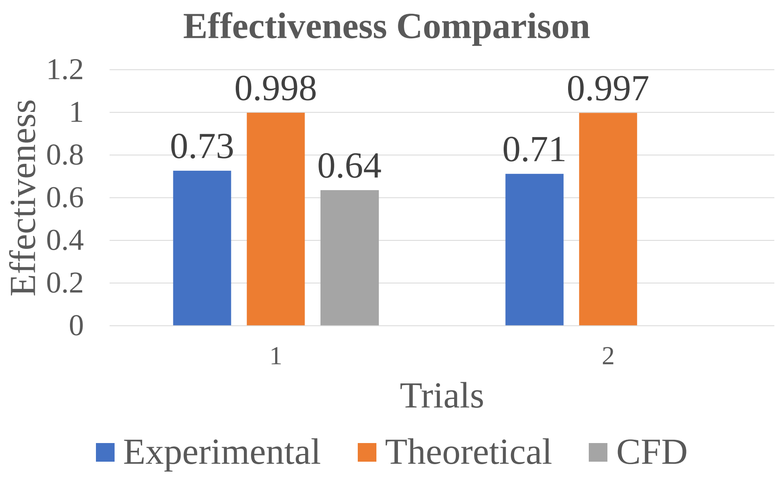
SETUP, EXPERIMENTAL

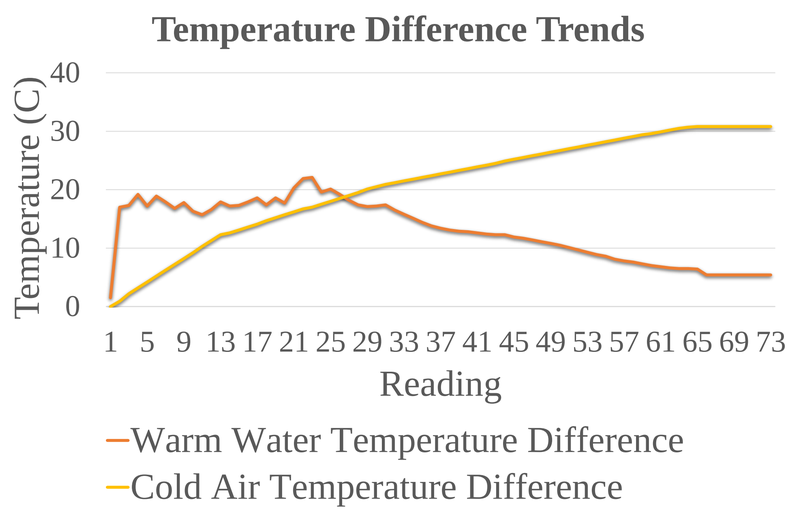
In our testing setup, heated water is circulated from a tank where it has been warmed via heating coils, while cool air is supplied by an evaporative cooler with its outlet positioned below the system. Pressure gauges and temperature sensors monitor the states of the fluids throughout the experiment. The two figures show the theoretical planned setup and the in-lab experimental setup.



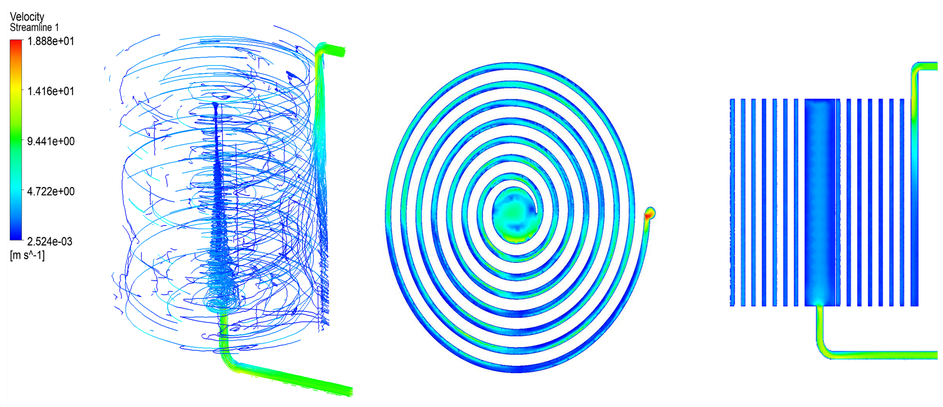
DISCUSSIONS & RESULTS

Different procedures were employed for evaluating the two-phase spiral plate heat exchanger using hot water and cold air including steady state, transient, and hydraulic analysis. These tests assess the exchanger's ability to maintain thermal conditions over time, examine its response to changing conditions, and check pressure and flow characteristics for efficient operation. Comparative analysis of the steady-state results reveal that theoretical results predict higher effectiveness, followed by experimental, and lastly the CFD simulation results. The effectiveness of the experimental results was around 0.72 and increased with the increase of the flow rate. Regarding the transient graph, it's evident that the temperature difference between the water inlet and outlet fluctuated unpredictably, diminishing over time. Conversely, the temperature disparity between air inlets and outlets escalated, exhibiting a pattern resembling a square root function, with a rapid initial rise followed by a gradual deceleration. This thorough examination facilitates the refinement of the heat exchanger's design to increase the efficiency over different industries.





We simplified the mesh to model water flow within the heat exchanger, resulting in the depiction of velocity streamlines and profiles shown in the accompanying images. Notably, velocities are considerably higher prior to entering the spiral, while flow velocities near the spiral walls are markedly lower.



ACKNOWLEDGEMENT

We extend our sincere gratitude to Dr. Mohammed Kamil from the Mechanical and Nuclear Engineering Department at the University of Sharjah for his invaluable guidance and support. Additionally, we express our appreciation to Eng. Ahmed Alobaid and Eng. Mohammed Ammar for their generous assistance. Lastly, we are deeply grateful to our parents for their encouragement and support during the semester.

Design of a Smart Mechanical Platform to Lift Small Vehicles Parked in No Parking Places

Students: Hamda Almheiri | Sara Alkaram | Maryam Alassi

Supervisor: Prof. Naser Nawayseh

Introduction:

In our problem overview, we're addressing the challenge of illegally parked vehicles causing urban disruptions. These vehicles contribute to issues like traffic congestion, pose safety risks, and obstruct emergency services, exacerbating urban challenges. In addressing the persistent challenge of urban disruptions caused by illegally parked vehicles, we've engineered a groundbreaking solution: a user-friendly, smart electromechanical scissor lift. This innovative system can efficiently relocate small vehicles weighing up to 2000kg, all controlled through a convenient mobile app interface. What sets our solution apart is its seamless navigation beneath vehicles, eliminating the need for manual labor and ensuring a quick and easy resolution to parking violations. Our prototype, meticulously crafted from a combination of 3D-printed components and carefully selected ready-made parts, underwent rigorous dynamic and static stress analyses to ensure its structural integrity and operational safety. This comprehensive approach reflects our commitment to providing urban environments with a reliable, efficient, and technologically advanced solution to the challenges of unauthorized parking.

Design of a Smart Mechanical Platform to Lift Small Vehicles Parked in No Parking Places

Author: Hamda Almheiri, Sara Alkaram, Maryam Alassi
Supervisor:Prof. Naser Nawayseh
Examiners Committee: Dr. Hussein Ali Hussien, Prof. Khalil Abdelmawgoud

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INTRODUCTION

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BACKGROUND

Illegal parking poses a persistent challenge for urban planners worldwide, typically addressed through towing and wheel clamping, each with its drawbacks. Towing can be slow and damaging, while wheel clamping merely immobilizes vehicles without removing them, exacerbating traffic issues. These traditional methods are manpower-intensive and inefficient, especially in congested urban areas, often worsening traffic congestion.
Recognizing these challenges, there's a pressing need for a superior solution. Our electro-mechanical scissor lift directly tackles these issues by efficiently lifting and relocating vehicles with minimal contact, speeding up the process of clearing no-parking zones while reducing the risk of damage. This innovative approach not only enhances the efficiency of managing parking violations but also mitigates potential conflicts between vehicle owners and authorities.
Moreover, the scissor lift represents a shift towards technology-driven urban management, aligning with broader smart city initiatives aimed at enhancing urban living through advanced mechanics and automation. The incorporation of a screw lifting mechanism into the scissor lift concept holds significant economic and social potential. While various lifting methods exist, each suited to different applications, the 2-post and 4-post lifts have gained widespread use in automotive and industrial contexts, prioritizing stability and strength. The 2-post design facilitates easy access to the vehicle's underside, while the 4-post structure is tailored for storage and fundamental maintenance tasks .The need for more flexible and space-efficient solutions in various sectors has led to the emergence of the scissor lift as a viable option.
Various lifting mechanisms, such as hydraulic, pneumatic, and screw-based systems, are employed in scissor lifts, each with unique advantages. However, the electro-mechanical mechanism utilizing a lead screw stands out as the optimal choice due to its precise control, reliability, and reduced environmental impact compared to traditional hydraulic systems.
Among lead screw thread types like square, buttress, and acme, the acme thread is preferred for scissor lifts due to its robustness, efficiency, and resistance to wear. Its trapezoidal shape provides superior load-bearing capacity and self-locking characteristics, ensuring stable and safe operation in lifting applications.

CONCLUSION

The proposed electro-mechanical scissor lift presents an innovative solution to unauthorized parking in urban areas, providing an efficient alternative to towing and wheel clamping. This technology-focused approach emphasizes precision, environmental sustainability, and safety, helping organize and streamline urban transport.

Our project developed a prototype specifically for relocating vehicles in no-parking zones. It combines 3D-printed and sourced components, with designs analyzed for stress in SolidWorks. Equipped with Mecanum wheels for enhanced maneuverability, the lift features detailed calculations on force, torque, and efficiency to ensure optimal performance. Remote control functionality is enabled through a smartphone, utilizing Arduino-programmed motors and servos. This project lays the groundwork for future enhancements and broader applications.

THEORY / METHODS

Our electro-mechanical scissor lift is designed based on solid engineering principles, focusing on mechanics and automation. It features a screw lifting mechanism that transforms rotational motion into linear, allowing for smooth vehicle lifting with minimal energy. We applied mechanical advantage, material strength, and stress analysis to ensure structural integrity and durability. Control systems automate the lift for efficiency and safety, minimizing human intervention. Using SolidWorks, we modeled and simulated the lift's performance, optimizing the design before actual construction, which ensured that our prototype was both effective and sustainable, aligning with urban environmental goals.

SETUP, EXPERIMENTAL

Our experimental setup for the electro-mechanical scissor lift included constructing a detailed prototype based on our SolidWorks simulations, using both ready-made parts and 3D-printed components for easy modifications based on testing feedback. We carried out thorough testing in a controlled environment, evaluating the lift's performance across various parameters, such as load capacity, and stability. These tests involved using weighted dumbbells, ensuring the lift could manage real-world demands. Additionally, we controlled the movement and the lead screw using a Bluetooth RC car app, allowing for precise manipulations and assessments of the lift's functionalities under various conditions.

