Al-Mustaqbal University
College of Enginering and Technologies

Graduation Projects

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• اشراف:
أ.م.د. أزهر محسن عبد
• اعـداد:
كــوثر حسيــن ناجــي
• متابعة ودعم:
ا.م.د. تيسير سمير جعاز
م.م. علي حسنين محسن
م.م. دعـاء حـازم عزيـز

PART ONE

PROJECTS OF

Department of Mechanical

Power Engineering

Proj.No.1 — Optimizing Dynamic Vibration Absorbers for Vibration Control in Cantilever Beams under Harmonic Excitation

Prepared by:

1- Hussein Ali Gouda
2- Maytham Kareem Hashem
3- Hassan Abd Al-Qadir Lazim,
4- Ihab Ali Hussein
5- Haider Abbas Nail
6- Hassan Hadi Jwad
7- Hassan Hassan Wawi
8- Ahmad Mohammad Katran
9- Ali Mohammad Abd Al-Hussain

Supervised by:
1- Prof. Dr. Salwan Obaid Waheed Khafaji
2- Assist. Lec. Teeb Basim Abbas

Sustainable Development Goals Performed:

Abstract

Abstract:

Dynamic Vibration Absorbers are commonly used to reduce vibrations in mechanical systems. This work experimental studies were conducted to analyze the dynamic behavior of a beam with and without dynamic vibration absorber for boundary condition. (pinned-free). The beam is subjected to the dynamic input, and the response of the beam was measured at various locations using accelerometers. The experimental results show that both mass and stiffness have a significant effect on reducing the dynamic response up to 97%. The minimal requirements of the DVA parameters can achieve better reduction in the dynamic response if the DVA is located at the point of maximum displacement

Experimental Part

Experimental : An experimental setup was designed to evaluate the effectiveness of a Dynamic Vibration Absorber (DVA) in reducing vibration and displacement in a beam. The setup includes a beam, a DVA, an excitation source, and a measurement system. Sensors record the beam's response with and without the DVA to analyze its performance. Factors such as attachment location, stiffness, and damping are studied. The setup, developed at Al-Mustaqbal University, aids in optimizing vibration control in various engineering fields.

Results and conclusions

Fig (2) effect of stiffness at beam (t=0.12m of pin free with and without DVA at $\omega = 6.75\pi$. m = 100 gram . k = 68.5, 140.2 377.3 N

Fig (1) Effect of stiffness at beam (t=0.12m) pin free with and without DVA at $\omega = 6.75\pi$. m =
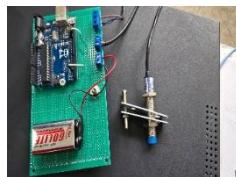
1.The frequency ranges of the optimal designs increase as the mass ratio increases, and the maximum frequency range of 0.510 to 1.022 is attained at a mass ratio and damping ratio of 0.6 and 0.321,
respectively.

2. Both mass and stiffness have a significant effect on reducing the
dynamic response about 97%   for the pinned beam, for example.

3.Minimal requirements of the DVA parameters can achieve better
reduction in the dynamic response if the absorber is located the point of maximum displacement of the beam.

Proj.No.2   Experimental Heat transfer study in cylindrical system of different arrangement immersed in porous media

Prepared by:

Zaid Adel ali

Thamer Ali Abdul Hussein

Amen Musa Hassan

Abbas Saadoun Abdel

Murtada Haider Kazem

Supervised by:

Assist. Lec. Ali baqer hussein   Assist. Lec. Hiba Mohsen abed

Sustainable Development Goals Performed:

Abstract

Abstract:

Many applications and industrial processes depend on heat exchangers to contribute to heat transfer. To increase the heat transfer area and obtain a heat exchanger in a smaller size for the same efficiency or the same size with higher efficiency, the porous media is used. Also, the buried pipes underground used to transport steam, oil and other fluids. Heat transfer through them can be enhanced by the type of porous media surrounding these tubes and its configurations. In this investigation used four cylinders with in a square duct once without porous media and other with gravels as porous media at porosity 0.44 with two arrangements of cylinders in-line and staggered.

Experimental Part

The study was carried out using an experimental model consisting of a 40 cm long steel test channel containing thermally insulated heating cylinders. Gravel was used as a porous medium with a porosity of 0.44, and the cylinders were arranged in a linear and zigzag manner to study their effect on heat transfer. The study was carried out using an experimental model consisting of a 40 cm long steel test channel containing thermally insulated heating cylinders. Gravel was used as a porous medium with a porosity of 0.44, and the cylinders were arranged in a linear and zigzag manner to study their effect on heat transfer.
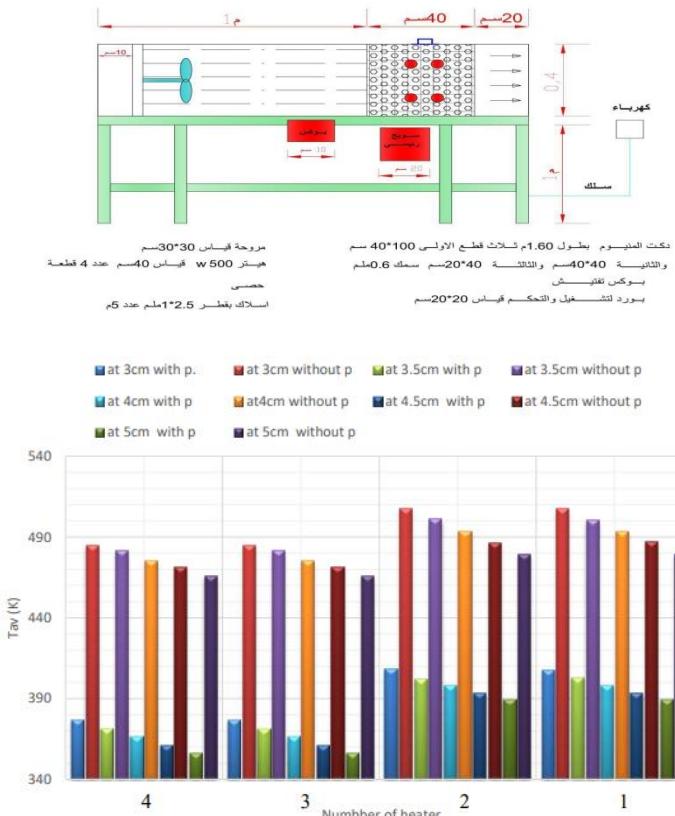
The average temperature of each cylinder in the inline arrangement depends on the location of the cylinder in relation to the air flow. Where the average temperature in the third and fourth cylinders is less by 20 °k than the average temperature in the first and second cylinders, because of the third and fourth cylinders are exposed to air flow directly in contrast to the first and second cylinders, as shown in the figure
.

تأثير الظروف الخارجية على أداء نظام تبريد مجمع

Prepared by:

10- عباس رشيد حسن	11- اثير عباس نايف	12- حسين علي محمد
13- ميثم كاظم كريم	14- صادق صالح عودة	15- مصطفى جبار محمد
16- أنور عباس فاضل	17- علي حمزة كاظم	18- يوسف مناف محمد
19- علي طالب عباس		

Supervised by:

أ.د.حيدر كريدي راشد

Sustainable Development Goals Performed:	Reducing the electrical energy consumed by the central cooling system of the Energy Research Center building by studying and addressing the impact of external conditions on the performance of this system.

Abstract

In this research, the effect of external conditions on the performance of a combined cooling system applied to the Energy Research Center at Future University was studied. The effect of outside air temperature, the air inlet velocity, solar energy incident on the complex, carbon dioxide content, and outside air humidity were studied to achieve a comfortable condition. To achieve optimal performance, the thermal performance of the system was calculated based on air velocity values, Reynolds number, its relationship with temperature, humidity, and its effect on the flow quality (Laminar) or (Turbulent) to obtain the optimal Coefficient of Performance (COP) for this manifold. The results of the system performance rate showed clear changes in performance rate with changes in the external conditions of this system.

Methodology

Methodology : Heat recovery fans are essentially air-to-air heat exchangers that recover energy from the air escaping a building. They are used to provide fresh ventilation while saving heating and cooling energy. Heat recovery fans are commonly installed in residential and office buildings in many domestic applications, especially during the summer in our country, Iraq. The building's indoor air quality was calculated based on building facility standards to include adequate ventilation systems in public and residential buildings. The complex used at Future University can be seen in the figure (1). Side view of the device as shown in the figure (2)

Figure (1): Future University Energy Research Center.

Results and conclusions

Results and conclusions:
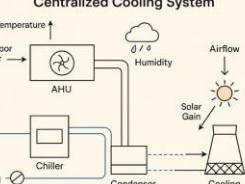
Figure (3): the external conditions that effect on the performance of cooling system.

The outer air velocity ranges from 0.3 m/s to 5.5 m/s and the corresponding Re number ranges from 200 to 2000. the average discrepancy between the predicted Nu number and the experimental values is less than 10% and the average discrepancy between the predicted pressure loss and the experimental values is less than 2%. The good agreement between the predicted and experimental results indicates that the numerical model is reliable to predict heat transfer characteristics and flow structure in compact heat exchangers.
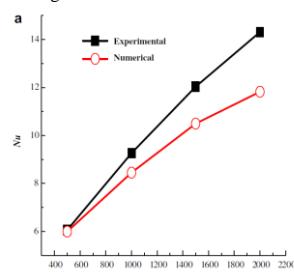


Figure (4): relation between Reynolds number and average Nusselt number
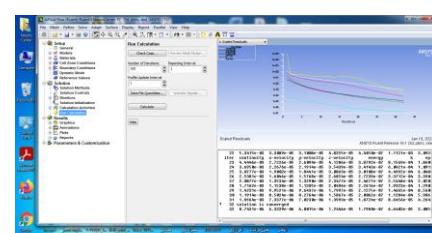
Figure (5): The convergent of numerical solutions.

Proj.No.4 Sunflower-Inspired Solar Panel System with Dual-Axis Sun Tracking and Automated Opening/Closing Mechanism

Prepared by:

20- Mohammed Abbas Jabbar 21- Qasim Jabbar Awad 22- Hassan Abdul Kadhim
23- Ali Faisal Ghazi 24- Ahmed Falah Hassan 25- Akram Majed Mutairi
26- Thamer Ali Abbas 27- 28-

Supervised by:

3- Prof.Dr. Qusay Rasheed 4- M.SC Ali Ajmi Faleh

Sustainable Development Goals Performed:

Abstract

Abstract:

This research presents an innovative approach to improving solar energy efficiency by combining bio-inspired designs with advanced solar tracking technologies. The primary objective of the study is to develop a solar panel system modeled after the sunflower's natural heliotropic behavior, which maximizes sunlight absorption through its ability to track the sun's movement.

The proposed system integrates a dual-axis sun tracking mechanism that ensures the solar panels continuously face the sun throughout the day. This tracking system mimics the movement of sunflower heads, allowing for optimized energy capture during both morning and afternoon hours. The dual-axis tracking provides a greater degree of accuracy in positioning the panels compared to single-axis systems, reducing energy losses caused by misalignment.

In addition to the tracking system, the research incorporates an automated opening and closing mechanism for the solar panels. This mechanism is designed to enhance the system's efficiency by adjusting the angle and orientation of the panels based on environmental conditions such as sunlight intensity and temperature. The automated system ensures that the panels are optimally positioned for maximum energy collection while also minimizing mechanical wear and tear.

Through this bio-inspired design and the implementation of cutting-edge technology, the study aims to significantly enhance solar energy utilization, increase the lifespan of solar panels, and reduce maintenance costs. The results of the system's performance under various environmental conditions will be evaluated, providing insights into its viability for large-scale application in sustainable energy solutions.