RESULTS

The Torque on Lead Screw: The raising torque and lowering torque was found to be:

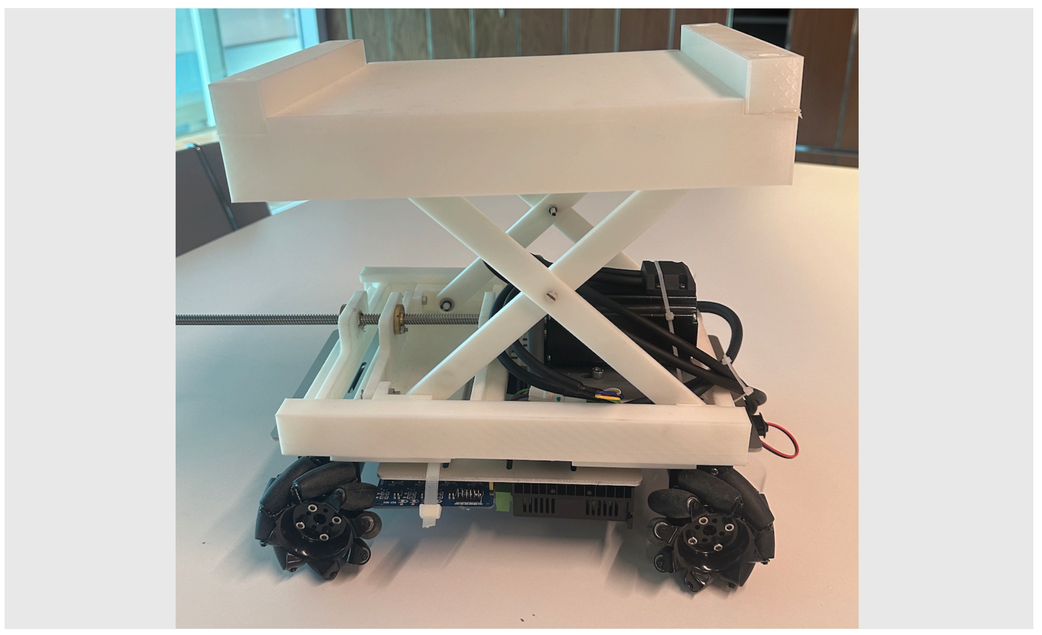
T_R	T_L
0.3886 N.m	0.125 N.m

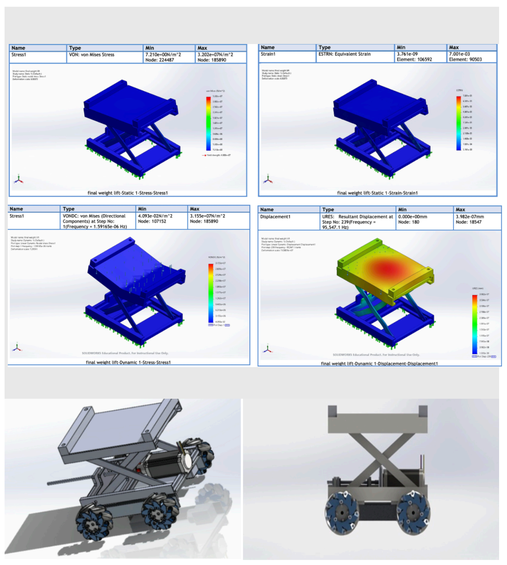
The shear stress, the bending stress at root of thread, the axial nominal stress, and the bearing stress was found:

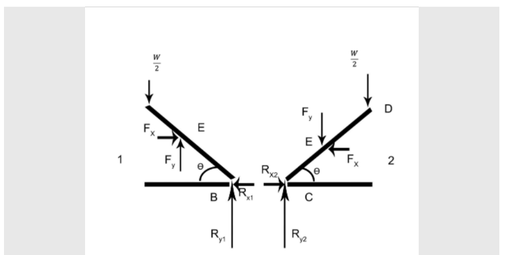
τ	7.95 Mpa
σ_b	5.7690 Mpa
σ	-3.218 Mpa
σ_B	-1.727 Mpa

Finding the radius that will provide the same rotational to linear motion transformation, the raising and lowering force, and the efficiency was found to be:

r_{eq}	$1.27 \times 10^{-3}\ m$
F_R	118.90 N
F_L	98.425 N
η	32 %







angle (deg)	Fx (N)	Fy (N)	Rx (N)	Ry (N)
49.46	85.53	0	85.53	50
55	70.02	0	70.02	50
60	57.74	0	57.74	50
65	46.63	0	46.63	50
70	36.40	0	36.40	50
75	26.79	0	26.79	50

DISCUSSIONS

FORCE ANALYSIS:
- Fx (N): Horizontal force decreases with angle increase, suggesting less force needed for lifting at higher elevations.
- Fy (N): Vertical force remains zero, indicating a possible oversight or balanced load.
- Rx (N): Horizontal reaction force decreases similarly to Fx, indicating less ground support as the angle increases.
- Ry (N): Vertical reaction force is constant at 50 N, showing consistent ground support regardless of the angle.

TORQUE ON LEAD SCREW:
1. Torque: More torque required to raise the load (0.3886 Nm) compared to lowering it (0.125 Nm) due to friction.
2. Force: Higher force needed to lift (118.90 N) than to lower (98.425 N) the load, affirming the impact of friction.
3. Efficiency: At 32% efficiency, most of the force is lost to friction, indicating room for improvement by reducing friction.

STRESS ANALYSIS ON LEAD SCREW:
- Shear Stress (τ): Maximum shear stress at 7.95 MPa due to torsional forces.
- Axial Nominal Stress (σ): Compressive stress along the axis at -3.218 MPa.
- Bearing Stress (σB): Stress on bearing surfaces at -1.727 MPa.
- Bending Stress (σb): Stress at the thread's root at 5.769 MPa, a critical point for stress concentration.

MECHANICAL ADVANTAGE:
- The mechanical advantage of 4 suggests that the system is effective in reducing the input force needed, thanks to the high leverage of the screw mechanism.

MECANUM WHEEL SELECTION:
- Wheel Size: 4-inch suitable for the total 15 kg weight.
- Factor of Safety (FOS): High safety margin with FOS of 4, balancing safety, weight, and cost, ensuring reliability under various conditions.

Soildworks Stress Analysis
- Design 1:
  - Minimum and maximum von Mises stresses are significantly different, with the maximum exceeding the material's yield strength, indicating a failure point.
- Design 2 Static Analysis:
  - Stresses and strains are within safe limits, with a factor of safety of 1.5 ensuring the design stays within the elastic range and is structurally sound.
- Design 2 Dynamic Analysis:
  - Stress and displacement analyses show stability but point out areas that might need reinforcement due to localized stress and slight deformations.

ACKNOWLEDGEMENT & REFERENCES

We extend our deepest gratitude to Prof. Naser Nawayseh for his invaluable guidance and mentorship, which significantly shaped our project's success. We also thank Dr. Abdulla Alassi for his essential expertise in simulations, helping refine our models. Lastly, we appreciate the University of Sharjah for enabling us to pursue this innovative project.

Lead screw calculator. Lead Screw Calculator - AMB Robotics Calculator. (n.d.). https://ambcalc.com/lead_screw?=&od-u=0.001&od=8&pitch=20&starts=1&angle=30&nut-mat=Brass&force-u=1&traise=0.193&traise-u=1&tlower=-0.765&tlower-u=1&lraise=60.626&lraise-u=1&llower=-240.236&llower-u=1&force-c=%5E&force=1
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Design of Solar-Powered Machine to Turn Plastic Waste into 3D Printing Material.

Students: Omar Zakareya Alkamali | Mohammed Moosa Sharfian | Abdulrahman Abdulla Abdulrahman | Abdulla Ali Alnuaimi

Supervisor: Prof. Khalil Abdelmawgoud | Prof. Abdulwahab Bin Mohammad

Introduction:

Polymer recycling has several significant impacts, both environmentally and economically. This Senior Design Project aims to get the potential benefits of combining 3D printing technology with plastic recycling. Our project is to convert recovered polymers into premium 3D printing filaments while focusing on sustainability and resource efficiency. We investigate the nuances of several recycling techniques, including chemical and mechanical polymer conversion methods. In order to ensure that the final filament is suitable for various printing applications, an extensive review of the literature on polymer recycling has been performed to evaluate its mechanical integrity, thermal stability, and rheological qualities. Our study thoroughly examines the environmental consequences linked to recycling techniques, going beyond technical factors. A setup was designed and installed that can be converted into a machine to convert the harmful polymer materials into a 3D filament. The project supports entrepreneurship projects that made the SDP team a job creator rather than a job seeker. Our results highlight the growing need for sustainable materials in industrial settings and their economic viability. Our efforts have resulted in designing and implementing a scalable production process that can transform waste plastics into high-grade filaments for 3D printing.

Title: Design of solar-powered machine to turn plastic waste into 3D printing material.

Omar Zakareya Alkamali, Mohammed Moosa Sharfian, Abdulrahman Abdulla Abdulrahman, Abdulla Ali Alnuaimi

Supervisors: Prof. Khalil Abdelmawgoud, Prof. Abdulwahab Bin Mohammad

Examiners Committe: Prof. Muataz Ali, Dr. Adewale Olalekan Giwa.

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INTRODUCTION

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BACKGROUND

Innovation in sustainable materials is at a dynamic crossroads where plastic recycling and 3D printing filament production meet. Researchers and practitioners alike are increasingly looking to synthesizing recycled plastics as a feasible source for 3D printing filament as the world struggles with the growing issues of plastic pollution. The critical research and developments in this emerging industry are reviewed in this literature review, which also looks at the technological, environmental, and financial aspects that highlight the game-changing potential of turning waste plastic into premium filament for additive manufacturing. Types of Polymers Used in the UAE: As a dynamic and rapidly evolving nation, the United Arab Emirates (UAE) is a paradigm of the transformative potential of economic growth and diversity. The expanding demand for polymer materials across various industries, such as construction, packaging, automotive, healthcare, and more, reflects a country's lofty ambitions. It will examine polymers in the UAE in-depth, breaking them into major categories and illuminating their applications. ABS is a versatile thermoplastic with high mechanical strength and impact-resistant. It's resistant to various temperatures and has more flexibility than stiff polymers. ABS is a material that can be 3D printed with FDM technology. Bed temperatures should be about 80-110°C, while the optimal printing temperature is between 220-240°C. Since printing produces fumes requires a well-ventilated space (Kim et al., 2023). ABS's versatile qualities make it a viable choice for 3D printing in many industries, from functional prototyping to producing automobile parts and consumer items. Its strong impact resistance and temperature tolerance allow many technical and production applications flexibility. In conclusion, different 3D printing applications call for different polymers. PE and PP are ideal for prototypes, flexible parts, and chemically resistant components because to their adaptability and durability. PS is great for applications without impact protection because of its transparency, such as clear prototypes and electronic casings. The United Arab Emirates (UAE) has shown a rising interest in technology and innovation, and the ABS plastic used in 3D printing is a strong and adaptable material that can be used for many purposes. Careful study of physical and mechanical qualities and printing settings is required to maximize the potential of any polymer in 3D printing applications.

CONCLUSION

In conclusion, our project emphasizes how crucial it is to recycle plastic to protect the environment, particularly in the UAE and worldwide. We believe that our novel strategy of recycling particular plastic kinds into 3D printer filaments will significantly impact society and the environment. Furthermore, the project represents a rethinking of using the SDP in an entrepreneurship project that helps us create our job. Our in-depth examination of the literature and much study has allowed us to pinpoint essential opportunities and difficulties in recycling. These discoveries have shaped our design assumptions, providing a solid basis for subsequent implementation. Setting up and installing our intended machine and procedure is a crucial next step in achieving our goals. We can progress toward a more environmentally conscious future by utilizing cutting-edge technology and sustainable practices. Essentially, our research offers a viable path toward resource efficiency and environmental stewardship, demonstrating a solid commitment to sustainability and innovation in waste management.

THEORY / METHODS

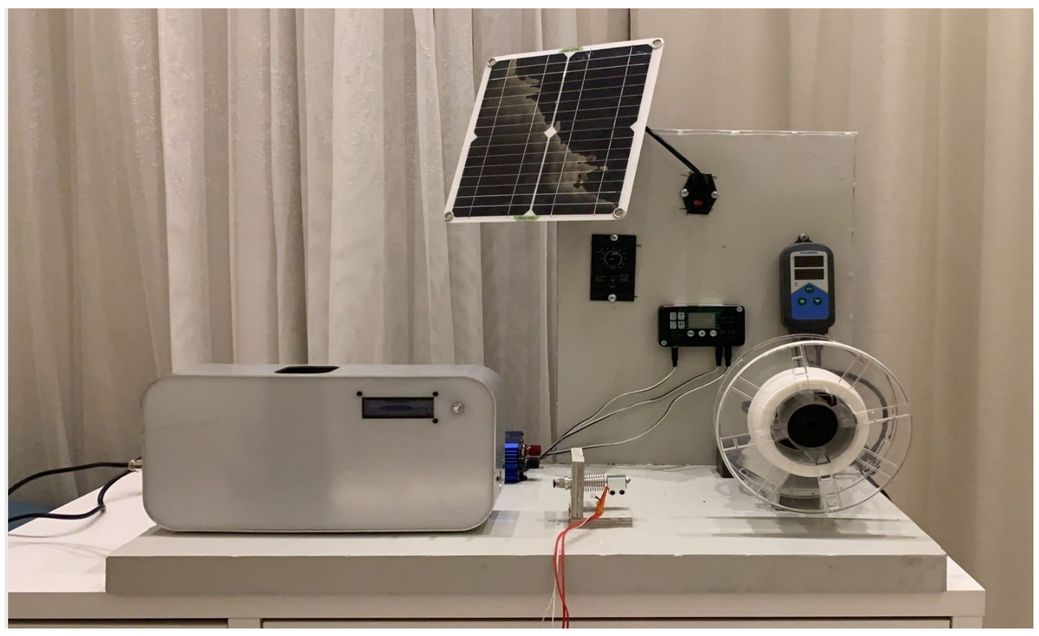
Most 3D printers use a wire as feed material, so the first option is to develop an extruder that permits the manufacture of the wire. This allows us to start the process of printing from plastic granulate. The process starts feeding the hopper with the plastic. The screw drags and breaks granulate. The extrusion process continues until the material comes out of the nozzle creating he wire which will be guide by a plastic tube into the printer´s head.
Apparently this option is the simplest one but there are some problems to be solved. The biggest problem is when the extruder stops working all the plastic inside the canal lowers its temperature and solidifies. So is not possible to start the process again. Furthermore, as the wire comes out with a high temperature and in a melted way, the material gets stuck into the tubes walls and the printing process is not uniform and it can block the tube.

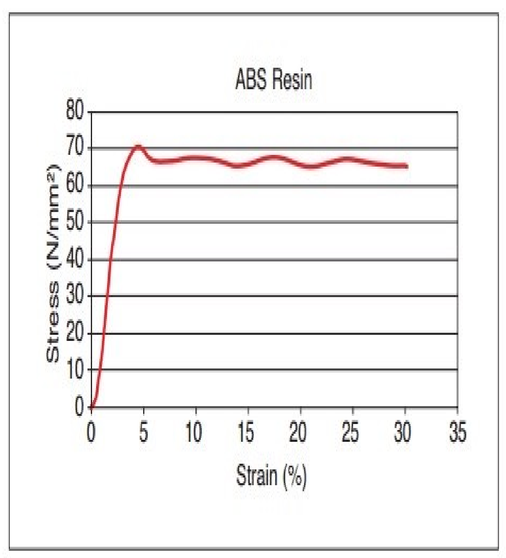
SETUP, EXPERIMENTAL

The most crucial part in making the filament is the extruder, which the broken-down plastic enters it and then heats up the nozzle, turning the plastic into a wire-shaped plastic with a small diameter. After the plastic leaves the extruder, the diameter in which the plastic leaves with is a bit bigger than the one needed for the filament which is 1.75mm in diameter, therefor we had to get another nozzle to turn the plastic into the needed diameter. After the battery plastic leaves the second nozzle the had to have a rotating motor which will pull the plastic from the second nozzle and the plastic will be turning in a circular motion around the roller which we have ready, the motor also needs to a controller which we also ordered for it. The system's power source is a battery that is being charged using solar energy with a solar panel, making the system environmentally friendly. Since the battery is DC powered, we had to get an inverter to turn the battery source into an AC source.

RESULTS

we can determine of our extruder is the helix angle of the screw by below equation. Since the Diameter in our screw is 15 mm.
= 17.65
Screw Lengths: For amorphous thermoplastic, the feeding zone is between 20% and 25% of the screw length, the compression zone between 32% and 38% and for the metering zone between 40% and 45% . We based our decision of the zones lengths on the percentage from the total length that normally has each zone. The percentages used in each zone are obtained as follows:
%= %/%1+%2+%3
L1% = 20 / 20 + 32 + 40 = 0.217
L2% = 32 / 20 + 32 + 40 = 0.348
L3% = 40 / 20 + 32 + 40 = 0.435
Feeding Zone Length: L1 = 0.217 * 300 = 65mm
Compression Zone Length: L2 = 0.348 * 300 = 105mm
Metering Zone Length: L3 = 0.435 * 300 = 130mm
After doing these calculations we run the machine and produce the results after some trials getting the most accurate results we have looked for. The ABS plastic filament with a diameter of 1.75 mm, that was produced after tests and trials adding some filler to get the properties that permit for 3D priniting uses. by trial and error method we got the required filament at a temperature of 150 celsius and 5 RPM.





DISCUSSIONS

After some testing and trials, the extruder machine worked efficiently and was ready to produce the filament. By putting the temperature and speed at these values at 150 c and 5 RPM, we got some results after some calculations and looked for the properties of the plastic type used, which was ABS. By doing this step and producing with the exact size, we have gone through halfway of the procedure, but this was not enough because we should ensure that the used plastic is efficient for the 3d printing machine. We recognized that the filament is somehow brittle, and after testing and calculations, it seems that ABS plastic needs to add filler to use the filament in the 3D printer. To ensure that the product is acceptable, we have built a dog bone testing sample using our filament to test it using tensile test so we can check whether the plastic is useful or not. It seems that 60 MPa and rate of strain 5% the bone will fracture. Human error easily occurs when changing and playing with speed and temperature values. This main error caused the results to differ from the aimed numbers. Another source of error was the Improper feeding of plastic wastes by inadequate shredding and mixing of materials, which caused inconsistencies in the extrusion process. The last error that occurred to us was a mechanical issue with the extrusion where the screw was not rolling and moving due to some contaminants inside the machine that lead to lag and failure in some tests done by us. After producing the final 3D printing filament, we analyzed some points. The extrusion machine was very sensitive and needed an accurate temperature and speed reading to produce the exact product asked for. Also, the plastic wastes we got directly from bottles and other wastes need to have some pre-steps such as washing from any contaminants and adding the exact amount of filler to make it applicable for the 3D printing device because taking the plastic directly to the extrusion will not produce a useful filament that will print in the 3D printer. ABS plastic is a very efficient type used in 3D printing, so we should ensure that we extract the full benefit from it by keeping the properties as possible. Lastly, by getting the results out, it seems that Cooling is a crucial procedure that should be conducted while experimenting to ensure that the properties won't be affected. Considering these points, we have produced and built what we aimed to do in our senior design project, but some failures and errors occurred due to different circumstances. As the failure and errors were highlighted, we can say that if we avoid them, the exact results will come out with the lowest possibility of errors.

ACKNOWLEDGEMENT & REFERENCE

we are sincerely thankful for the assistance and encouragement provided by a multitude of individuals and entities. First and foremost, we extend our deepest gratitude to Prof. Abdul Wahab Bin Mohammad and Prof. Khalil Abdelrazek Khalil, their guidance and mentorship were instrumental throughout the entire duration of this project.. Additionally, we would like to thank our families for their support, encouragement, and patience, which provided us with the motivation to continue with this project.

Kim, M.S. et al. (2023) 'A review of biodegradable plastics: chemistry, applications, properties, and future research needs', Chemical Reviews, 123(16), pp. 9915–9939.

Hybrid Electric Vehicle (HEV) Improvements to Frame

Students: Abdulrahim Ahmad | Ahmed Khaled, Salem Almheiri | Khaled Esmaeil

Supervisor: Dr. Hussien Ali

Introduction:

This project focuses on the design and development of an improved Hybrid Electric Vehicle (HEV) frame, aiming to achieve a lighter weight, and similar or higher strength compared to the existing mild steel frame. The frame was handdrawn with the attachments and structural elements. Using AutoCAD and ANSYS software, we designed the frame and conducted the stress analysis to gain information about the existing car frame. The proposed solution was to design a new frame using lightweight and high strength materials. The senior project aims to optimize the frame's design, considering load distribution, structural requirements, safety regulations, enhancing the efficiency, performance and the structural integrity of the HEV. Finally, fabricating the frame and installing it on the HEV to observe the enhancements in performance.

Hybrid Electric Vehicle (HEV) Improvements to Frame

Abdulrahim Ahmad, Ahmed Khaled, Salem Almheiri, Khaled Esmaeil
Supervisor: Dr. Hussien Ali
Examiners Committee: Prof. Khalil Abdelmawgoud, Dr. Adewale Olalekan Giwa.

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BACKGROUND

The utilization of aluminum in the automotive industry has gained significant attention due to its unique properties and potential benefits. Aluminum is a lightweight material that offers high strength-to-weight ratio, making it an attractive choice for various automotive applications. Its low density allows for significant weight reduction compared to traditional materials like steel, resulting in improved fuel efficiency and reduced emissions in vehicles. One of the key advantages of aluminum is its excellent corrosion resistance. Aluminum forms a natural oxide layer on its surface, which acts as a protective barrier against environmental elements and prevents rusting. This makes aluminum a durable and long-lasting material for automotive components, ensuring the longevity of the vehicle. In terms of structural properties, aluminum exhibits impressive strength characteristics. It has a high tensile strength, allowing it to withstand significant loads and stresses. Aluminum also possesses good fatigue resistance, enabling it to endure repetitive loading cycles without failure. These properties make aluminum suitable for supporting structural elements and ensuring the integrity of the vehicle's frame. Furthermore, aluminum offers excellent formability and versatility in manufacturing processes. It can be easily shaped and formed into complex geometries, facilitating the production of intricate automotive components. This versatility allows for innovative designs that can optimize performance and meet specific requirements. Considering the global shift towards environmental sustainability and the pursuit of more energy-efficient transportation, the utilization of aluminum in automobiles aligns with these goals. By reducing the weight of vehicle components, including the frame, using aluminum can contribute to lower fuel consumption and emissions, thereby promoting greener mobility solutions. In the context of the senior project, the theoretical background supports the decision to transition from a steel frame to an aluminum frame for the HEV. The lightweight and high-strength properties of aluminum, along with its corrosion resistance and manufacturability, make it a suitable material choice for enhancing the frame's performance and sustainability. The project aims to tap into the potential benefits of aluminum, aligning with the broader industry trend of leveraging this material to achieve efficient and environmentally friendly automotive designs.

CONCLUSION

In summary, our senior design project centered on enhancing the Hybrid Electric Vehicle (HEV) frame by utilizing lightweight, high-strength materials such as carbon fiber, aluminum alloy, and others. Our goal was to surpass the capabilities of the existing mild steel frame, providing a frame with reduced weight and increased strength. Throughout the project, AutoCAD, SolidWorks, and ANSYS were employed to draft the frame and analyze load information, crucial for the design phase. Following the design phase, we proceeded to fabricate and test the proposed frame design. I am pleased to report that the frame passed all tests as intended, confirming its strength, durability, and reliability, thus achieving our main objective. This success not only validates our meticulous design and construction processes but also underscores the potential benefits of our improved HEV frame in elevating vehicle performance and sustainability. The successful implementation of our design concept could pave the way for the development of more efficient and environmentally friendly hybrid electric vehicles, addressing the challenges of reducing weight and increasing strength in automotive frames.