Methodology

Methodology

The sunflower-inspired solar panel system is a biomimetic design that enhances solar energy harvesting by mimicking the heliotropic movement of sunflowers. Sunflowers naturally track the sun throughout the day, maximizing light absorption and photosynthesis. Inspired by this principle, the sunflower solar panel system follows the sun's trajectory to optimize energy collection. This is achieved using light sensors (LDRs), servo motors, a motor driver, and an Arduino Nano microcontroller. Additionally, the system incorporates a mechanical folding mechanism that allows the panels to close when sunlight is unavailable, protecting them from environmental hazards such as strong winds and heavy rainfall.

The design consists of three major components:

Sun Tracking Mechanism – Ensures continuous alignment of the solar panels with the sun to maximize energy efficiency.

Folding Mechanism – Protects the system by closing the panels when light is insufficient.

Power Generation and Control System – Converts solar energy into electricity while regulating motor movement for tracking and folding.

Each of these components is facilitated by carefully selected hardware elements, which are described in detail below.

Results and conclusions

The home prototype was meticulously crafted using lightweight foam material, ensuring ease of fabrication while maintaining structural integrity. The design process involved precision cutting using a CNC machine, which allowed for high accuracy in shaping the walls, roof, and other architectural elements. The individual foam pieces were assembled using strong adhesive glue, ensuring durability and stability.

To enhance the aesthetic appeal and provide a realistic finish, a color cover was applied to the foam surface, replicating the look of real building materials. The prototype also features LED lights with resistors, which illuminate different sections of the house to simulate real-world electrical applications. These LEDs are controlled via an Arduino Nano, powered by the solar energy harvested by the sunflower-inspired tracking system.

This prototype serves as a functional model to demonstrate the effectiveness of the integrated solar power system in providing energy for household and street lighting applications. The Arduino Nano serves as the central controller, processing data from the sensors and displaying system information. It collects voltage and current measurements, calculates power consumption, and manages battery charging through the 3S balanced charger module, which ensures proper charging and discharging of the 12.6V lithium-ion battery pack, protecting it from overcharging, overcurrent, and short circuits. To monitor power usage, a voltage sensor measures the output voltage from the solar panels and battery pack, while an ACS712 current sensor tracks real-time current drawn by the load. A 20×4 LCD display provides real-time data, including battery voltage, current consumption, and power output, ensuring easy monitoring of system performance. Additionally, a 1S battery level indicator is used for checking the charge level of a single lithium cell, while a 3S battery level indicator displays the charge status of the entire 3-cell battery pack.

The seamless integration of these components results in a fully autonomous solar energy system that efficiently manages power generation, storage, and consumption.

Proj.No.5

Design and implementation of a hybrid wind turbine-solar cell power generation system

Prepared by:

29- Mortada Jassim   30- Mohammed Ali Shaker   31- Saif Majed
32- Hussein Salim   33- Abbas Salim   34- Abdullah Ahmed
35- Mustafa Fadel   36- Abbas Habib   37- Mustafa Mohammed

Supervised by:

Prof. Dr. Qusay Rasheed Al-amir

Sustainable Development Goals Performed:

SDG7, SDG9, SDG11, SDG13

Results and conclusions

Abstract:
This project aims to develop an efficient and sustainable solution for generating electricity from renewable sources by combining wind and solar energy into a single system. The system relies on solar cells to generate electricity during sunny periods, while wind energy is harnessed via wind turbines during windy periods or at night, ensuring continuous power generation throughout the day. The project includes engineering design, simulation, practical implementation, and performance analysis to improve the system's operational efficiency and ensure its stability. This project is a step towards promoting the use of renewable energy and providing practical solutions for generating electricity in environmentally friendly ways.

Methodology

Methodology:
The experimental aspect of the project includes the following components:
1. Three-blade wind turbine system: The type of wind turbine used in this project is a vertical axis wind turbine (VAWT), mounted on a 9-meter-high pole, generating 800 watts at 12 volts (DC).
2.
3. Solar cell system: Two solar cells, each with a capacity of 100 watts and a voltage of 21 volts (DC).
4. Charge controller: Regulates the flow of energy from the turbine and solar cells to the batteries or loads. It protects the system from overcharging or overdischarging.

    12-24 DC MPPT for wind
    24 DC MPPT for solar
4. Inverter: Converts the direct current (DC) generated by the solar cells and batteries into alternating current (AC) that can be used to power electrical devices.
5. A 42-meter-long DC photovoltaic (DC) flyer (3 meters distributed across the tree's 14 poles, representing the electrical load) of the hybrid system.

Results and conclusions:

As shown in the figure, the orange curve has a semi-bell shape, starting at 6 AM and peaking around 1 PM, then gradually declining. As the figure also shows, the blue curve has a sine wave-like oscillation, showing significant output from 9 PM to 5 AM, the peak of wind speed.

In addition to the above, the green curve shows relative stability in generation, with two peaks: one during the day (due to the sun) and the other at night (due to the wind). In other words, the green line represents hybrid energy, which is the sum of the two energy sources and exhibits stability and balance throughout the day.
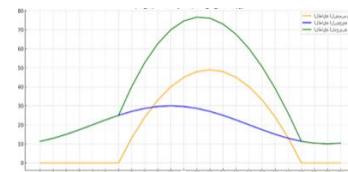

Figure (1): System performance curve

Figure (2): Photograph of the proposed system

Proj.No.6   Mobile Robot Arm Experimental Study

Prepared by:

7- جواد كاظم فارس	4- أسعد صالح مشعان	1-مشتاق طالب عطية
	5-أمجد صالح مشعان	2- حسنين جبار علي
	6- حمزة عايد عباده	3- سلام ياسر كريم

Supervised by:

5- Prof. Dr. Essam Zuheir Fadhel   6- Assist. Prof. Dr. Mohammed Ali

**Sustainable Development Goals Performed:**

Abstract:
This presentation covered a variety of aspects related to robotics, from its historical development to its modern practical applications, with a particular focus on the JETANK robot. the main points and conclusion can be summarized as, it's clear that robots have become an essential component of our societies. This development contributes to improving productivity, providing innovative solutions in various fields, and addressing future challenges.

Experimental Part
Basic Robot Components

1. Base Frame: A metal tracked structure that supports the rest of the components and provides stability.
2. Jetson Nano Module: To execute programming commands and process images and video.
3. Motors: DC motors to control movement and the robotic arm.
4. Robotic Arm: Consisting of joints to perform grasping and positioning tasks.
5. Camera: To collect data and identify objects.
6. Sensors: Including LiDAR, temperature, and ultraviolet sensors.
7. Battery: A rechargeable power source.
8. Wireless Communication Module: Including Wi-Fi and Bluetooth for remote control.
9. Control Board: Connects all components and executes instructions.

Results and conclusions
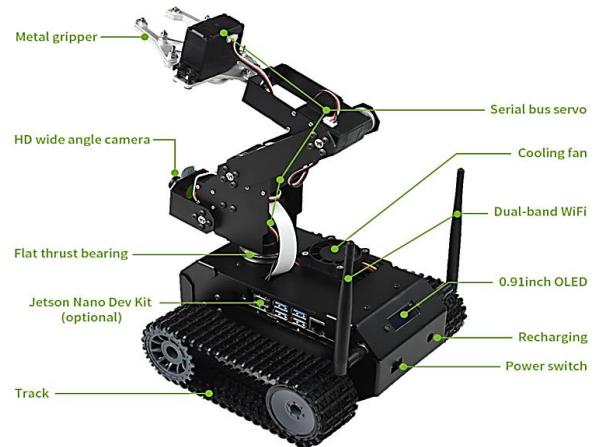
1. Structure and Design:
o The robot is equipped with a crawler-mounted base that allows it to move easily in various environments.
o The arm is composed of multiple servo motors, giving it multiple degrees of freedom.
2. Control Systems:
o It contains a controller (usually a Raspberry Pi or Jetson Nano) that supports Wi-Fi connectivity.
o It contains multiple USB ports, indicating the possibility of connecting additional sensors or cameras.
3. Connectivity and Programming:
o It supports wireless connectivity, allowing it to be controlled remotely.
o It is programmable using Python, C++, or the Arduino IDE.
4. Arm Functions:
o The arm is capable of picking up and moving objects, executing precise movements, and performing pre-programmed tasks.

New design of solar water heater storage system equipped with double-walled spherical tank

Prepared by:

38- Hassan Mitham Karim   39- Ali Hussein Hadi   40- Sajjad Fadhel Hadi

41- Zaid Hussein Abdul Hassan   42- Ali Zuhair Hassan   43- Amin Haitham Abdul Rahim

44- Ali Ahmed Abdul Hassan,   45- Ahmed Hamed Abdul   46- Hamza Hussein Ibrahim,

Supervised by:

7- Prof. Dr. Qusay Rasheed Al-amir

Sustainable Development Goals Performed: SDG7, SDG9, SDG11, SDG13

Results and conclusions

Abstract:

In commercial active solar water heaters, during the convection process, water is continuously circulated between the collector and the tank. The water is heated in the collector and then stored in an insulated tank on the roof. The shape of the collector and tank is an important factor in the development of solar thermal energy storage systems. In this study, the collector and tank were designed as spherical, stable, symmetrical, and capable of tracking the sun regardless of the angle of inclination. Also, in an innovative approach, the solar thermal energy storage tank was designed as a double-walled spherical tank.

Methodology

Methodology:

The practical aspect of the project:

The project's experimental device, as shown in Figure (1), can be manufactured in two stages:

The first stage: The water cycle stage, consisting of a tank made of galvanized iron, a 1 cm diameter copper pipe 20 m long, a water pump, a valve to control the amount of water flow, and a flowmeter to measure the volumetric flow rate.

The second stage: The spherical tank with a diameter of 30 cm made of galvanized iron, containing 30 kg of phase-change wax, is manufactured.

Results and conclusions:

The temperature of the water in the tank is measured by placing thermocouples at different elevations. Water is used as the working fluid in the spherical solar heater at flow rates of 1.25 and 2 liters per minute, circulating between the collector and the tank to harvest energy throughout the day.

The power level and temperature rise to a peak point, then decrease due to the decrease in solar radiation and the rise in water temperature. Unlike conventional insulated heaters, the outer surface of the spherical tank is uninsulated and acts as an active energy absorber. This surface allows the system to operate statically when the flow is separated. The PCM material helps store heat while the sun is on and later turns into an insulator when it freezes, prolonging energy use.

Figure(1)represents an illustrative diagram of the testing device.
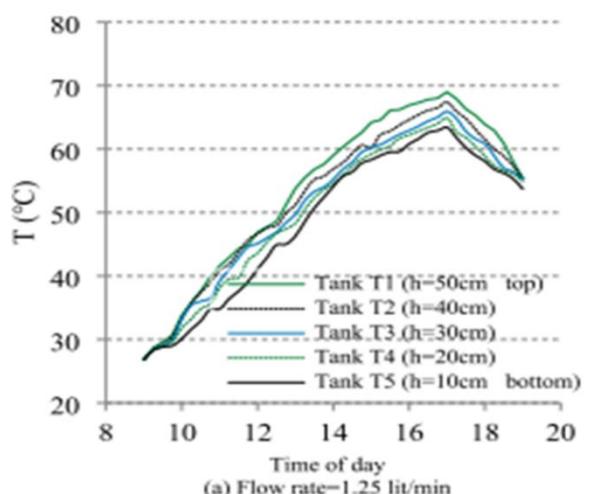

Figure (2): The figure shows the temperature of the spherical tank water at different heights from the tank floor during daily heat load and at different flow rates of circulating water.

Proj.No.8

Using Micro-Technologies to Improve the Efficiency and Sustainability of Electrical Power Systems at the Future Energy Research Center

Prepared by:

47- مسلم عقيل هادي	48- مصطفى عماد عباس	49- عقيل عبد علي
50- حسن مسلم دايخ	51- مؤمل ابراهيم	52-
53- حسن سعدي	54- رائد ماجد نعمة	55-

Supervised by:

8- ا م د ازهر محسن عبد   9- م م اسماء محمد حميد

Sustainable Development Goals Performed:

Abstract:

Smart Building Management System integrates HVAC and power controls to reduce energy use and costs, offering fast, reliable responses via touchscreen and mobile apps for sustainable, renewable energy solutions.

Methodology

Methodology:

The methodology involved developing a Smart Building Management System using a connected touchscreen and mobile application for 24/7 control of lighting, fans, cooling, and temperature. Occupancy sensors automate device operation, reducing energy consumption. Energy usage is monitored across three electrical lines linked to specific loads. The Graview platform enables centralized control for large institutions. The system operates via Wi-Fi locally and supports remote online management for effective, low-cost, and reliable building energy optimization


Results and conclusions

Results and conclusions:

This project successfully achieved full control over lighting and fan systems, including adjustable fan speeds from zero to eight. Control is provided through a connected touchscreen that operates continuously, regardless of internet availability, and a mobile application linked via email. The system automatically turns lighting and fans on or off by detecting occupancy, shutting down devices one and a half minutes after the room is vacated, significantly reducing power consumption. Within the facility, only a Wi-Fi connection is required for control, while remote access and monitoring are possible online, enabling operation and shutdown of devices as well as real-time energy consumption tracking.

For larger facilities such as hospitals, the Graview platform was implemented on computers, allowing device management via email and password. This platform is more suitable for managing extensive electrical networks where mobile apps or touchscreen controls alone are insufficient. Energy consumption is monitored across three distinct electrical lines, each assigned to specific loads: fans on line one, entrance lighting on line two, and laboratory and computer room lighting on line three. Presence sensors control lighting activation to optimize energy use.

Through both the mobile app and computer platform, users can monitor real-time consumption in watts and amperes for each line. Data can be analyzed over daily, weekly, or monthly periods, with graphical charts generated to visualize energy usage patterns clearly. Overall, the system demonstrates effective energy management, enhanced user control, and scalability, proving its suitability for both small and large-scale smart building applications.

Proj.No.9

Design of the air duct network for the cooling system of the complex
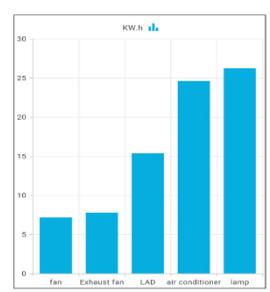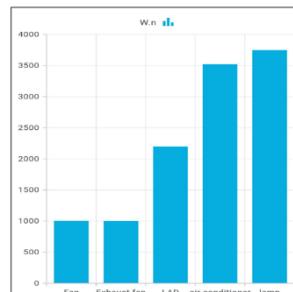
Prepared by:

56- Abbas Ali Hussein   57- Mohammed Abbas Hussein   58- Ali Razzaq Jaafar
59- Baqer Talib Kazim   60- Khader Abbas Rashid   61- Hussein Mansour Hassan
62- Marwan Adnan Hamid   63-   64-

Supervised by:

10- M.s.c. Mohsin .O. Naser   11-

Sustainable Development Goals Performed:

Abstract

This research aims to design an effective air duct network for a cooling system in the workshops of the College of Air Conditioning and Refrigeration Technologies. The design of the air duct network is an essential part of the cooling systems, as it ensures the optimal distribution of cooled air and reduces heat loss, which directly affects the efficiency of the system and energy consumption. The study analyzes the factors affecting the selection of the size and design of the air ducts, including the size of the building, the internal distribution, the required ventilation rate, and the surrounding climatic conditions. The results showed that a good design of the air duct network contributes to reducing energy consumption compared to traditional designs, in addition to improving air distribution and reducing noise inside the building. The research includes recommendations for improving future designs to ensure achieving a balance between effective performance and economic cost..

Methodology

Designing the ductwork

Based on the previous data and analysis, engineers begin designing the ductwork network, which includes determining:

• The optimal air path: The most efficient paths for air transfer must be determined, whether horizontal or vertical.

• Components: Choosing the appropriate pipes in terms of size and materials (such as aluminum, stainless steel, or plastic). Figure(3.1)

• Openings and outlets: Determining the location and size of openings and outlets in different rooms to ensure even air distribution.

• Pressure loss calculations: The pressure loss in the network is calculated due to bends, branches, and other components (such as fans and filters).

Results and conclusions

Analysis of Results

The results of the air duct design include improving the even distribution of air, reducing pressure loss, improving energy efficiency, ensuring environmental comfort for users, and controlling noise. The results also ensure ease of maintenance and compliance of the design with approved engineering standards.

Discussion of Results

After evaluating the results based on the specified objectives, if the main objectives such as balanced air distribution, reducing pressure loss, and achieving user comfort are achieved, the project is considered successful. This contributes to improving the efficiency of the system and reducing operational costs, while ensuring a comfortable and healthy environment for users.

Accurately determining the dimensions of the ducts

• Challenge: One of the most difficult challenges is choosing the appropriate dimensions for the air ducts. If the ducts are too small, this may lead to pressure loss and increased energy consumption. However, if they are too large, they may be expensive and not achieve energy efficiency.

• Solution: Flow and pressure calculation equations were used accurately to determine the optimal dimensions based on the size of the rooms, the type of activity in each room, and the ventilation requirements.

Balancing Efficiency and Comfort

• Challenge: It was necessary to balance system efficiency (such as reducing energy consumption) with user comfort (such as ensuring good air distribution and appropriate temperatures).

• Solution: The ideal air distribution points were identified to ensure that each room or area in the building received the appropriate amount of air without affecting environmental comfort.

Proj.No.10   Improvement of Indirect Evaporative Cooling System

Prepared by:

65- Hussein Jalal Abbas   66- Haider Batah Ghazi,   67- Hussam Saad Hussein
68- Sajad Abdul-Hamid Rasheed   69- Hussein Ali Jawad   70- Murtadha Nofal Salih
71- Haidera Mohammed   72-   73-

Supervised by:

12- Assist. Prof. Dr. Esam Muhe Mohammed   13-

Sustainable Development Goals Performed:

Abstract

The performance of indirect evaporative cooler (IEC) in the environment of Iraq is assessed experimentally. The wet pad used in indirect evaporative coolers is one of the main parts affecting the output of an evaporative cooler.

In this study, a corrugated cellulose fiber was focused as a wet media for water evaporation and the performance of this pad material was used as a cooling agent. The main design parameters considered are the water flow and the wetted pad in the designing of the cooler. During the testing of the cooler the ambient temperature in the range from 31.9o C to 36.2o C and relative humidity lower than 55% were considered to the ambient air.

The air temperature and relative humidity of the conditioned space were measured and the effectiveness of the cooler was determined. The results obtained show that effectiveness of the IEC system is in range of 81.4–89.1% and measured relative humidity of the conditioned space is in the range of 41-55%.

As an overall the IEC system with pad material of 4 cm thickness showed a comparatively better performance with maximum effectiveness of 89.1%.

Methodology

Manufacturing of the indirect evaporative cooler
The heat exchanger of the IEC system was manufactured by using two concentric ducts manufactured from galvanized iron and having a dimension (150 mm * 200 mm) for the inner and (300 mm * 400 mm) for the outer duct with 3-meter length. A water pump and a fan to push air into the inner duct were used. Three temperature sensors distributed at the beginning and end of the duct to record temperatures. A design of the manufactured IEC system is shown in Fig (1). It can be observed the heat exchanger, a reservoir for water and adapter parts for testing the IEC system. The water distribution was carried out through perforations in the upper part of the device.
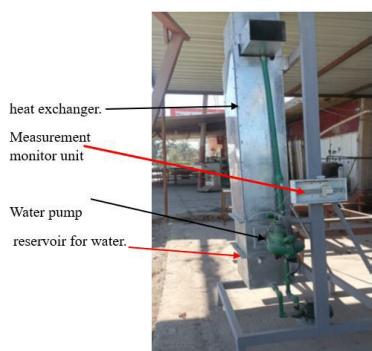

Fig. (1) design of the manufactured IEC system

Results and conclusions

The experimental measurements were recorded for the ambient dry- and wet-bulb temperatures, supply (IEC) temperature, room dry- and wet-bulb temperatures (Room temperature), and room relative humidity (%). The calculated effectiveness from 0.8.00 to 13.00 daily time of test of operation on May and the results obtained are shown in the following table.

From the results obtained it can be seen that the evaporative cooler with pad material of four centimeters layer will give better reasonable performance and maximum effectiveness obtained is 89.1%. So, according to this study, one can conclude that this cooling system can provide better cooling in the summer season.

The variation of effectiveness versus outside input temperature is presented in Fig. (3). From fig. (3) it will be seen that the indirect evaporative cooler (IEC) with pad material of (4cm) layer thickness shows better performance from 31.9 oC to 36.2o C.

Proj.No.11   Study AIR SYSTEM CONDITIONING
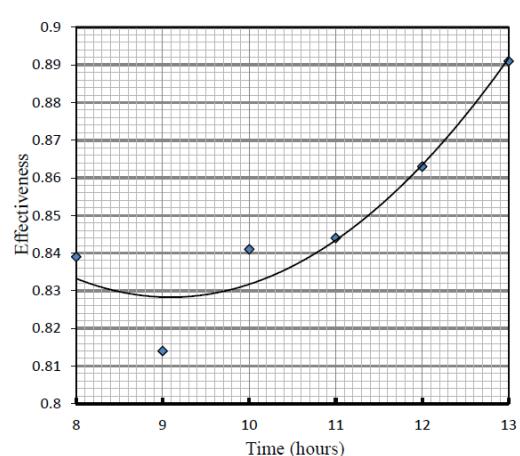
Prepared by:

74- Ahmed Hussein Sakhil	75- Reda Ali Jawad	76- Mojtaba Tahseen Ali
77- Abbas Alaa Mahdi	78- Mohammed Alaa Kamel	79- Mustafa Mohammed Kazim
80-	81-	82-

Supervised by:

14- Dr. Abdul Karim Abdul Wahab   15-

Sustainable Development Goals Performed:

Abstract

Air conditioning systems are essential for maintaining indoor thermal comfort, air quality, and energy efficiency in buildings. The design of these systems involves a multidisciplinary approach that combines mechanical engineering, thermodynamics, architecture, and environmental science .

The primary design objectives are to maintain optimal temperature, humidity, and air velocity;

To reduce energy consumption through efficient system design and control;

To ensure adequate ventilation and filtration;

To balance initial investment with operating and maintenance costs

To integrate renewable energy sources and environmentally friendly refrigerants.

The project for Fourth Year 2024 / 2025 is study the central air conditioning for the small building. It is describing the requirements methods for calculating the requirements for cooling load and determine the other equipment's which will be used in this project, like, type of compressor, condenser, evaporator, and expansion valve

Methodology

Unit of Refrigeration:

The practical unit of refrigeration is expressed in the terms of [Tone of refrigeration]. A tone of refrigeration is defined as the amount of refrigeration effect produced by the uniform melting of one tone [1000kg] of ice from and at 00c in 24 hours. The latent heat of ice is 335 kj/kg, therefore one tone of refrigeration:

1 TR = 1000 x 335 kJ 24 hours

$$= \frac{1000 \times 335}{24 \times 60}$$

= 232.6 kJ / min.