THEORY / METHODS

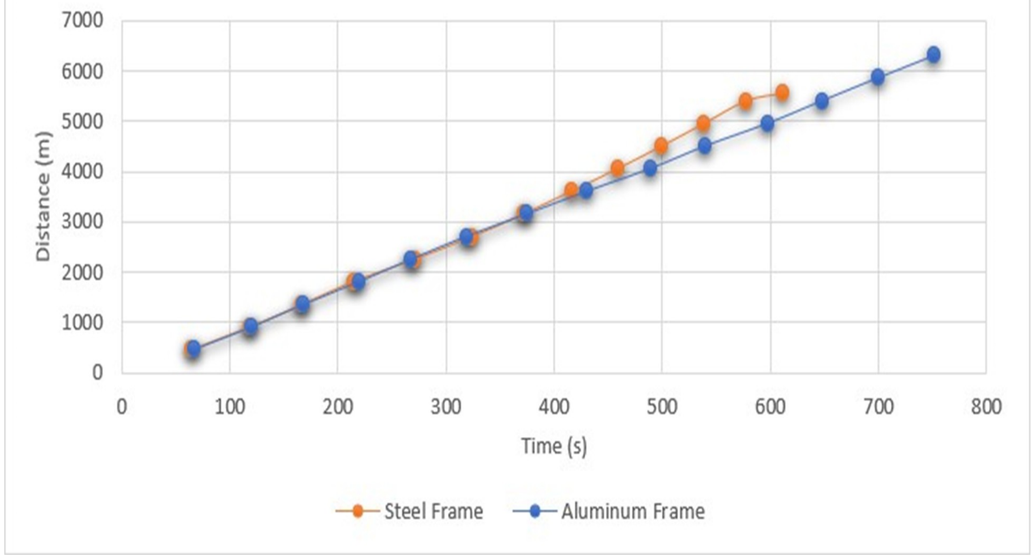
The senior project aimed to enhance a Hybrid Electric Vehicle (HEV) by replacing its steel frame with an optimized aluminum one. Aluminum's lightweight nature offers improved fuel efficiency and emissions reduction. Its strength, corrosion resistance, and versatility in manufacturing enable complex designs. The methodology involved design optimization using CAD software, material selection based on aluminum's properties, and precise fabrication techniques like extrusion and welding. Tests, including simulations and physical assessments, validated the frame's performance and durability. Overall, the project aimed to boost the vehicle's performance, safety, and sustainability through the transition to an aluminum frame, validated through comprehensive testing.

SETUP, EXPERIMENTAL

The senior project involved transitioning a Hybrid Electric Vehicle (HEV) from a steel frame to an optimized aluminum one. It utilized CAD software, fabrication equipment, and testing apparatus. Design optimization ensured compliance with load distribution, safety standards, and manufacturing processes. Aluminum alloys were evaluated for weight reduction, strength, corrosion resistance, and formability. Fabrication techniques like extrusion or welding were used. Testing included dynamic simulations with ANSYS software and physical tests like impact and fatigue tests. A comprehensive performance test compared parameters such as battery voltage, current, speed, and fuel efficiency. Documentation was maintained. The project aimed to validate the aluminum frame's design, construction, and performance, emphasizing benefits in weight reduction, strength, durability, and vehicle performance.

RESULTS

One of our main objectives in this project is to design a frame that is lighter in weight but can withstand all the loads and stresses acting on it. The mass test shows us the difference in mass between the steel frame and the aluminum alloy frame. For the existing steel frame, the total mass was 13.6 kg and for our aluminum alloy frame it was 7.3 kg. We can observe that the mass of the frame was reduced by 46.32% which shows that our design was successful when it came to reducing the mass of the frame.



DISCUSSIONS

Software simulations

The software simulations conducted in SDP I gave us crucial information about how the frame will react to the loads acting on it. Through simulating the total deformation and the equivalent (Von Mises) stress we observed the reaction of the frame and decided whether the design is safe or not. In Figures 29 & 30 we can see the equivalent (Von Mises) stresses for the Steel & Aluminum frame, the simulation shows a blue color (minimum stress) for the majority of both the frames. Although, the minimum stress for the Steel frame is 17.8 KPa and for the Aluminum frame it is 18.8 KPa from this observation we can see that the Steel frame is slightly stronger than the Aluminum frame. For the total deformation simulation we can observe that the maximum total deformation for the Steel frame was 0.0038129 m but for the Aluminum frame we can see a slight increase with 0.010759 m. From the simulations we concluded that the Steel frame is stronger than the Aluminum frame, this was expected due to the mechanical properties of steel being better than Aluminum alloy when it comes to strength. Although, we decided to sacrifice some strength and fabricate the frame using Aluminum alloy to get better overall performance, because according to our simulations the design will still be safe and functional.

Performance test discussion

The performance test proves whether our design was successful or not, by making a direct comparison between the performance of the HEV with the steel frame and the aluminum alloy frame while driving at the same speed. As shown in Graph that the HEV with the steel frame the battery drained from 48 V to 35 V after cruising for a distance of 5550 m and the time it took was 611.99 seconds. Compared to the HEV with the Aluminum frame the battery drained from 48 V to 35 V after cruising for a distance of 6300 m and the time it took was 751.89 seconds. We can see that the HEV performed better when it was equipped with the Aluminum frame, because not only did it drive for a longer distance of 750m the battery took 139.9 seconds longer to drain. This brings us to a conclusion that the aluminum frame allowed the HEV to have better fuel consumption compared to the steel frame.

ACKNOWLEDGEMENT & REFERENCES

We would like to express our appreciation to:

- Dr. Hussien Ali Hussien, our advisor, whose expertise and guidance played a crucial role in helping us achieve the successful outcome of this work.
- Prof. Khalil and Dr. Adewale, to give us advice to develop the project and improve the SDP 1 report.
- The department of mechanical and nuclear engineering, which helped us with the necessary knowledge and skills to finish the project and write this report.
- Eng. Rashid Alrashid, for his exceptional skills in assembling the car, installing the frame with precision, and conducting thorough tests to evaluate its performance.

Radiological Screening for Underground Water Quality Assessment

Students: Joud Salim | Maitha Al-Ali | Fatema AlShamsi | Shaikha AlTeneiji

Supervisor: Dr. Bassam Khuwaileh

Introduction:

Groundwater is an essential resource in arid regions such as the United Arab Emirates (UAE). Alain, located in the eastern region of the UAE, is renowned for its agricultural importance fueled by ancient falaj systems that are utilized for irrigation using water sourced from underground wells. This agricultural prowess not only strengthens the UAE's food security but also upholds its cultural heritage and promotes sustainable development. Given the significance of groundwater, radiological screening becomes imperative to maintain its quality. This project employs advanced instruments, such as the BE2825 High Purity Germanium Detector System and Spectroscopy Software Genie-2000, to quantify the activity concentrations of naturally occurring radioactive materials (NORMs), specifically Radium226, Thorium232, and Potassium40, to ensure the compliance with regulatory standards set by prominent international organizations including the International Atomic Energy Agency (IAEA), the World Health Organization (WHO), the Abu Dhabi Quality and Conformity Council (ADQCC), and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) to safeguard the public health and mitigate health risks and associated with radioactivity exposure and preserve the environment.

Radiological Screening for Underground Water Quality Assessment

Joud Salim, Maitha Al-Ali, Fatema AlShamsi, Shaikha AlTeneiji
Department of Mechanical & Nuclear Engineering

INTRODUCTION

Groundwater is an essential resource in arid regions such as the United Arab Emirates (UAE). Alain, located in the eastern region of the UAE, is renowned for its agricultural importance fueled by ancient falaj systems that are utilized for irrigation using water sourced from underground wells. This agricultural prowess not only strengthens the UAE's food security but also upholds its cultural heritage and promotes sustainable development. Given the significance of groundwater, radiological screening becomes imperative to maintain its quality. This project employs advanced instruments, such as the BE2825 High Purity Germanium Detector System and Spectroscopy Software Genie-2000, to quantify the activity concentrations of naturally occurring radioactive materials (NORMs), specifically Radium^{226}, Thorium^{232}, and Potassium^{40}, to ensure the compliance with regulatory standards set by prominent international organizations including the International Atomic Energy Agency (IAEA), the World Health Organization (WHO), the Abu Dhabi Quality and Conformity Council (ADQCC), and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) to safeguard the public health and mitigate health risks and associated with radioactivity exposure and preserve the environment.

BACKGROUND

The analysis of naturally occurring radioactive materials (NORMs), such as Radium^{226}, Thorium^{232}, and Potassium^{40}, is crucial for understanding their potential health risks in water sources. Activity concentrations, which represent the amount of radioactive material in a given volume of substance, are assessed using equations accounting for factors like gamma-ray yield, detector efficiency, sample volume, and measurement time. Regulatory limits for these materials in drinking water are established based on health risk assessments, with organizations such as the IAEA, ADQCC, UNSCEAR, and WHO providing guidance. Additionally, radiation hazard indices like Radium equivalent activity index (Ra_{eq}), absorbed dose rate (D), total annual effective dose rate (E), external hazard index (H_{ex}), and internal hazard index (H_{in}) play an integral role in evaluating radiation exposure health risks and hazards.

The principle of operation of High Purity Germanium (HPGe) detectors relies on gamma radiation interacting with the germanium crystal to produce electron-hole pairs, generating electrical signals proportional to the gamma-ray energy. Interactions such as photoelectric effect, Compton scattering, and pair-production occur inside the detector, contributing to energy spectrum formation. Electronic instrumentation, including preamplifiers, amplifiers, and Multi-Channel Analyzers (MCA), processes these signals for analysis. The liquid nitrogen cooling system maintains the detector at near absolute zero temperatures, reducing thermal noise for improved energy resolution.

Lead and copper shielding are vital components surrounding the HPGe detector, which minimizes the background radiation and provides shielding to the detector from external interference. The resolution of the HPGe detector is crucial for distinguishing between gamma-ray energy levels emitted by the different radionuclides. Calibration processes ensure accurate energy and efficiency calibration, correcting for nonlinearities in the detector's response. Energy calibration adjusts the energy scale of spectra, while efficiency calibration establishes the detector's response to gamma-rays of different energies, accounting for intrinsic and geometric efficiencies. These calibration steps are essential for accurate identification and quantification of naturally occurring radioactive materials (NORMs).

CONCLUSION

The assessment of groundwater quality in the Alain region of the United Arab Emirates (UAE) through the analysis of naturally occurring radioactive materials (NORMs) reveals crucial insights into the safety and sustainability of water resources. The project, conducted using advanced instrumentation and meticulous methodologies, sheds light on the activity concentrations of Radium^{226}, Thorium^{232}, and Potassium^{40}, along with associated radiation exposure risks.

The findings underscore the significance of maintaining stringent radiological screening measures to safeguard public health and environmental integrity. While Radium^{226} concentrations exceeded permissible limits set by international organizations, indicating potential health risks associated with its presence in groundwater, Thorium^{232} was not detected, suggesting lower occurrence levels in the studied area. The presence of Potassium^{40}, was within acceptable ranges.

In conclusion, this project provides valuable insights into the radiological characteristics of groundwater in the Alain region, laying the foundation for informed proactive interventions.

THEORY / METHODS

Sample collection begins with gathering 3 groundwater samples from each 8 restricted-access wells in Alain, including landmarks such as Alain Green Mubazzarah, Jabel Hafeet, Host Springs, Alain Oasis, and AlQattara Oasis. Samples are drawn using submersible pumps to fill sterilized containers. Each sample's precise location is recorded using GPS and labelled with the relevant information. Then, the samples are stored appropriately during transport. Collaboration with Abu Dhabi Environment Agency and Alain Municipality ensures the operation under all necessary permits and authorization.

Water samples undergo filtration and are transferred to standardized polyethylene Marinelli beakers, to match the volume geometry of the standard calibration source, enhancing measurement accuracy, and for more symmetrical sample-detector geometry. Acidification with hydrochloric acid minimizes radionuclide adsorption and microbial growth. Samples are securely sealed to eliminate air inclusion, then stored to achieve secular equilibrium for approximately 27 days.

The measurement technique involves using the HPGe detector to assess the activity concentrations. Spectrum acquisition, for approximately 20 hours, and analysis utilize specialized Genie-2000 software and calibration standards, ensuring accurate readings. Total net counts under selected photopeaks, adjusted for background counts and efficiency factors, determine the activity concentrations. Results are cross-checked with established standards to validate accuracy and compliance and are used to quantify the radiation risks associated with radiation exposure.