In actual practice, one tone of refrigeration is taken as equivalent to: 210 kj/min or 3.5 kw.


Results and conclusions

Conclusion

This research has examined the fundamental principles and practical approaches involved in the design and implementation of air conditioning and refrigeration systems specifically tailored for small buildings. Through detailed analysis of thermal loads, energy efficiency metrics, system sizing, and equipment selection, it is evident that optimal HVACR design in small-scale buildings requires a balance between performance, cost-effectiveness, sustainability, and occupant comfort.

The study highlights that advancements in energy-efficient technologies, such as variable refrigerant flow (VRF) systems, inverter-driven compressors, and smart controls, offer significant potential to reduce energy consumption while maintaining desired indoor conditions. Moreover, proper system design—considering local climate, building orientation, insulation, and usage patterns—greatly enhances the overall efficiency and reliability of the installed systems.

In conclusion, effective air conditioning and refrigeration design for small buildings is not merely a technical task but a multidisciplinary effort that incorporates mechanical engineering, building science, and environmental considerations. Future developments in renewable energy integration and intelligent control systems are poised to further transform the HVACR landscape, making such systems more adaptive, resilient, and environmentally friendly.

Proj.No.12 — Air Duct Design Report with Calculations
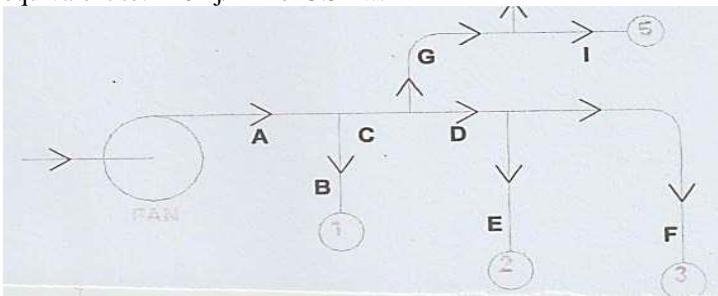
Prepared by:

83- Amir Haqi Ismail
86- Issa Mahdi Salman
89- Rabie Musa Kazem

84- Hassanein Ali Nouri
87- Ali Mitham Mahdi
90- Awham Abdul-Har Shanu

85- Jawad Kazem Eidan
88- Ali Rahim Jabr
91- Ali Saleh Hamza

Supervised by:

16- Dr. Mahmood shaker   17-

Sustainable Development Goals Performed:

Abstract

Summary about air ducts in air conditioning

Air ducts are pipes or ducts used in air conditioning, ventilation and heating (HVAC) systems to transfer cooled or heated air from the air conditioning unit to various parts of the building, and then return the air to the unit for reprocessing.

✓Its main function:
• Distribution of treated air (cold or hot) inside the building.
• Withdraw the return air for re-cooling or heating.
• Maintaining indoor air quality.

✓Types:
1. Metal air ducts: often made of galvanized sheet, durable and used in large projects.
2. Flexible Ducts: Light and easy to install, used in tight or residential spaces.
3. Fiberglass air ducts: provide good thermal and sound insulation.

✓Air Duct Design Factors:
• The size and area of the place.
• Air flow speed.
• Reduce the loss of pressure.
• Thermal and acoustic insulation.

✓The importance of maintenance:
• Prevent accumulation of dust and mold.
• Improve the efficiency of air conditioning.

Methodology

Central and distributed systems:

The difference between central and distributed systems is in the distribution of air inside the building,

where central systems rely on distributing air from one location spatially and steadily

while distributed systems rely on distributing air from a central source to each area in the building via dedicated ducts or openings.

Multiple factors must be taken into account when determining the appropriate type of system, such as

the size of the building, its various uses, and ventilation needs, to ensure that the system complies with the air requirements and provides comfort and efficiency in use.

This is what will be discussed in detail in the installation of a central cooling unit with

its branches in the Energy Research Center building affiliated with Future University

Results and conclusions

Which system is best for your project?

Central air conditioning is the ideal choice if you're working on a large commercial project or need to cool or heat a large space uniformly.

Concealed air conditioning is the best choice if you want to achieve a stylish interior appearance and preserve small spaces while providing efficient and quiet air distribution.

5.2 Common Mistakes When Calculating Air Conditioning Ducts

Common mistakes that can lead to an inefficient design include: Not adequately considering pressure loss.

Using duct dimensions disproportionate to the space to be air-conditioned.

Excessive air velocity, which leads to increased noise and decreased efficiency.

Calculating the air conditioning duct is an essential step to ensuring your air conditioning system operates at peak efficiency and provides the desired thermal comfort. Following the correct steps and standards can avoid many airflow-related problems and improve overall system performance.

Proj.No.13 — Investigation Experimental of a Solar Energy

System driven Water Desalination HDH

Prepared by:

92- حيدر هاشم مهدي   93- حسين فخري حسين   94- صباح عباس حسون
95- علي فاضل عباس   96- عادل عباس مجيد   97- Ali Rahim Jabr
98- كمال ترتيب عيسى   99-   100-

**Supervised by:**

18- Dr. Zahrah AlKhafaji   19-

Abstract

Many technologies were tested among them on of the most important method was the desalination of abundant salt water. It is an effective method of providing freshwater. However, it is not economical method from energy requirement perspective. This issue can be resolved using renewable energy sources as proposed in this work. A humidification – dehumidification desalination (HDH) unit consists of two series connecting with Evacuated tube collectors (ETSC) of (1.92 m2) total area. A humidifier, de-humidifier, fan, pumps and other accessories are built in a AL - Mustaqbal university Iraq -Babylon. (latitude 33.33°and longitude 44.14). The effect of salty mass flow rate through collector, humidifier and dehumidifier in the range of 60 to kg/hr on the unit performance was studied. The experimental work was achieved in February 2025. It was found that the maximum water outlet temperature from ETSC is 76°C for experimental work results, when the mass flow rate of salty water 60 kg/hr. The dehumidification process through the dehumidifier characteristic is recognized by high sensible heat ratio, while in the humidifier characteristic is by low sensible heat.

Methodology

Modeling of the Evacuated Tube Solar Collector The Evacuated glass tubes are filled with water and placed in open, starts heating the water in the glass tubes. Since the density of the cold water is heavier than hot water, it starts rising in the insulated water tank, and cold water sinks into the glass tubes. On cycle repetition, water heats up, known as thermo-siphon and is based on natural convection. The solar radiation incident on the collector of the outer glass the short radiation is incident on the inner tube consists of the heat pipe where the radiation falls on the external surface of the heat pipe and causes the working fluid near the surface to evaporate instantaneously. The vapour thus formed absorbs latent heat of vaporization and this part is evaporator region then vapour travels to other end of pipe causing vapour to condense this part is condenser region giving up the heat (thermal energy) to the manifold where the heat is exchanged with cold fluid passing through the manifold. The heat picked by the evaporator sinks at the condenser

section. Heat loss in the adiabatic section is mostly ignored for good insulation. The working fluid is maintained at lower pressure in the heat pipe. The working fluid evaporates at the evaporator section and creates a vapour pressure to flow to the condenser section to condense. The evaporation and condensation happens at saturated temperature. The wick develops a capillary pressure to pump condensed liquid from condenser to evaporator to complete the circulation. The pumping can also be done by gravitation in gravity assisted heat pipes which is also common in solar collectors as shown in figure(3.2).
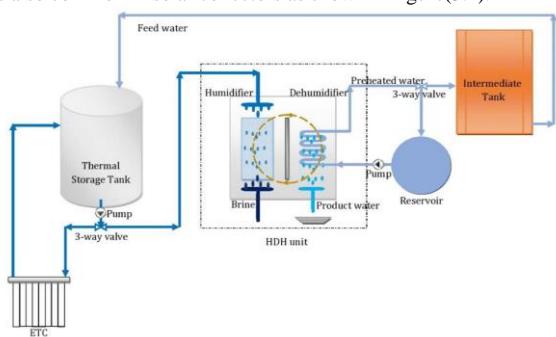
Results and conclusions

From the experimental results, it can be concluded the following:

1. The maximum water outlet temperature from ETSC is 76°C for experimental work, when the mass flow rate of saline brackish water 60 kg/hr.

2. The maximum experimental efficiency is for the first ETSC which reached about 62%. Furthermore, the overall thermal efficiency is 59%, when the mass flow rate of water is 60 kg/hr.

3. As the mass flow rate of water increases the overall daily efficiency of the ETSC increased. The maximum overall thermal efficiency for the ETSC is 60 kg/hr.

4. The maximum mass daily water production happens when the mass flow rate of water is 60 kg/hr for experimental results.

5. The dehumidification process through the humidifier is characterized by high sensible heat ratio, while in the dehumidifier, it is characterized by low sensible heat.

PART TWO

PROJECTS OF

Department of Computer

Engineering

Proj.No.1	Measuring of Cell Phone Electromagnetic Radiation

Prepared by:	
1- Abbas Akeel Jawad Kadhim	2- Muslim Akeel Jawad Kadhim

Supervised by: Prof. Dr. Abdulkareem Abdulrahman Kadhim

Abstract:

Every day, no matter where you are, you will see people using their cell phones. People use their cell phones for more than just making calls though, they used them for texting, searching the Internet, and entertaining as well. Electromagnetic radiation from cell phone or other communication systems affect the health and may lead to serious disease such as cancer. This is the responsibility of the cell phone operators. They should keep the radiation level below some specified figure. Thus, the task of the present project is to measure the strength of the electromagnetic field (both electrical and magnetic) in the Al-Mustaqbal University campus. The university campus is divided into 10 regions and the radiation is measured using hand held measuring device. The investigation showed that the radiation levels are relatively high at student club and administration building.

Methodology:

The project methodology can be summarized into the following stages:

1- Purchasing a suitable device to measure both electrical and magmatic radiation (ERICK HILL RT 100).
2- Dividing University Campus into 10 regions.
3- Take measurements of the meter at different times of the day in each region.
4- Record the readings for further analysis.

Results and conclusions:

The results showed that the high level of electromagnetic radiations is shown in busy regions (such as Student Club).

Further, among different time of measurements, it is sown that at 1:30 PM the radiation is very high. As a final conclusion it is recommended to avoid busy area and peak hours of the work. Another effective behavior is to keep distance from the cell phone while talking.

Proj. No 2	Building a Voice Controlled Home Automation System with Arduino

Prepared by:	
1-Baker Yassin Karim Kaballa	2- Sajjad Abul Ameer Jaber
3- Hassanein Muhanad Hassan	4- Hassan Balsam Abdul Hussein

Supervised by: Dr. Laith Hassnawi

Sustainable Development Goals Performed:	SDG15

Abstract:

Establishing home automation system to improve comfort, and implemented using Arduino UNO, Bluetooth HC-05 and application platform seems attractive option. Among various automation is seems effective since it reduces human efforts and compatibility viz smartphone with interface software Arduino-convenience and quality of life has gained popularity and errors with improved efficiency. These systems also address for household electrical appliances electric lamp and table fan human assistance to control the household appliances. In this Keywords: Home Automation, Electrical Appliances, Voice Recognition, Arduino, Bluetooth Module, Smartphone Application. problem of elderly/ disabled people else they require dedicated receives input signal from a device having Bluetooth researchers to develop flexible techniques for home automation schemes.