SETUP, EXPERIMENTAL

The measurement technique relies on the HPGe detector for precise assessment of gamma activity concentrations in water samples. Spectrum acquisition and analysis, facilitated by Genie-2000 software, ensure accuracy through calibration standards. Total net counts under selected photopeaks, adjusted for background and efficiency factors, determine activity concentrations, validated against established standards.

Utilizing the HPGe detector guarantees high-resolution and sensitive measurements of gamma radiation emitted by radionuclides in water samples. Genie-2000 software enables thorough analysis, ensuring results traceability to recognized standards for credibility. The extended 20-hour measurement duration captures the variations in activity concentrations, enhancing data comprehensiveness.

RESULTS

The analysis of 24 groundwater samples from eight wells revealed a range of activity concentrations for Radium^{226}, varying from 4.44×10^{-1} to 2.26×10^{-1} (Bq)⁄L, with a mean value of 9.68 (Bq)⁄L ± 4.86×10^{-1} (Bq)⁄L. Thorium^{232} was below was the minimum detectable activity (MDA) and was not detected in all 24 samples. In contrast, Potassium^{40} displayed activity concentrations ranging from 1.07 (Bq)⁄L to 2.76×10^{1} (Bq)⁄L, with a mean value of 4.92 (Bq)⁄L ± 1.05 (Bq)⁄L. Additionally, the mean Radium equivalent activity index measured at 1.35×10^{1} (Bq)⁄L Moreover, the mean absorbed dose rate was 6.20 (nGy)⁄hour. Furthermore, the mean annual effective dose rate is measured at 76.1 (μSv)⁄year. In addition, the mean external hazard index was calculated at 2.72×10^{-2} (Bq)⁄L and the mean internal hazard index was calculated at 5.33×10^{-2} (Bq)⁄L.

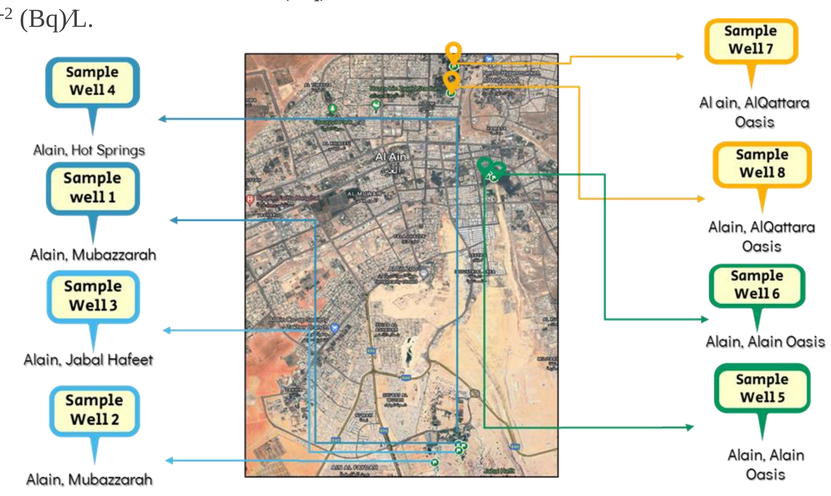


Figure 1: Sample Collection Locations in Alain Region.

Table 1: Average Activity Concentrations Calculations of Alain Wells.

Average Activity concentrations (Bq/L)		
Region	**K-40**	**Ra-226**
Green Mubazzarah (Well 1)	20.415 ± 6.83	6.826 ± 0.37
Green Mubazzarah (Well 2)	-	22.442 ± 0.181
Jabal Hafeet (Well 3)	2.308 ± 0.46	10.898 ± 0.561
Hot Springs (Well 4)	9.593 ± 0.096	12.626 ± 1.37
Alain Oasis (Well 5)	2.332 ± 0.0119	0.464 ± 0.0206
Alain Oasis (Well 6)	-	10.764 ± 0.259
AlQattara Oasis (Well 7)	2.262 ± 0.882	4.347 ± 0.92
AlQattara Oasis (Well 8)	2.486 ± 0.117	9.044 ± 0.208

Table 2: Radiation Hazard Indices Calculations of Alain Wells.

Radium Equivalent Activity Index (Bq/L)	Absorbed Dose Rate (nGy/hour)	Annual Effective Dose Rates (μSv/year)	External Hazard Index (Bq/L)	Internal Hazard Index (Bq/L)
1.35E+01	6.20E+00	7.61E+01	2.72E-02	5.33E-02

DISCUSSIONS

The analysis of the twenty-four groundwater samples from eight wells from Alain region revealed a range of activity concentrations. For Radium^{226}, the activity concentrations varied from 4.44×10^{-1} to 2.26×10^{1} (Bq)⁄L, with a mean value of 9.68 (Bq)⁄L ± 4.86×10^{-1} (Bq)⁄L. These elevated levels of Radium^{226} exceed the permissible limit of 1 (Bq)⁄L that is endorsed by prominent international organizations including the International Atomic Energy Agency (IAEA), the World Health Organization (WHO), the Abu Dhabi Quality and Conformity Council (ADQCC), and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). Some attributable to factors such as solubility, common-ion effect, and mineral fragmentation contributing to its presence in groundwater. Thorium^{232} was not detected in any of the twenty-four samples, likely due to its lower occurrence in groundwater and the minimum detectable activity (MDA). The absence of Thorium^{232} in some wells could be linked to geological characteristics and hydrogeological variations, underlining the complexity of its distribution in aquifer systems. In contrast, Potassium^{40} displayed activity concentrations ranging from 1.07 (Bq)⁄L to 2.76×10^{1} (Bq)⁄L, with a mean value of 4.92 (Bq)⁄L ± 1.05 (Bq)⁄L. The presence of Potassium^{40} in groundwater is influenced by the geological composition and agricultural activities, including the use of Potassium-containing fertilizers. This agricultural input of Potassium^{40}, combined with natural background levels, contributes to the elevation of the overall activity concentrations of Potassium^{40} in groundwater. Additionally, the Radium equivalent activity index is measured at 1.35×10^{1} (Bq)⁄L, falling under the recommended limit of 370 (Bq)⁄L endorsed by prominent international organizations including the International Atomic Energy Agency (IAEA), the World Health Organization (WHO), the Abu Dhabi Quality and Conformity Council (ADQCC), and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) indicating no significant health risks. The absorbed dose rate, 6.20 (nGy)⁄hour, follows the ALARA principle to minimize radiation exposure to individuals. The annual effective dose rate is measured at 76.1 (μSv)⁄year, relatively reasonable compared to the recommended limit of around 0.1 (mSv)⁄year set by WHO, ADQCC, UNSCEAR, and the IAEA. Furthermore, both the external hazard index of 2.72×10^(-2) (Bq)⁄L and the internal hazard index of 5.33×10^(-2) (Bq)⁄L fall under the permissible limit set by WHO, ADQCC, UNSCEAR, and the IAEA.

ACKNOWLEDGEMENT & REFERENCES

The authors extend their appreciation to the esteemed University of Sharjah and the Department of Mechanical and Nuclear Engineering. The authors convey their gratitude to their supervisor, Dr. Bassam Khuwaileh. His commitment to academic excellence has influenced the quality of this project. The authors extend their appreciation to the Abu Dhabi Environment Agency, Abu Dhabi Quality and Conformity Council, Abu Dhabi Agriculture and Food Safety Authority, and Alain Municipality. Their commitment to building a thriving sustainable community has significantly contributed to the success of this project. The authors would also like to express their gratitude to the Radiation Lab engineers, Eng. Samar El-Sayed and Eng. Ahmad Ababneh for their technical assistance and contributions to the project

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Sustainable & Renewable Energy Engineering

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Sand-Based Thermal Energy Storage for CSP Systems in the UAE”

Students: Aisha H. Alowais | Aaisha A. Alshezawi | Maytha H. Alharmi

Supervisor: Dr. Bashria A. Yousef

WINNER

Introduction:

With the growing trend towards the use of renewable energy systems, the need for integrating energy storage technologies becomes more prominent to accommodate for the intermittent production of these systems. Thermal energy storage (TES) has the potential to effectively reduce wasted energy and improve the overall utilization of renewable energy sources (e.g. sun, wind). The purpose of this project is to investigate the feasibility of using sand as a storage media for low-to-medium temperature sensible heat storage applications.

Sand-Based Thermal Energy Storage for CSP Systems in the UAE

Aisha H. Alowais Aaisha A. Alshezawi Maytha H. Alharmi
Supervisor: Dr. Bashria A. Yousef

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INTRODUCTION

With the growing trend towards the use of renewable energy systems, the need for integrating energy storage technologies becomes more prominent to accommodate for the intermittent production of these systems. Thermal energy storage (TES) has the potential to effectively reduce wasted energy and improve the overall utilization of renewable energy sources (e.g. sun, wind). The purpose of this project is to investigate the feasibility of using sand as a storage media for low-to-medium temperature sensible heat storage applications.

BACKGROUND

Sand-based TES systems follow the principle of sensible heat storage, in which their primary function is to act as a high-power and high-capacity reservoir for excess thermal energy (from PV or CSP systems). A compelling reason to use sand is that it is an abundant and costless material in the UAE and surrounding regions. In addition, sand is able to withstand high temperatures with minimum to no alteration. However, the thermophysical properties of sand, including its specific heat capacity, thermal conductivity, and dry density, are affected significantly by factors like particle size distribution and geographical location.

In addition, compared to other storage materials, the thermal conductivity of sand is relatively low. Therefore, as an effort to improve the rate of heat transfer within the storage system, copper was proposed as a cost-effective additive obtained from material scarps to enhance the overall thermal conductivity. Depending on the form, purity, and percentage of copper added, the effect on both the thermal conductivity and specific heat would change accordingly.

CONCLUSION

Based on the obtained experimental results, it can be safely concluded that sand has a promising potential to be used as a thermal energy storage media. Moreover, sand obtained from desert regions in the UAE appears to have more favorable thermo-physical properties, in addition to its great abundancy. Finally, and depending on the intended application, different forms and percentages copper metal can be incorporated with the sand to obtain a faster charging/discharging rate, while pure sand can be used for applications that require more heat retention.

THEORY / METHODS

- **Part 1:** Different samples were collected from Ras Al-Khaimah and Sharjah, including desert, beach, and mountain sand, and the best sample was selected after property testing (XRF, Thermal Conductivity, Specific Heat Capacity, Density, and Sieve Analysis).
- **Part 2:** To test the effect of adding copper to the sand, two case studies were conducted using different forms and percentages of copper, and the sand/copper samples were tested for the thermal conductivity and specific heat capacity.
- **Part 3:** To test the effectiveness of desert sand at retaining heat, a storage system using a helical coil heat exchanger was built and used to run charging/discharging experiments on three case studies (sand, sand with large copper shavings, sand with small copper pieces).

SETUP, EXPERIMENTAL

- The experimental procedure for all the case studies (part 3) involved charging for 4 hours and storing for 12.5 hours. The Graphtec data logger connected to k-type thermocouples, recorded the temperature distribution, and a CARIO CD-200F heating circulator heated and circulated the water through the helical copper coil heat exchanger attached to the sand storage tank. Once the temperatures stabilized, the heating circulator is turned off and the storage phase starts, maintaining a closed system while recording the data.