Methodology:

The system is designed by using three main components, first is microcontroller Arduino Uno, second is Bluetooth module HC-05 and third is mechanical relay. Firstly, user gives the command to microcontroller by using speech recognition system of smartphone and system software application via Bluetooth module HC-05. The microcontroller acts accordingly to the command give user and controls the functionality of mechanical relay. The Arduino Uno is programmed using Arduino IDE which is software; the user interface application is Arduino Voice Control. As the figure 8 shows it is the home automation system, or we called Voice Controlled Home Automation.
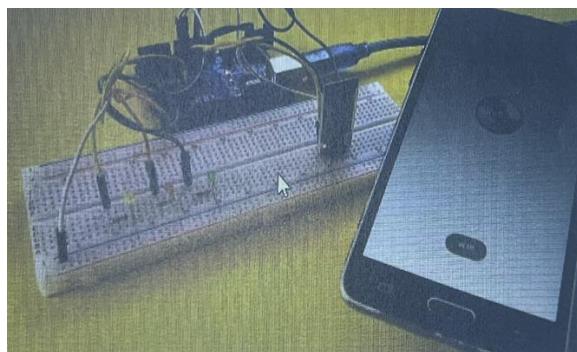
Results and conclusions:

Four persons with different accents and from different age groups were used to test the effectiveness of the voice (speech) recognition application and the switching mechanism. The result of the test carried out on the implemented voice-controlled lighting system is displayed in Table. The commands correspond to the various lighting points that can be turned on or off by using voice. To give the command that switches on or off any lighting point, the point's name is called and the word "On" or "Off" is spoken immediately after. This can be seen from the way the items (speech commands) are written under the 'command' column. The other columns, namely, A, B, C, D, tracks the number of times out of four (4), that the corresponding lighting being controlled responded (by switching on or off).

Command	Test Persons (Out of 4 times)			
	A	B	C	D
Turn on/off room	3	2	3	4
Turn on/off table	4	3	3	3
Turn on/off bedroom	4	4	2	3
Turn on/off security	3	3	4	4
Turn on/off all	4	4	4	4

the study was aim to implement the voice user as an input to microcontroller to always control the lighting system. From the results, the AMR voice application was used successfully to capture the voice commands. The voice recognition APIs in the application could identify the specific commands used except for a few instances. The commands were used to activate the respective relays thereby controlling the lighting.

Proj.No.3 — Design and implementation of smart welding glasses

Prepared by:

1. Ahmed Wanas Sheal
2. Jafar Saad Hasan
3. Ali Abedalkarem Kazar
4. Jaafar Sadaq

Supervised by: Ass.Prof.Dr.Abdullah Jabar Hussain

Sustainable Development Goals Performed: SDG 3

Abstract:

Smart welding goggles offer comprehensive protection by dramatically reducing excessive glare and effectively blocking harmful ultraviolet (UV) and infrared (IR) radiation, both of which pose serious risks of retinal damage and long-term vision impairment. Their advanced adaptive-filter technology automatically darkens the lens in milliseconds upon arc ignition, ensuring that welders never accidentally expose their eyes— even if they forget to manually lower a traditional helmet visor. In addition to optical safety, integrated particulate and fume filters shield the eyes from toxic metal oxides, smoke, and airborne dust generated during welding, contributing to healthier respiratory conditions. Designed with a slim, low-profile form factor and adjustable headgear, these goggles enable operators to maneuver comfortably in confined or awkward workspaces— such as inside pipe joints or behind structural beams—without sacrificing protection or visibility. Continuous real-time monitoring of ambient light levels and welding arc intensity, coupled with an intuitive heads-up display, further enhances user awareness and productivity, making smart welding goggles an indispensable tool for modern industrial applications.

Methodology:

Smart welding glasses integrate advanced technologies to enhance safety and efficiency in welding operations. Their methodology typically involves:

1. **Automated Welding Integration** – Some smart glasses are designed to work with automated welding systems, using CCD vision positioning and six-axis robotic assembly to ensure precision.
2. **Adaptive Lens Technology** – These glasses often feature auto-darkening filters that adjust in real-time to protect the welder's eyes from intense light and UV radiation.
3. **Sensor-Based Enhancements** – They may include temperature sensors, vibration alerts, and mobile connectivity for monitoring welding conditions and ensuring safety.
4. **Laser Welding Techniques** – Some methodologies involve precision laser welding, which minimizes heat distortion and improves the durability of welded components.
5. **Glass Welding Methods** – In cases where glass components are involved, a three-stage heating process (softening, melting, and annealing) is used to ensure strong and reliable welds

Results and conclusions:

Smart welding glasses represent a significant advancement in welding technology, offering enhanced safety, precision, and efficiency. These glasses integrate features such as

1. auto-darkening filters
2. high-precision laser welding and CCD vision positioning, ensuring welders have optimal visibility while protecting their eyes from harmful radiation and intense light exposure.

Additionally, automated welding systems for smart glasses manufacturing have streamlined production, reducing defect rates and improving overall efficiency. The integration of six-axis robotic assembly and tray loading mechanisms has made the process more reliable and cost-effective.

In conclusion, smart welding glasses not only improve the safety and comfort of welders but also contribute to the automation and precision of modern manufacturing processes.

Proj.No.4	**Study and implementation Search Counting the number of attendances using Python based on face detection algorithms**
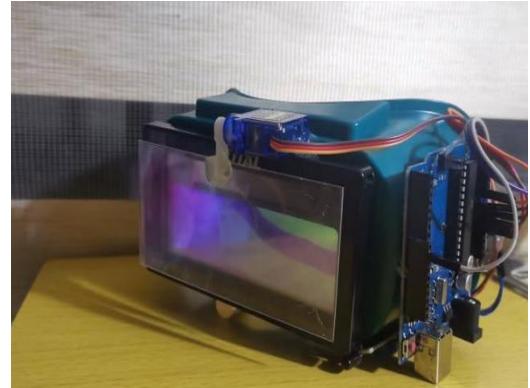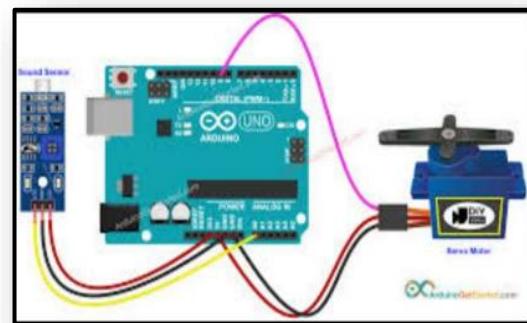
Prepared by:

1- **Hassanein Muhammad Abdul redha**   2- **Asmahan Salem Abd Zaid**

3- **Nidal Karim Khalaf**   4- **Iman Habib Nazir**

Supervised by: Asst. Prof. Ali Kadhim Bermani

Sustainable Development Goals Performed: SDG4

Abstract:

A system using ESP32-CAM, IR sensor, and 16x2 LCD was created to detect and count people. The IR sensor triggers the ESP32-CAM to detect faces with OpenCV, and the count is shown in real time on the LCD.

Methodology:

The system uses an **ESP32-CAM**, an **IR sensor**, and a **16x2 LCD** to count faces. The IR sensor detects motion to trigger the camera, which captures and processes images with OpenCV's Haar Cascade for face detection. The count is shown in real time on the LCD. Sensor calibration improved accuracy and reduced errors. The system was successfully tested in different environments for attendance tracking.

Results and conclusions:

This project developed a real-time automated attendance system using an ESP32-CAM, IR sensor, and 16x2 I2C LCD. It accurately counts people through face detection and motion sensing, providing immediate feedback. Challenges such as detection accuracy, latency, and power consumption were addressed via hardware calibration and software optimization. The compact, cost-effective system is suitable for classrooms, offices, and public spaces. Future enhancements may include advanced machine learning for improved accuracy, cloud-based remote monitoring, and expanded biometric tracking for enhanced security.

Proj.No.5

Counting AL-Mustaqbal University Victors Predication from Sensor Data

Prepared by:

1- **Shaima Obaid Muhammad**   2- **Sawsan Hussein Ali**

3- **Amir Muhammad Jabbar**

Supervised by: **Asst. Prof. Ali Kadhim Bermani**

Sustainable Development Goals Performed: SDG4

Abstract:

This project introduces an intelligent Arduino-based gate to count daily visitors to Al-Mustaqbal University, including students, staff, and faculty. The system uses ultrasonic sensors for accurate detection—even when two people pass side by side—and a GY-906 (MLX90614) infrared sensor to measure ambient temperature. A push button is included to reset the counter. This cost-effective and automated solution offers accurate, real-time foot traffic monitoring for crowded environments like schools and offices

Methodology:

The project follows these key steps:

1. Selecting compatible, low-cost components
2. Prototyping the circuit on a breadboard
3. Writing and testing code in Arduino IDE
4. Integrating hardware and software
5. Testing and calibration for accuracy

Results and conclusions:

The project successfully built a smart Arduino-based gate for counting people and detecting high temperatures. It uses ultrasonic sensors, a GY-906 IR thermometer, an LCD, a buzzer, and a reset button. The system achieved:

- Accurate counting (even for two people at once)
- Contactless temperature measurement
- Real-time display and fever alerts
- Low-cost and reliable performance

It proved effective in crowded places and can be further improved f

Proj.No.6

Design of an Intelligent Traffic System Using Sensors for Managing and Improving Traffic Flow

Prepared by:

1- Muhannad Muhammad Shaker Hussein   2- Maytham Mahdi Jassim Hammadi

3- Muhammad Jassim Safi Tarin   4- Furnas Farhan Afar

Supervised by: Dr. Mohammed Hassan Alwan

Sustainable Development Goals Performed: SDG11

Abstract:

Traffic Flow worldwide has led to loss of human lives due to failure in transporting accident victims, critical patients, medical, equipment's and medicines on time. With the unending growth in vehicular traffic everywhere, the fusion of Internet of Things (IoT) has embarked as a promising platform for an Intelligent Traffic Management System (ITMS). In the literature, researchers have suggested various solutions, this intelligent traffic management system is for a smart city after considering the research gaps which are yet to be explored in the current scenario. Our proposed solution, presents a counter measure to get rid the problem of the traffic light system when the Timers is not enough to fix the jam in the streets. To show the advantages of our proposed solution over already proposed solutions the observed results exhibit the superiority of our proposed solution over state-of-the-art solutions

Methodology:

Intelligent Traffic Management System (STMS) uses a comprehensive range of essential specialized equipment to operate them, focusing on improving traffic flow, reducing congestion, and enhancing safety. Main components include Arduino panels such as Mega, which are essential for data acquisition, processing and Control traffic lights. High brightness and energy-saving traffic light LEDs act as visual signals for Regulate traffic, while various sensors are strategically positioned throughout the traffic network monitors the presence and flow of the vehicle. These core components support test boards and traversing wires, which facilitate rapid prototyping and Communication during system development. A reliable power supply ensures uninterrupted operation of the system.
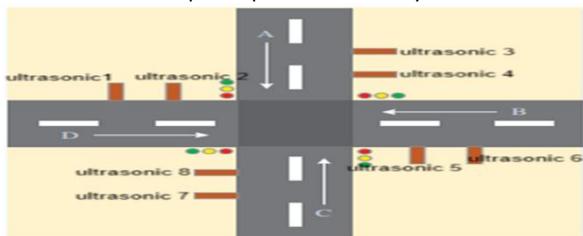
Results and conclusions:

The design of self–adaptive traffic light system is easy to realize, and this can be implemented in real-life, integrated with a manual control system for better reliability. This model is suitable for intersection with traffic flowing in one direction in each road. In the practical implementation, eight Ultrasonic Sensors were placed in total, two sensors for each road to detect traffic density. Since traffic builds up at sensors near the signal compared to the sensors away from the signal. The internal sensors have more priority, i.e. if only the internal sensor is detecting traffic, then that road is given a green signal. If only external sensors are detecting traffic, then that road is not given a green signal. In the practical implementation, many sensors may be used rather than only two. The sensing time to detect traffic from a sensor in hardware implementation is set 10s so that each road with highest traffic density is going to open for 10s until the sensor again detects the traffic density in each road. The core of the project, the Arduino Mega development board, is found capable of addressing 256 kb for flash memory and 8kb for the bootloader. The CPU speed was 16 MHz and at each interruption of 10 s, the controller reads the signal from sensors. In total 20 digital pins were used, 12 for LEDs and 8 for sensors, the rest were unused

Proj.No.7	Smart Device for Managing and Optimizing Water Consumption in Homes using Artificial Intelligence

Prepared by:

1- Sameer Bassem Mohsen 2- Ameer asmaeel khalil

3- Moayed Hussein Rashid 4- Akram Salim Karim

Supervised by: Dr. Mohammad Hassan Alwan Aldulaimi

Sustainable Development Goals Performed: SDG12

Abstract:

Water management is one of the crucial topics discussed in most of the international forums. Water harvesting and recycling are the major requirements to meet the global upcoming demand of the water crisis, which is prevalent. To achieve this, we need more emphasis on water management techniques that are applied across various categories of the applications. Keeping in mind the population density index, there is a dire need to implement intelligent water management mechanisms for effective distribution, conservation and to maintain the water quality standards for various purposes.