RESULTS

Part 1 Results (Property Testing):

Test	Desert Sand	Beach Sand	Mountain Sand
Specific heat at 300°C (kJ/ kg.K)	1.316	1.075	0.983
Thermal conductivity (W/m.K)	0.202	0.209	0.235
Density(g/cm^3)	1.625	1.747	1.382

Desert Sand (Sharjah) | Mountain Sand (Ras-Al Khaimah) | Beach Sand (Ras-Al Khaimah)

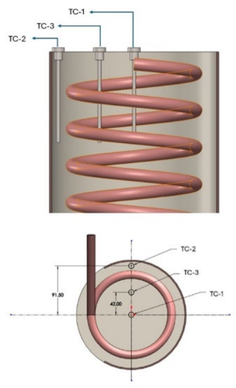
Part 2 Results (Effect of Copper Powder vs Shavings):

Mixture/Percentage	Specific Heat Capacity at 298 °C			Thermal Conductivity		
	10% Cu (J/g °C)	20% Cu (J/g °C)	30% Cu (J/g °C)	10% Cu (W/m K)	20% Cu (W/m K)	30% Cu (W/m K)
Sand with Copper Shavings	0.96	0.954	1.008	0.355	0.343	0.414
Sand with Copper Powder	0.875	1.101	0.951	0.241	0.284	0.308
Pure Sand	1.321 J/g °C			0.201 W/m-k		

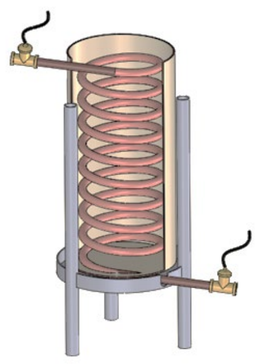
Copper Shavings

Copper Powder

Experimental Set-Up:



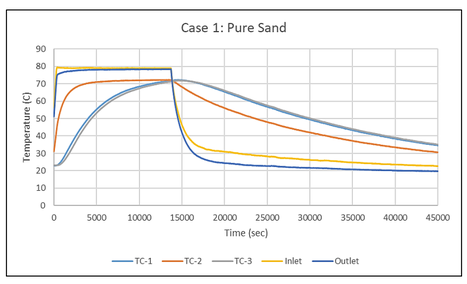
Thermocouple Positions

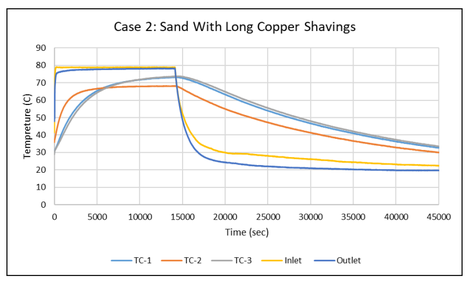


3D Storage Tank Drawing

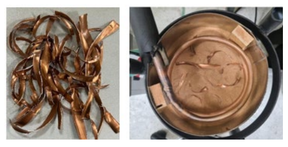
Complete Set-Up

Part 3 Results (Temperature Distribution and Heat Retention):

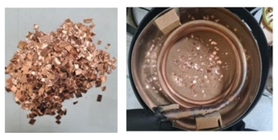




Case study	Specific Heat (kJ / kg °C)	Q_{in} (kJ) (During Charging Phase)	Q_{out} (kJ) (During Storing Phase)	$Q_{remaining}$ (kJ) (After Storing Phase)
Pure Sand	1.234	1090.6	845.54	245.06
Sand with Large Copper Shavings (2% Copper)	0.942	859.7	671.46	188.14
Sand with Small Copper Pieces (4% Copper)	0.924	843.8	632.02	211.68



Sand with Large Copper Shavings



Sand with Small Copper Pieces

DISCUSSIONS

Part 1: Due to the unique physical features of each sand sample, the thermo-physical properties varied as well. Based on the results, desert sand appeared to be the better option for TES as it had a relatively higher specific heat capacity, comparable thermal conductivity, and the highest availability in the region.

Part 2: The addition of copper to the sand significantly increased the overall thermal conductivity, showing great potential for an improved rate of heat transfer. However, the addition of copper also decreased the overall specific heat capacity, meaning less heat would be retained.

Part 3: Comparing the temperature distribution for each case, the rate of temperature increase during the charging phase was significantly faster for cases with sand/copper mixtures. This is due to both the higher thermal conductivity and lower specific heat capacity, which entailed that less heat input is required to reach higher temperatures. On the other hand, the case with pure sand was able to retain more heat during the storing period due to the slower discharge rates and higher capacity.

At the end, it appeared that adding copper to the sand results in faster charging/discharging rates, while the use of pure sand results in better energy storage.

ACKNOWLEDGEMENT

We thank our supervisor, Dr. Bashria, for guiding us through this project and offering good advice, guidance, and support. We also offer our gratitude to Dr. Ali Radwan and Prof. Mamdouh Assad for their assistant in system analysis, in addition to Prof. Abdulhai for facilitating necessary arrangements in aid of our study. Moreover, we thank Eng. Hamad Al Ali for his assistance in the prototype assembly and testing, in addition to Eng. Mohamad Qaisieh, Eng. Fahad Hasan, Eng. Fahad Faraz, and Eng. Mohammed Shameer.

Department of Sustainable and Renewable Energy Engineering

Design of Floating Solar PV/Wave Generator Hybrid Power System

Students: Abdullah Hashem Al-Gafri | Mohammad Saadat Abdelmuhdi | Abdalla Tahir Al-Ali

Supervisor: Prof. Chaouki Ghenai

Introduction:

- The world needs more clean energy because burning fossil fuels harms the environmental.
- Floating solar panels as a solution for generating clean electricity, particularly in areas with limited land space like crowded cities.
- Combining floating solar panels with other clean energy sources could be a game-changer. So, we studied Floating Solar-Based Hybrid WithWave Energy Converter" system.

Design of Floating Solar PV/Wave Generator Hybrid Power System

Students Name: Abdullah Hashem Al-Gafri - Mohammad Saadat Abdelmuhdi - Abdalla Tahir Al-Ali

Supervisor name: Prof. Chaouki Ghenai

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INTRODUCTION

- The world needs more clean energy because burning fossil fuels harms the environmental.
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- Combining floating solar panels with other clean energy sources could be a game-changer. So, we studied Floating Solar-Based Hybrid With Wave Energy Converter" system.

BACKGROUND

- **Floating Solar PV Technology:** This section explains how solar panels on floating platforms can generate clean energy. It highlights the advantages like saving land, improved efficiency in hot climates, potentially reducing water evaporation, and easy integration with existing water infrastructure.
- **Wave Energy Technology:** This section dives into different wave energy conversion methods like oscillating water columns, waterfall power, point absorbers, and wave gliders. It also explores factors affecting wave power generation like wave height, speed, direction, and water depth.
- **Benefits of the Hybrid System:** This section highlights the potential benefits of a hybrid system. It can generate more electricity than separate systems, provide a more reliable power source, avoid land use conflicts, and maximize resource utilization. Finally, it mentions ongoing research projects exploring the feasibility of this hybrid system.

CONCLUSION

This study explored a promising hybrid system that combines wave energy converters with floating PVs. Wave height was found to be the key factor influencing power generation, with high-wave locations like Oregon performing best. While converter efficiency matters, it has a smaller impact. These results suggest that strategically placed, well-designed systems with efficient wave conversion can be a viable renewable energy source. Further research is needed to optimize converter selection and improve power prediction models for even better performance.

THEORY / METHODS

This research explores a hybrid floating solar PV and wave generator system. The first stage involves using analytical methods and response surface methodology to optimize the design for best performance. Then, large-scale models and simulations will be created to analyze the energy production capabilities. Finally, the project will be validated by designing, building, and testing a small-scale prototype of the system to gather real-world data and confirm its functionality.

SETUP, EXPERIMENTAL

The setup consists of :

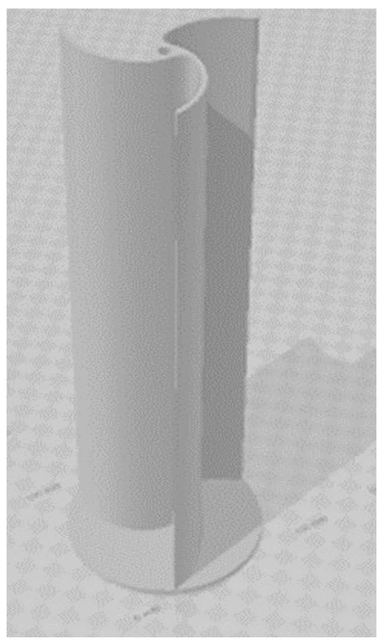
- A tank with the size of 200x50cm from aluminum.
- A U-shaped holder (in the tank) holds the turbine by a shaft and a gear that is connected through a belt by another gear.
- Wave maker is also implemented in the setup that has various speeds.
- PV over a floater and a normal PV as a reference.

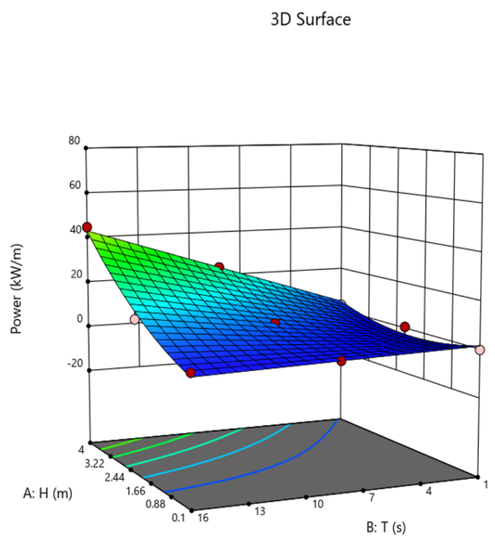
RESULTS

The results show how wave height has a much greater impact on power production than wave time frequency. For example, the 3D surface diagram shows that when the height is slightly changed, the power will react to that with a substantial change.

For the large-scale modeling we can see how high the annual energy production is and how the capacity factor is relatively high. Because in Oregon it has high waves compared to other locations.

As for the experimental results, the difference between FPV and normal PV in maximum power was around 3.5% for FPV.





DISCUSSIONS

Our wave tank setup uses electricity to create waves that mimic real ocean waves. These waves spin a turbine, generating electricity. we've also added floating solar panels. After placing a PV on the water and the other PV on the ground (both were flat) we noticed that the waves didn't affect the FPV negatively, but it had a higher power max than the one placed on the ground by 3.5%. Which could be because of the cooling effect done by the water on the flouting PV.

The included graph on the bottom right confirms that wave height has the biggest impact on power output, with increased height leading to significantly more power compared to a smaller increase from higher wave frequency. This aligns with the equation (likely H^2 * f) showing height squared multiplied by frequency.

Additionally, the drawing on the left is the turbine we drew, and 3D printed it after more than one trial.

ACKNOWLEDGEMENT

First and foremost, we are thankful to Allah S.W.T., the Creator, for granting us the capacity to finish this report paper. We extend our appreciation and thankfulness to Prof. Chaouki Ghenai, our supervisor, for his invaluable guidance. We also express our gratitude to Dr. Ahmed Galal, who was always welcoming to our inquiries. We express our sincere thanks to the Eng. Fahad Niaz at the solar PV for his help in testing the setup.

Department of Sustainable and Renewable Energy Engineering

Hybrid CPV Module for Energy Generation

Students: Omar Khalid | Ibrahim Ershaid | Seif Tahayneh

Supervisor: Dr. Ali Radwan

Introduction:

Our SDP project studied the feasibility of a hybrid CPV system as well as how to assemble and implement it to increase the efficiency of a traditional PV System. crystalline based PV cells can reach up to 20%. Furthermore, CPV's have efficiencies reaching up to 41%. The main drawback of using CPV's is that they can only capture the beam radiation and we must capture the solar radiation on it, this means that a cooling system in required. Our purpose is to combine both PV technologies, this will allow the CPV to capture the beam radiation and the crystalline Pv cells will capture the diffuse radiation. The crystalline pv cells were made bifacial so that they would also capture the reflected radiation.

Hybrid CPV module for energy generation

Students Name: Omar Khalid , Ibrahim Ershaid , Seif Tahayneh
Supervisor name: Dr. Ali Radwan

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BACKGROUND

This system utilizes all 3 types of irradiances.
The Direct irradiance hits the Fresnel lens that concentrates the light onto a glass prism that further concentrates the light onto a multijunction cell. multi-junction solar cells combine multiple layers of solar cell materials to capture a broader range of the solar spectrum, thereby achieving higher efficiencies than single-junction cells.