Results and conclusions:

This work provides a comprehensive review of a wide range of proposed and designed water Saving work based on the Internet of Things Management systems. Describes a general structure for smart water managing systems, followed by detailing the different applications associated with the Internet of Things Water management systems by classifying these systems into Residential, industrial and agricultural. This work reviews the latest research proposed for the design of IOT-based water management systems as applicable to every application. This discussion concludes with a new visual presentation IOT-based water management system by using modern water temperature technologies and sensors to avoid water waste.

Methodology:

1. **Temperature measurement:** The sensor measures the temperature of the water inside the tank.
2. **Temperature control:** When the temperature reaches a value below the required limit, the system turns on the heating element. If the temperature is higher than the specified value, the cooling system will be turned on.
3. **Data filtering:** The data is read from the sensor and processed via a control unit such as Arduino, and the desired temperature value can be set using the user interface.
4. **Interaction with the screen:** The current display displays the temperature and allows the user to easily adjust the settings.

Test No.	Cold	Hot	Required	New
1	18	42	30	30
2	20	36	28	28
3	15	48	35	34
4	12	40	20	21
5	22	37	29	29
6	9	38	19	21
7	11	52	45	44

Proj.No.8   An intelligent system to predict diabetes
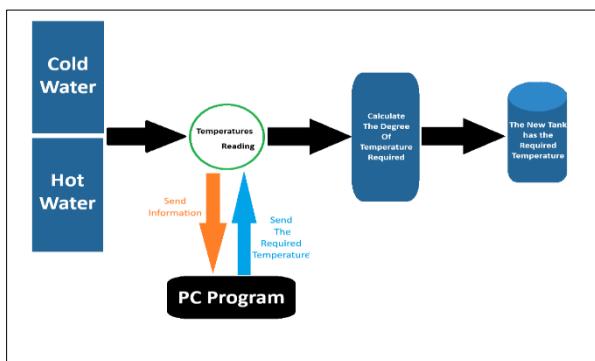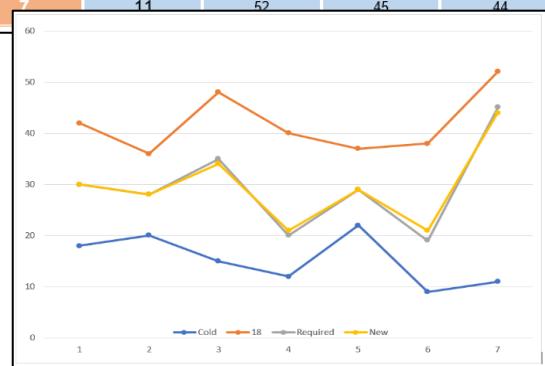
Prepared by:

1.Ali Zaid Kadhim   2. Hussein Jalal Ahmed   3. Taha Kadhim Safi

Supervised by: Dr. Hussein Alkhamees

Sustainable Development Goals Performed: SDG9

Abstract:

This project developed an intelligent diabetes prediction system using machine learning to improve early diagnosis and support clinical decisions. It utilized the PIMA Indian Diabetes dataset, containing eight clinical features from 768 patients. Several ML models were tested—such as decision trees, random forests, logistic regression, XGBoost, SVM, and KNN—after preprocessing steps like missing value imputation, feature scaling, and class balancing.The DDTM model achieved the best performance with 76% accuracy and a 75.9% F1 score. A user-friendly interface built with Tkinter allows users to input data and view predictions. Glucose level, BMI, and age were identified as the most important features. The results highlight the effectiveness of tree-based models and thorough preprocessing. Limitations include the small dataset size and the absence of lifestyle/genetic data, which future work could address..

Methodology:

The methodology included preprocessing the PIMA dataset, training multiple ML models with hyperparameter tuning, and addressing class imbalance using SMOTE. The best model was integrated into a Tkinter-based GUI for easy user interaction and prediction.

Results and conclusions:

The results showed that the DDTM model delivered the best performance, achieving the highest accuracy and F1-score compared to other models like Random Forest, XGBoost, Logistic Regression, SVM, and KNN. Data preprocessing played a crucial role in improving model performance, especially the use of QuantileTransformer for feature scaling . These techniques significantly enhanced the model's ability to detect diabetic cases.Feature importance analysis revealed that glucose level, body mass index (BMI), and age were the most influential factors in predicting diabetes, which aligns with established medical knowledge. Confusion matrices were also used to visualize and evaluate model performance, contributing to better understanding and trust.A graphical user interface (GUI) was developed using Tkinter, allowing users to input patient data and receive real-time predictions, making the system more practical and user-friendly for healthcare environments.In conclusion, the project demonstrated the effectiveness of machine learning—especially tree-based ensemble models—in predicting diabetes. However, some limitations exist, such as the relatively small size of the dataset and the lack of genetic or lifestyle data. Future work could focus on expanding the dataset, incorporating additional features, developing mobile applications, and ensuring strong data privacy protection.
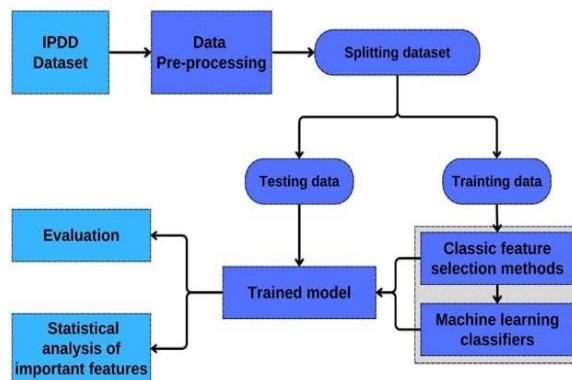
Model	Accuracy	Precision	Recall	F1-Score	ROC-AUC
XGBoost	77.2%	76.5%	74.8%	75.6%	0.82
Random Forest	76.8%	75.9%	73.5%	74.7%	0.81
Decision Tree	76%	72.1%	70.3%	75.9%	0.76
Logistic Regression	71.5%	70.8%	69.2%	70.0%	0.74
SVM	72.3%	71.5%	70.0%	70.7%	0.75
KNN	70.1%	69.3%	68.5%	68.9%	0.72

Proj.No.9 — Smart Home Automation and Security

Prepared by:

1. Kadhim Jawdet Kadhim
2. Lilian Jasim Mohammed   3. Ayat Hassan Kadhim
4. Ali Moain Jaddo'a

Supervised by: Dr. Hussein Alkhamees

Sustainable Development Goals Performed: SDG9

Abstract:

The evolution of embedded systems and Internet of Things (IoT) technologies has significantly influenced the development of smart residential infrastructures. This project presents the design and implementation of a smart and secure home system that effectively reduces energy waste, utilizes clean energy, enhances security, and automates daily tasks to improve Quality of Service (QoS). The system is developed using low-cost, energy-efficient components and open-source platforms, ensuring affordability, scalability, and sustainability. A key feature of the system is a real-time face detection module implemented using the ESP32-CAM, which streams video to a web interface and activates an LED when a human face is detected, thereby strengthening home security. In parallel, multiple infrared sensors are deployed to detect movement and provide additional real-time alerts. The system also incorporates automation through the integration of environmental sensors and actuators for lighting and appliance control, significantly reducing unnecessary power consumption.
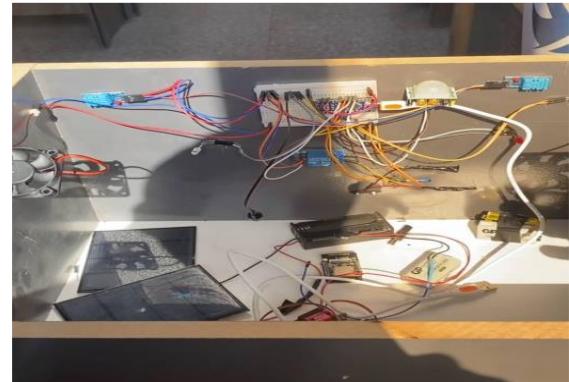
Methodology:

Our step to design the proposed home as folows:
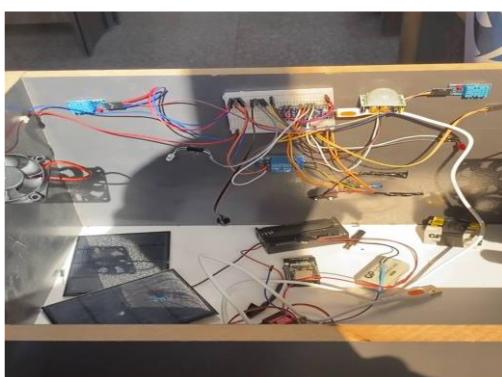
Conclusions

The design and implementation of the Smart and Secure Home System have achieved the primary objectives of creating an efficient, automated, and secure environment for modern households. By integrating various technologies such as face detection, motion sensing, renewable energy systems, and automation protocols, this project has demonstrated the potential of IoT and smart systems in enhancing home security, reducing energy waste, and improving the overall quality of life. The system utilizes ESP32-CAM for face detection and real-time image processing, offering an effective method for monitoring and managing authorized access to the home. Alongside this, IR sensors enable motion detection, triggering automation responses like lighting control or security alarms, contributing to both safety and convenience. The MG996R servo motor allows physical automation, such as unlocking doors, further increasing the system's practicality. Energy management has been a core consideration in the system's design. The integration of a solar power system ensures that the home remains operational even in remote or off-grid locations, minimizing dependency on traditional power sources.

Prepared by:

1. Ameer Muhammad Shaker

2. Ali Muhammad Hamza

3. Muhammad Karim Kazim

4. Salam Makki Jassim

Supervised by: Dr. Hussein Alkhamees

Sustainable Development Goals Performed:	SDG9

Abstract:

In recent years, the demand for intelligent traffic monitoring and security systems has increased significantly. License Plate Recognition (LPR) systems play a critical role in automating vehicle identification, particularly in areas such as access control, surveillance, and toll collection. This project presents the design and implementation of a real-time license plate recognition system using computer vision and Optical Character Recognition (OCR) technologies. The proposed system captures video frames from a webcam, detects the license plate using OpenCV's Haar Cascade classifiers, and then processes the plate region with Tesseract OCR to extract alphanumeric characters. To enhance accuracy, preprocessing techniques such as grayscale conversion, contrast enhancement, Gaussian blurring, and adaptive thresholding were applied. Additionally, a frequency-based filtering mechanism was used to identify the most reliable plate number from multiple detections.