The mono-crystalline cells surrounding the multijunction cells absorbs the diffused irradiance and finally the reflected irradiance is absorbed by the bifacial cells. This process helps in maintaining a high overall efficiency. Dual-axis trackers continuously follow the Sun and offer steady power production all day long. High Concentration Photovoltaic (HCPV) systems use lenses or mirrors to focus a large area of sunlight onto a small, highly efficient photovoltaic cell. This concentration increases the power output per unit area of the cell, making HCPV systems particularly effective in sunny environments. Combining this with traditional PV yields a system that is operational in all weather conditions and excels even more in sunny ones.

CONCLUSION

In conclusion, PV technology still has room to grow. Traditional silicon Panels is regarded as the main factor in PV technology, which is unfortunate when there is yet much left to be explored. HCPV could provide solutions to many of the issues associated with silicon PV. Though there has been much debate on the subject, HCPV's can overcome all the issues associated with PV's. This is made evident by the comparisons in terms of price, performance, and efficiency.

METHODOLOGY

Assembling the system involved multiple steps. First was designing the overall system and then we manufactured each component. First the dual axis system involved making a concrete base, assembling the main and support beam, then placing the actuators and control panel. Second, was designing the bifacial panels with embedded multijunction cells. Third, was designing the clamps to hold the system together which was 3d printed to the exact measurements. Lastly, was the frame to hold the lenses which involved several workshops with a plethora of materials in order to manufacture a sturdy frame to hold everything together.

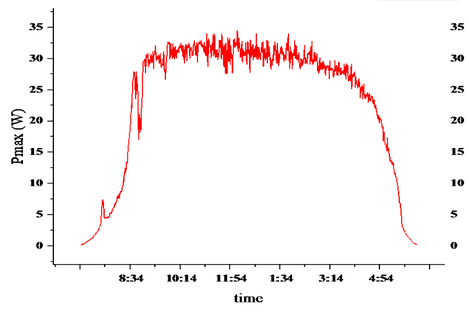
SETUP, EXPERIMENTAL

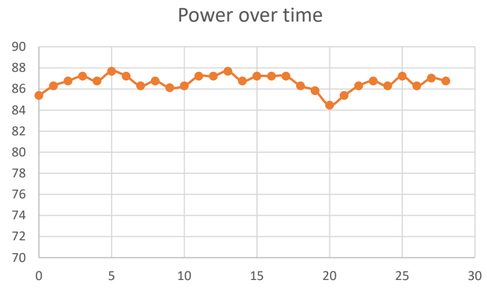
This system consists of several parts. Firstly, the tracking system that holds everything together and rotates to track the sunlight. Next, the top part of our system consists of 2 main parts. The concentration panel and the solar panels underneath it.
The concentration panel holds the Fresnel lens. Finally, the solar panels consists of the multijunction cells that are surrounded by mono-crystalline cells.

RESULTS

The traditional system followed an inverse parabolic curve of power production across the day. This is typical as it is corresponding to the horizontal radiation received by a fixed object. The highest power point was around 33W.

However, the HCPV system performed much better and had a constant power production of around 86W. This is due to multijunction cells and the tracking system it was placed on.





DISCUSSION

The two figures correspond to the power output of the traditional tilted system and our HCPV system (respectively).

We tested the performance of the tilted monocrystalline panels over 6 days and then averaged out the power outputs over the entire solar day. this was done to analyze the performance of the stationary system in order to calculate the maximum power produced to compare it to the system mounted to the dual axis tracking system. The figures show the setup as well as the tilt angle of 25 degrees that we utilized (latitude angle) for the most optimum results from the panels.

After assembling the solar cells with the dual axis tracking system, our system produces 80 W of power. This power output is higher than the power output from the conventional pv cell, which justifies our research. The power also follows a constant paths similar to the irradiance received on the tracking system. Overall comparing both systems, we can effectively prove that the HCPV is more efficient at capturing all the types of irradiance.

ACKNOWLEDGEMENT

We would like to extend our gratitude to our professors and colleagues who provided us with constant support. We would like to extend our gratitude to our examiners and Dr Ali Radwan who gave us his time and effort to the level we wanted.
Finally, we would like to thank all the lab engineers who made everything easier for us.

Department of Sustainable and Renewable Energy Engineering

Solar Hybrid Car

Students: Maryam Alnaqbi | Yaqeen Alnaqbi | Sheikha Alnaqbi

Supervisor: Dr. Zafar Said

Introduction:

An electric motor and an internal combustion engine that uses energy stored in batteries power hybrid electric vehicles. When the engine is turned off, the battery can power the power auxiliary loads, and the engine idle is reduced. it is necessary to find solutions to provide hybrid cars with alternative sources, such as kinetic energy, solar energy, or both combined, in order to make cars more efficient and sustainable. this project is to build a smart system for self-charging the electric motor of a hybrid car through the combined solar and kinetic energy of wheels to meet the car's needs in the event that one of the sources is not working.

Solar Hybrid Car

Students Name:Maryam Alnaqbi, Yaqeen Alnaqbi, Sheikha Alnaqbi
Supervisor name: Dr. Zafar Said.

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INTRODUCTION

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When the engine is turned off, the battery can power the power auxiliary loads, and the engine idle is reduced. it is necessary to find solutions to provide hybrid cars with alternative sources, such as kinetic energy, solar energy, or both combined, in order to make cars more efficient and sustainable.
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BACKGROUND

Solar energy is one of the most efficient renewable energy sources available all year. It can be gathered and used in a variety of ways, the most frequent of which is to generate electrical or thermal power for homes, businesses, utilities, and other reasons.
The sun's radiation is capable of generating heat, causing chemical reactions, or producing electricity. The general amount of solar energy that occurs on the earth is massively in the world's modern and projected energy requirements.. If certainly harnessed, this highly accurate display has the potential to satisfy all fateful energy needs. The best approach to use solar energy to generate electricity is to use solar panels (photovoltaic cells) composed of semiconductor materials to gather solar energy and convert it to electricity. Solar panels are placed practically edge to edge at solar power facilities to capture sunlight across large areas. There are three types of solar panels are monocrystalline, polycrystalline, and thin-film solar panels. Each of these types of solar cells is made uniquely, so that is why the effect is not equal and has a different aesthetic appearance

CONCLUSION

In summary, solar energy is a versatile renewable resource that stimulates the development of other renewables. Despite varying distribution, most regions receive enough sunlight for basic needs. While photovoltaic technology efficiently converts sunlight into electricity, its current efficiency requires large surface areas. Hybrid vehicles combining kinetic and solar energy offer a solution to electric vehicle limitations, providing continuous self-charging and mitigating range anxiety.

THEORY / METHODS

This hybrid car has 2 stepper motors both will be placed on the tyres, and a solar panel placed on the top of the car, those two things have one function is to generate power, the stepper motors will generate power while the tyres are moving and the solar panel from the sunlight, the power that we get from the solar panel will direct saved in the battery.We have create an application showing the voltage for each battery, so first if we enter the application we can see which battery its working now and the voltage for the battery, then if the original battery drain directly switch to the spare battery and will show the voltage of it.if the original battery voltage become less than 9 that mean its drain and the relay will directly convert it to spare battery.In the back of the car there is two sensors one for the original and the other for the spare battery, if the original sensor was green that mean it working now and the spare battery it off.also there is a screen to show the percentage for each battery.

SETUP, EXPERIMENTAL

We started our work on designing the circuit of the solar panels and using tin solder to fix the wires connection.Then we built the motor with wheels design.After we completing our design of the system box (this box we use it to install the electrical part's inside it), we used laser cutter machine to form the box parts.Then we made each of the solar panels and the generator with the charging controller then we connected it to the battery.we install the solar panel on the top and we raise the panel using four metal bases.

RESULTS

Afetr we work on our car, we got a car with a stand-by system ,if the car can move for 700km and after that stop, our hybrid can will not stop, will switch the system and continue moving, and swithcing the system will only take about 1 second. And a hybrid car work with two batteries main and spare.by calculating the battery charging time from solar system and generator, According to the charging process, the solar panel takes about 2 hours and the battery will be full, and the steppers without the solar panel will take about 4 to 5 hours.

DISCUSSIONS

This hybrid car has 2 stepper motors both will be placed on the tyres, and a solar panel placed on the top of the car, those two things have one function is to generate power, the stepper motors will generate power while the tyres are moving and the solar panel from the sunlight, the power that we get from the solar panel will direct saved in the battery. The car contains of 2 batteries, the main car battery and the battery that we place it(the spare battery), and the main purpose for the spare battery is to start the vehicle while the main battery drain.
Our system is a stand-by system, After the fuel finishes the car will not stop but will switch to the other system, for example, if the car can move for 700km and after that stop, our hybrid can will not stop, will switch the system and continue moving, and swithcing the system will only take about 1 second.
In our system, we placed sensors in the batteries (we used lead acid batteries) to measure the main battery voltage. Usually, the lead acid battery when it is full will be 14.6V and when the battery is empty it will be 9V, so the main purpose of the voltage sensor is to show us the voltage in the spare and the main battery.

ACKNOWLEDGEMENT

We would like to express our deepest appreciation to everyone who donated their time, knowledge, and support to the successful completion of the Solar hybrid car project. Special thanks go to our hardworking team members who worked diligently on all areas of the project, from conception to completion.
This project would not have been feasible without the collaboration and assistance of all of these people and organizations. Thank you for being a vital part of our efforts to create a greener, more sustainable future.

Department of Sustainable and Renewable Energy Engineering

Solar-Powered Electrolyzer

Students: Moza Alteniji | Roda Almaazmi | Ashba Alketbi

Supervisor: Dr. Muhammad Tawalbeh

Introduction:

The depletion of fossil fuels led countries to search for alternative resources, including renewable energy. Hydrogen is a promising energy source for the future because it is clean, versatile, and abundant. Green hydrogen is produced through water electrolysis and powered by renewable energy, mainly solar and wind. Green hydrogen offers various environmental benefits most importantly carbon emissions reduction.

Solar-Powered Electrolyzer

Moza Alteniji (U20101727)
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Supervisor name: Muhammad Tawalbeh

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INTRODUCTION

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BACKGROUND

Burning of fossil fuels causes CO2 with climate change and global warming, hence, sustainable energy sources are required. One promising alternative is green hydrogen. Green hydrogen is produced through a process called water electrolysis. Water electrolysis is defined as a process of using electricity to split water into hydrogen and oxygen. Hydrogen is produced at the cathode and oxygen at the anode during the electrolysis of water. Proton exchange membrane (PEM) electrolysis is a type of water electrolysis that uses a solid polymer electrolyte membrane. PEM water electrolysis offers several advantages over other electrolysis technologies, including high efficiency, fast response times, and the ability to operate at low temperatures and pressures.

CONCLUSION

The solar-powered electrolyzer system represents a promising solution for sustainable hydrogen production. By harnessing the abundant energy of the sun, this technology offers a clean and renewable alternative to traditional methods of hydrogen generation, reducing reliance on polluting energy sources and mitigating greenhouse gas emissions.

THEORY, METHODS

Solar-powered electrolysis involves the conversion of solar energy into electrical energy, which is then used to split water molecules into hydrogen and oxygen gases through the process of electrolysis. This approach offers a sustainable and environmentally friendly method for producing hydrogen, a clean energy carrier with various applications in transportation, industry, and energy storage. The main objective of this project is to design and evaluate the performance of the solar-powered electrolysis system in terms of hydrogen production efficiency, energy consumption, and overall system reliability. By studying the system's operation and optimizing its parameters, we aim to contribute to the development of sustainable hydrogen production technologies that can help mitigate climate change and promote the transition to a low-carbon economy.