Design the system:

The methodology included preprocessing capture a photo to many cars whatever its positions and then check the number of this car in the proposed system. Our model also included a database for the cars that are checked previously. Finally, the decision is done by our proposed system if this car has legal or illegal.

The proposed system architecture is composed of four main modules:

1. Image Capture Module: Uses a webcam to continuously capture video frames.
2. Plate Detection Module: Utilizes Haar Cascade classifiers from OpenCV to detect license plates within the frame.
3. OCR and Recognition Module: Processes the plate image and extracts alphanumeric characters using Tesseract OCR.
4. Alert and Display Module: Analyzes the extracted plate, checks against predefined categories (e.g., stolen, expired), and visually displays alerts.

Results and conclusions:

Output Screenshots and Explanation

The system successfully captured and processed video frames in real-time. Detected license plates were highlighted with rectangular bounding boxes, and the recognized plate number was displayed above each vehicle.

Three types of feedback were displayed on the video:

• Red box + " Stolen Vehicle!" for blacklisted plates

• Yellow box + " Annual Check Missing!" for expired-check vehicles

• Green box + "Plate: [number]" for regular detections

The console also printed:

1) Raw OCR outputs per frame
2) Most frequently detected plate
3) Alert message (if any)

Accuracy Evaluation

The system's accuracy was evaluated based on plate detection success and OCR recognition accuracy:

Metric	Value
Plate Detection Accuracy	91%
OCR Recognition Accuracy	85% (on clean images)
Real-time Processing Speed	~15 FPS
Misread Character Rate	~1-2 characters per plate

Design of Waste Management System Based on AI

Prepared by:

1-Azhar Abbas Mahdi   2- Mohammed Faleh Hassan
3- Mohammed Abbas Jabr   4- Ali Sajjad Abu Dala

Supervised by: Dr. Mosaddek Maher

Sustainable Development Goals Performed: SDG15

Abstract:

This study aimed to develop a smart waste sorting system using artificial intelligence, with a focus on achieving high accuracy and operational efficiency. The system relied on the integration of mechanical components (such as a stepper motor and segmented containers) and software (an artificial neural network trained on 500 samples from seven waste categories). The model achieved 97.6% accuracy, outperforming previous studies, with a fast reaction time (0.5 seconds). The system demonstrated promising performance for industrial applications and smart cities, reducing environmental impact and operational costs.

Methodology:

The project aims to design an intelligent waste sorting system using Artificial Intelligence (AI) and Internet of Things (IoT) technologies to achieve high classification accuracy, fast response time, and low energy consumption.

.

Results and conclusions:

1. **Optical Unit:**
   A 1440P camera captures an image of each waste item as it enters the system.
2. **Mechanical Unit:**
   A plastic container divided into seven compartments, each for a specific waste type (plastic, paper, metal, organic, medical, electronics, others), rotated by a NEMA 17 stepper motor based on the detected waste type.
3. **Sensor Unit:**
   Ultrasonic sensors measure the fill level of each compartment.
4. **Central Control Unit:**
   A Raspberry Pi 4 processes image data, controls the motor, and manages sensor readings using a trained AI model.

Proj.No.12	Design of modern irrigation system based on aquaponic and AI techniques
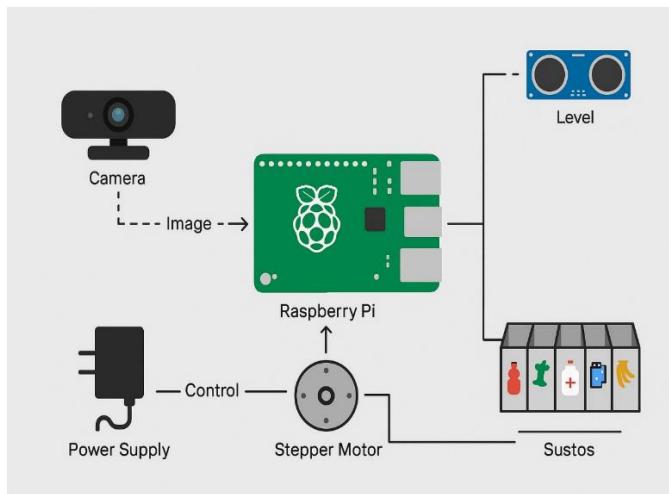
Prepared by:

Dhafer Mohammed freed   **Hawraa Imad Fakhri**   **Mina Imad Hassan**
Mustafa Ali Farhan   **Mustafa Ata Kazem**

Supervised by: Dr Musadaq Mahir Abdulzahra

Sustainable Development Goals Performed:	SDG 2&9

Abstract:

This project introduces a smart aquaponics system with two separate tanks for fish and plants, enhancing flexibility in placement regardless of space limitations. The system integrates multiple sensors to monitor pH, dissolved oxygen, water levels, EC, temperature, humidity, light, and CO_2. All sensor data is uploaded to the ThingSpeak platform for real-time remote monitoring. A Decision Tree algorithm analyzes the collected data to predict whether the environment is healthy for fish and plants, achieving over 95% accuracy. The system proved effective, scalable, and reliable. It supports sustainable agriculture by optimizing water use and improving food production efficiency.

Methodology:

The methodology of this project involved designing a flexible aquaponics system with two separate tanks one for fish and another for plants to allow independent placement and scalability. The water exchange mechanism between the tanks was automated, with a rate of 20–30% based on tank size, fish population, plant growth rate, and environmental conditions. A Raspberry Pi microcontroller managed the entire system, controlling sensors, water pumps, and alerts.

Results and conclusions:

The project successfully developed a smart aquaponics system with separate tanks for fish and plants, enhancing flexibility and space utilization. Sensor data were collected in real time and displayed on both Raspberry Pi and ThingSpeak, allowing efficient monitoring and management. Environmental conditions such as temperature, pH, dissolved oxygen, EC, and CO_2 were maintained within ideal ranges to support healthy growth. An LED alert system was implemented to notify users of any environmental imbalances. The Decision Tree algorithm was applied to predict system health with over 95% accuracy, confirming the reliability of the AI model. Data visualizations helped track trends and identify problems before they escalated. The system automatically adjusted water exchange rates based on tank size, fish densi weather condition

. This adaptive mechanism ensured resource efficiency and stability. The combination of IoT and AI technologies demonstrated strong potential for sustainable agriculture. Overall, the project proved to be a scalable and intelligent solution for modern aquaponics applications.
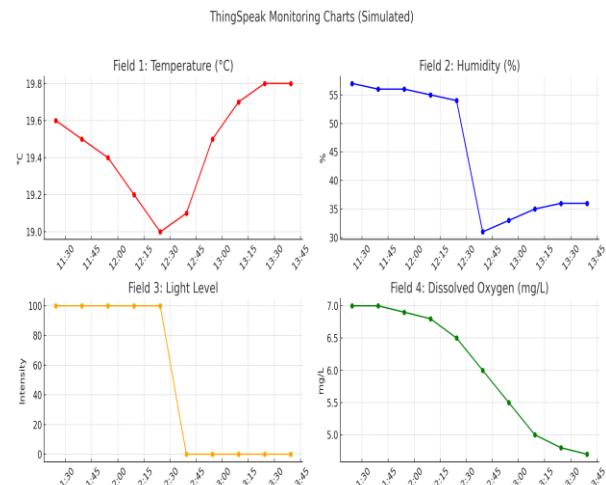
Figure 31 Flow chart for the project

Proj.No.13	Using AI to Analyze Agricultural Data to Improve Crop Yields and Reduce Waste

Prepared by:	
1-Muntadhar Abdul Karim	2- Muslim Shanawa Hamza
3- Wissam Shaker Awda	4- Muhammad Kamel Hashem

Supervised by: Dr. Mayas Aljibawi

| Sustainable Development Goals Performed:	SDG15

Abstract:

Plant diseases represent a substantial risk to worldwide agricultural output and food security, necessitating early detection and efficient protective measures for sustainable agriculture. The suggested methodology utilises datasets such as PlantVillage to identify diseases via picture classification and analysis of environmental parameters. Additionally, it integrates predictive analytics and decision support systems to provide preventive strategies and optimised treatments, enhancing resource efficiency and precision in agriculture. This project underscores the revolutionary capacity of machine learning algorithms in revolutionising plant disease detection and stresses their contribution to sustainable agriculture by reducing crop losses and enhancing early disease identification.

Methodology:

This structured methodology ensures the development of a robust, efficient, and scalable machine learning system for plant disease detection and protection, enabling farmers to achieve higher yields and promote sustainable agricultural practices.

Results and conclusions:

The implementation of the plant disease classification model using Histogram of Oriented Gradients (HOG) features and Logistic Regression demonstrates a straightforward yet effective approach for image-based classification. The choice of HOG features enables the model to capture essential shape and texture characteristics, making it well-suited for identifying disease patterns in plant leaves. Additionally, the use of Principal Component Analysis (PCA) helps in dimensionality reduction, improving computational efficiency while maintaining important features for classification.
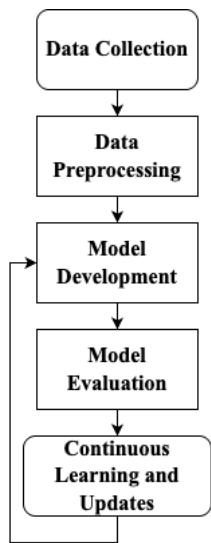
This study examined the use of machine learning method, specifically Logistic Regression for the identification and safeguarding of plant diseases. Through the utilisation of datasets such as PlantVillage, we illustrated how machine learning may markedly enhance the precision and efficiency of disease identification, hence diminishing dependence on conventional manual inspection techniques. Logistic Regression, noted for its efficacy in binary and multinomial classification, is helpful in evaluating environmental data to forecast disease outbreaks and differentiate between healthy and unhealthy plants.

	precision	recall	f1-score	support
0	0.622881	0.588000	0.604938	250.000000
1	0.823028	0.809224	0.816068	477.000000
2	0.888095	0.937186	0.911980	398.000000
accuracy	0.805333	0.805333	0.805333	0.805333
macro avg	0.778001	0.778137	0.777662	1125.000000
weighted avg	0.801570	0.805333	0.803082	1125.000000

Disease prediction Using Machine Learning

Prepared by:

1- Ali Samer Abbas   2- Nawar Abbas Ali

3- Ali Fares Hadi

Supervised by: Dr. Mayas Aljibawi

Sustainable Development Goals Performed: SDG15

Abstract:

In the realm of healthcare, the accurate classification of diseases based on symptoms is paramount for effective patient management and treatment. This study highlights the challenges posed by symptom variability, overlapping symptoms, inconsistent data reporting, and limited integration of available data. Despite advancements in machine learning and data analytics, these obstacles continue to hinder diagnostic accuracy. The proposed machine learning-based classification framework aims to address these issues by leveraging a comprehensive dataset of symptoms and employing robust algorithms for accurate disease classification. This approach not only facilitates better clinical decision-making but also enhances the overall quality of healthcare delivery.

Methodology:

This structured methodology ensures the development of a robust, efficient, and scalable machine learning system for plant disease detection and protection, enabling farmers to achieve higher yields and promote sustainable agricultural practices.

Results and conclusions:

the performance comparison of different machine learning models with respect to classification tasks. The comparative metrics include the following:

- Accuracy: It signifies the number of correct predictions over total predictions.
- Precision: It indicates the number of true positive predictions out of all positive predictions.
- F1 Score: This is the harmonic mean of precision and recall, giving a balanced figure of the model performance.