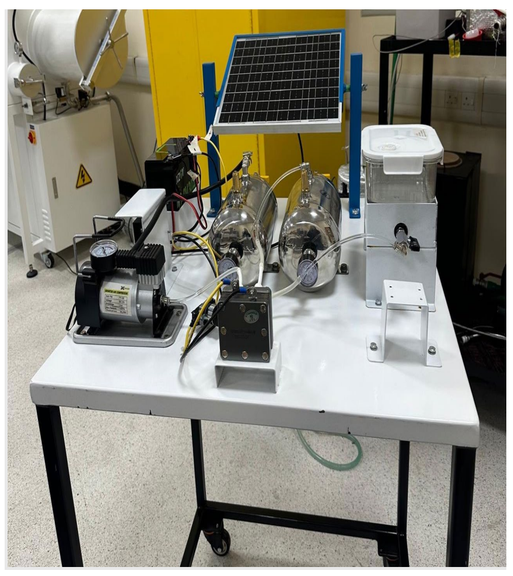
SETUP, EXPERIMENTAL

The system consists of a solar panel that is responsible for capturing sunlight during the day and converting it into electricity. A charger controller is powered by electricity and is responsible for controlling the voltage and current that reach the battery. The battery stores excess electricity from the solar panels to use during night or cloudy periods. The main part of the system is the PEM electrolyzer which will split water (H2O) into hydrogen (H2) and oxygen (O2). the hydrogen will undergo compression in a compressor before being stored in tanks. The oxygen can be used in industrial and medical processes, and the stored hydrogen can be used to generate electricity.

RESULTS

The water displacement experiment was conducted to quantify the hydrogen production rate. Within a duration of 8.20 seconds, the volume flow rate was measured to be 534.15 ml/min, while the mass flow rate was calculated to be 0.0438 g/min. Electrical parameters were recorded during the electrolysis process, with a voltage of 12.75 V and a current of 19.92 A. From these measurements, the electrical power was calculated to be 0.254 kW, and the energy consumed was determined to be 0.579 x 10^{-3} kWh. The efficiency of the system was determined to be 34.61%, indicating the proportion of electrical energy converted into hydrogen gas during the electrolysis process.

H2 production (ml/min)	534.15
H2 mass flow rate (g/min)	0.0438
Time (s)	8.20
Voltage (V)	12.75
Current (A)	19.92
Power (kW)	0.254
Energy (kWh)	0.579 x 10^{-3}
Pressure (MPa)	0.31
System efficiency (%)	34.61



DISCUSSIONS

The water displacement experiment allowed us to quantify the rate at which hydrogen gas was produced by the electrolyzer system. The measured volume and mass flow rates of 534.15 ml/min and 0.0438 g/min, respectively, provide a clear indication of the system's ability to generate hydrogen through electrolysis within the given time frame. The recorded voltage of 12.75 V and current of 19.92 A during the electrolysis process are crucial electrical parameters that characterize the operation of the system. These values indicate the amount of electrical energy supplied to the electrolyzer to facilitate the conversion of water into hydrogen and oxygen gases. The calculated electrical power of 0.254 kW and energy consumption of 0.579 x 10^{-3} kWh provide insights into the energy efficiency of the electrolyzer system. These values represent the amount of electrical energy required to produce the observed volume of hydrogen gas. The determined system efficiency of 34.61% is a key metric that reflects the effectiveness of the electrolyzer system in converting electrical energy into hydrogen gas. This value indicates the proportion of electrical energy that is successfully utilized for hydrogen production, with the remainder likely lost as heat or inefficiencies in the system.

ACKNOWLEDGEMENT

With great appreciation, We want to express our sincere thanks to our academic adviser Dr. Muhammad Tawalbeh for his invaluable guidance and support throughout the project. His insightful recommendations, constructive comments, and timely feedback were instrumental in shaping the research emphasis and direction. Last but not least, we would like to express our gratitude and best wishes to everyone who helped us with this project. Our family and friends' unwavering support and inspiration during difficult times catalyzed our perseverance and eventual success.

Department of Sustainable and Renewable Energy Engineering

Utilizing Seawater for Sustainable Green Hydrogen Production by Solar Energy

Students: Amna Al-Ali | Meera Altalyani | Meera Alhammadi

Supervisor: Prof. Ibrahim El-Sharkawy

Introduction:

Water electrolysis is a technique used to split fresh water therefore producing hydrogen. This process is done by an electrolyzer which operates from an electrical energy supply. For the sake of producing green hydrogen, a renewable energy source such as solar photovoltaics must supply the electrolyzer to produce pure hydrogen. The system proposed includes two sources, the solar panel, and the solar still to purify and desalinate seawater. The energy conversion process will start with the solar energy entering the solar panels to produce electrical energy, then the electrical energy will start the chemical reaction to split water, finally releasing the hydrogen as a useful fuel.

Utilizing Seawater for Sustainable Green Hydrogen Production by Solar Energy

Amna Al-Ali (U20101232)
Meera Altalyani (U20100005)
Meera Alhammadi (U20101047)
Supervisor: Prof. Ibrahim El-Sharkawy

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BACKGROUND

Many types of water electrolysis differ depending on the material used, operating temperature, state of electrolyte, chemical reaction, and many other properties. The are four main types of electrloyzers, alkaline, proton exchange membrane (PEM), anion exchange membrane (AEM), and solid oxide water electrolysis. By comparing between the different types, the PEM is the most effective one where it has an efficiency of 67-84% and it is already commercialized. It operates at low temperatures with a solid electrolyte (Nafion membrane) and uses platinum (Pt) a catalyst on the electrode, however, it is expensive compared to the other alternatives and this is mainly due to the use of precious catalyst. The operation of the PEM water electrolysis starts when electricity is applied to the electrolyzer and water is added to the anode where it splits into hydrogen ions and oxygen. The hydrogen ions migrates through the membrane where it reduce into hydrogen. As the electrolyzer needs fresh water, solar still distillation process is a potential method for utilizing solar energy as primary source for desalinating water. Both, the electrolyzer and solar still can be integrated to produce green hydrogen.

CONCLUSION

To conclude, the prototype have been constructed and tested. The setup included a PEM electrolyzer that is powered through rechargeable batteries. Moreover, an insulated tank at a higher elevation was responsible for supplying the water to the electrolyzer to produce hydrogen. In addition, solar stills was constructed and fabricated for the desalination of the seawater. Finally, several factors were tested for observing the effect on the electrolyzer's operation. Furthermore, the solar still needs to be investigated for further experiments.

THEORY / METHODS

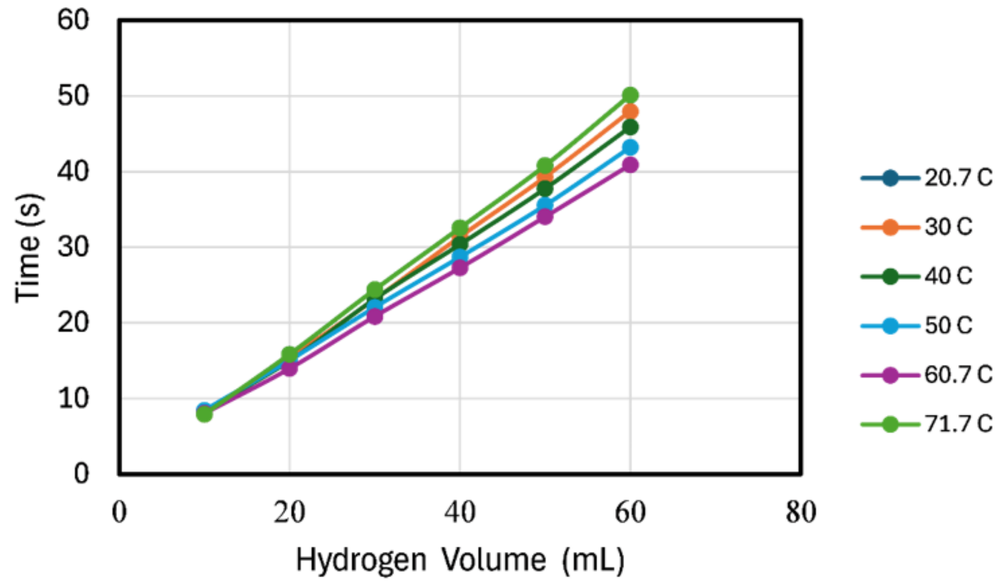
The study aims to develop a laboratory-scale prototype for a green hydrogen production via PEM electrolyzer powered by solar panels along with desalinating water using solar still. Moreover, the effect of temperature, voltage, and the total dissolved solids on the performance of the electrolyzer was studied and analyzed to observe the behavior of the electrolyzer under different conditions. Furthermore, the efficiency, hydrogen cost, and operational cost were calculated based on the obtained experimental results. To study the inaccuracy of the systems, and estimate the error included in the calculation of the efficiency, uncertainty analysis was performed.

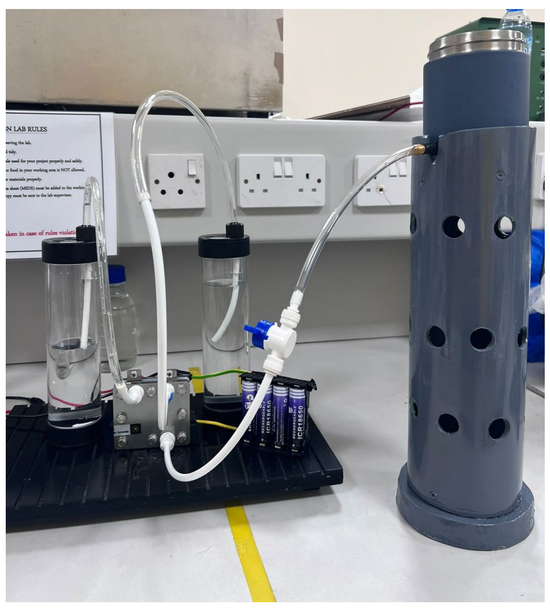
SETUP, EXPERIMENTAL

The system is composed of a solar panel, electrolyzer, hydrogen and oxygen collection tanks, an elevated insulated tank, rechargeable batteries, and a solar still. Once the battery is charged from the solar panels, and the retrieved fresh water from the solar still is available the electrolyzer operation can start. As water enters the electrolyzer and electrical energy is supplied, the electrolysis process will begin. Hydrogen and oxygen volumes can be measured using a device working on the principles of water displacement. Measurements were taken at different inlet water conditions, where the water temperature was increased via a heater and the total dissolved solids level was varied by the addition of salt. The operation voltage was changed as well.

RESULTS

The impact of voltage, temperature, and total dissolved salts (TDS) value of the electrolysis water on the hydrogen production rate as well as the efficiency of the system were studied. For the temperature effect, there was a noticeable improvement on the hydrogen production rate and the efficiency of the electrolyzer. As for the voltage, an increase in the volume flow rate was observed for higher voltages. Finally, the variation of the TDS level had an impact o the electrolyzer, as it improved the performance and increased the hydrogen flow rate. Furthermore, To study the effect of seawater, the solar still was operated to desalinate seawater and produce an output yield.





DISCUSSIONS

For the temperature effect The increase in the hydrogen flow rate and the efficiency is justified by the influence of temperature on the kinetics of the molecules in the reaction which increase the collision between the molecules thereby boosting the rate of the reaction. The temperature was varied between 20 °C to 70 °C where the highest volume flow rate was 103 mL/min at the highest the temperature. In addition to, the highest efficiency measured was 20% at 70 °C. A comparison between two different voltages was done to examine the effect of voltage on the volume flow rate. The two voltages were taken are 3.9 V and 3.6 V, where the current kept constant at 24 A. For the higher voltage, an improvement in the performance was observed where higher volume flow rates were obtained at the higher voltage. Also, the time required to reach a certain volume was shorter at 3.9 V. As for the TDS level, the increase in the TDS enhanced the rate of the reaction because it acts as a catalyst and promotes the hydrogen formation. The highest volume flow rate and efficiency were 68.79 mL/min and 14% respectively. Finally, an artificial seawater of 58,000 ppm was added to the solar still where the output yield was about 50 ppm.

ACKNOWLEDGEMENT

We would like to express our appreciation to every individual who supplied us with the details that are essential in completing this project. We would particularly like to extend our sincerest gratitude to our supervisor Prof. Ibrahim El-Sharkawy, since he invested his full effort in guiding our group toward the goal of completing this project as well as patiently supplying us with all the necessary requirements.

Department of Sustainable and Renewable Energy Engineering