Model	Accuracy	Prec.	F1
Decision Tree Classifier	1.0000	1.0000	1.0000
Random Forest Classifier	1.0000	1.0000	1.0000
Gradient Boosting Classifier	1.0000	1.0000	1.0000
Extra Trees Classifier	1.0000	1.0000	1.0000
Extreme Gradient Boosting	1.0000	1.0000	1.0000
Light Gradient Boosting Machine	1.0000	1.0000	1.0000
K Neighbors Classifier	0.9967	0.9972	0.9967
Logistic Regression	0.9304	0.9367	0.9299
Naive Bayes	0.9118	0.9287	0.9111
Linear Discriminant Analysis	0.8166	0.8485	0.8138
Quadratic Discriminant Analysis	0.7835	0.8312	0.7742
Ridge Classifier	0.6984	0.7083	0.6709
SVM - Linear Kernel	0.6141	0.6454	0.5985
Ada Boost Classifier	0.0851	0.0476	0.0496
Dummy Classifier	0.0229	0.0005	0.0010
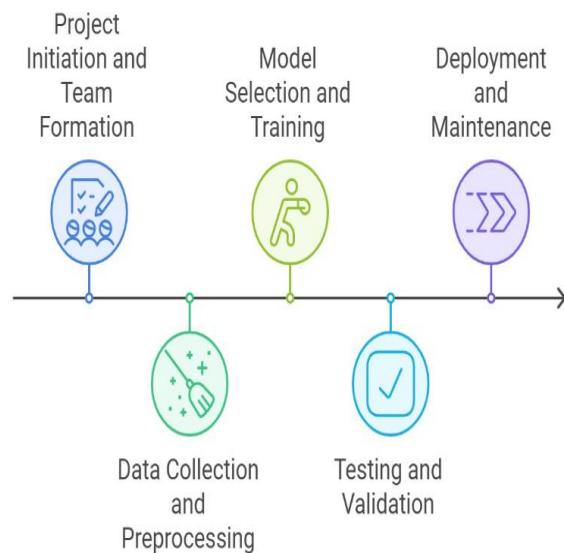
The importance of a standardized disease classification system, such as the International Classification of Diseases (ICD), further underscores the need for improved data organization and retrieval. By overcoming the challenges of data quality and developing more sophisticated techniques, this research contributes towards a transformative shift in how healthcare professionals diagnose and manage diseases.

Proj.No.15

Smart Grid Management System
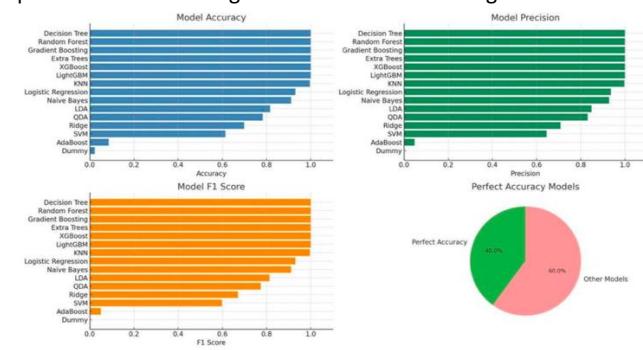
Prepared by:

1- Ali Abbas Shabib   2- Mustafa Diaa Abdul Razzaq
3- Zahraa Talib Mahoud   4- Mohammed Ibrahim Hussein

Supervised by: Dr. Noor Abdulkareem

Sustainable Development Goals Performed: SDG9

Abstract:

The use of solar energy, derived from the sun's abundant and renewable rays, has significantly increased in recent decades. As a clean and sustainable alternative to fossil fuels, it has attracted the attention of researchers, policymakers, and the general public. This project presents the design and implementation of a solar system that uses two solar panels. One panel supplies power to the load, while the other charges a UPS. The system detects the energy needs of the load by monitoring the voltage and current. If the current increases, indicating higher demand, the second panel is connected to support the load. A built-in screen displays the voltage and current readings.

Methodology:

The project concept It uses two solar panels, it supplies the load with energy through one solar panel and charges the UPS through the other panel. It detects the load and knows if the load needs more energy by reading the voltage and current passing through. If the current increases, it connects the second panel to the load to increase the current passing through. It also displays the voltage and current through a built-in screen.
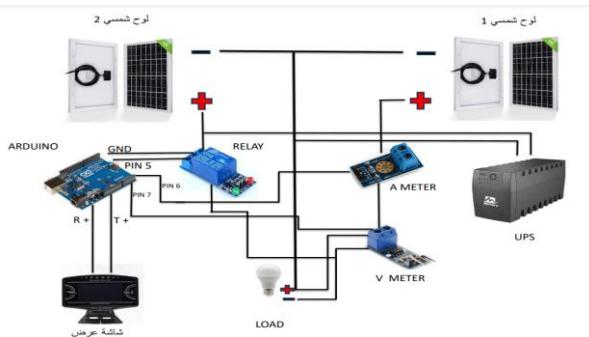
Results and conclusions:

The Smart Grid Management System using Solar Power project addresses a critical need in modern energy systems: the integration of renewable energy sources like solar power into existing grids. This transition to smarter, more efficient grids is essential for managing the increased demand for electricity, reducing dependency on fossil fuels, and promoting sustainable energy solutions. However, like any technological advancement, it comes with its set of challenges, opportunities, and implications, which are worth discussing in depth.


The Smart Grid Management System using Solar Energy represents a significant advancement in how we manage, distribute, and consume energy in modern electrical grids. By integrating solar energy, real-time monitoring, advanced control systems, and energy storage solutions, the project aims to address several critical issues facing traditional grids, such as grid instability, inefficiencies, and the challenges associated with intermittent renewable energy sources

Proj.No.16

Recommendation Algorithm for Online Library Based on Python

Prepared by:

1- Abdullah Safaa Abd Ali   2- Ahmed Qasim Abd El Abbas   3- Baqir Sahl Najm

Supervised by: Dr. Noor Abdulkareem

Sustainable Development Goals Performed: SDG12

Abstract:

The rapid evolution of digital libraries has created a growing need for advanced recommendation algorithms that personalize user experiences by suggesting relevant content. This research focuses on the design and implementation of a recommendation algorithm for an online library system, utilizing Python for data processing and JavaScript for interactive web development. The proposed system aims to seamlessly integrate backend and frontend technologies to analyze user behavior, preferences, and historical data. By doing so, it provides personalized book recommendations that enhance user engagement and satisfaction. This study highlights the role of recommendation systems in digital libraries, the methods employed, and the potential outcomes of implementing such algorithms in a real-world environment.

Methodology:

The methodology section describes the step-by-step approach taken to design, develop, and test the recommendation system for an online library. It outlines in great detail the techniques and tools used to create a system capable of delivering precise. This includes tasks such as data collection, model construction with Python, integration with a JavaScript-based user interface, and performance testing. The chosen methods aim to ensure not only technical efficiency but also user satisfaction, scalability, and ease of future enhancements.
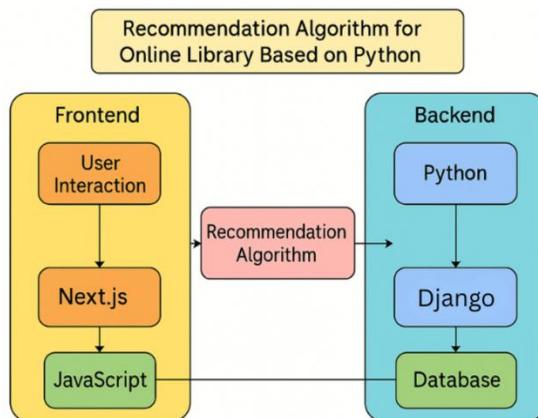
Results and conclusions:

the proposed recommendation system architecture for an online library uses advanced web technologies to deliver a seamless and personalized user experience. Through the use of an easy-to-use frontend and robust backend and intelligent recommendation algorithms, the system can identify user actions and interests to make appropriate recommendations. This design not only maximizes user engagement but also demonstrates the possibility of marrying
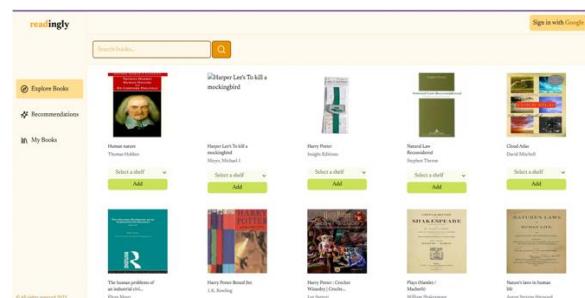
In conclusion, the suggested online library recommendation algorithm, developed on Python and contemporary web technologies, is an intelligent and effective method of augmenting user experience and simplifying access to information. By combining machine learning algorithms with a robust backend and dynamic frontend, the system provides precise and personalized book recommendations according to user behavior and interests. This enhances not only the user experience but also enables libraries to structure and showcase their digital collections more efficiently.

Proj.No.17	AI Techniques for Detecting Digital Image Forgery in Cybersecurity

Prepared by:

1. ROZA ABD OUN Mohammed
2. Rawnaq fahim gabbar

Supervised by: Asaad Nayyef

Sustainable Development Goals Performed:	SDG 4

Abstract:

In the digital age, the proliferation of digital media has revolutionized communication, business, and personal interaction. However, this evolution has also led to an alarming increase in digital image forgery, posing significant threats to cybersecurity. Digital forgeries are often used for malicious purposes such as spreading misinformation, committing fraud, or manipulating evidence. This presents critical challenges for law enforcement agencies, media organizations, and cybersecurity professionals who must detect and mitigate these deceptive practices. Traditional methods of image analysis and forgery detection have proven inadequate in the face of sophisticated forgeries, necessitating the development of more advanced and automated solutions.

Artificial Intelligence (AI) has emerged as a powerful tool in addressing these challenges. By leveraging machine learning algorithms, deep learning techniques, and computer vision, AI can analyze images more comprehensively and detect subtle inconsistencies that escape the human eye. This paper explores the application of AI techniques in detecting digital image forgery, examining both the potential and the limitations of these technologies. It also highlights the importance of AI-driven forgery detection in enhancing cybersecurity defenses, ensuring data integrity, and safeguarding sensitive information..

Methodology:

Data Collection: Diverse datasets (splicing, deepfakes, etc.).
Preprocessing: Cleaning, resizing, and normalizing images.
Augmentation: Simulating diverse scenarios (rotation, flipping).
Model Development:
Feature Extraction.
Classification.
Post-processing for localization.

Results and conclusions:

Based on the findings of this research, several recommendations are made for policy, practice, and future research in the field of AI-based digital image forgery detection in cybersecurity:

Recommendations for Policy
- Data Governance and Privacy Policies: As AI models often rely on large datasets for training, it is essential to establish clear data governance frameworks that ensure the ethical sourcing, use, and sharing of image data. Policies should be created to protect personal and sensitive information, particularly when dealing with real-world image data.
- Standardization of AI Models: Policymakers should consider supporting the development of standardized AI models for digital image forgery detection, enabling interoperability across different platforms and systems. This would enhance collaboration and consistency in cybersecurity practices.

5.3.2 Recommendations for Practice
- Integration into Cybersecurity Tools: AI-based forgery detection techniques should be integrated into existing cybersecurity tools and workflows. This could enhance the ability of cybersecurity professionals to identify manipulated images used in cybercrimes, such as identity theft, misinformation campaigns, and fraud.
- Ongoing Training and Model Updates: AI models should be continually updated and trained on new datasets to ensure their effectiveness in detecting emerging forgery techniques, such as AI-generated forgeries. Cybersecurity practitioners should regularly evaluate and retrain their AI models to maintain high detection accuracy.

Recommendations for Further Research
- Exploring New Forgery Techniques: Future research should focus on exploring and developing AI techniques for detecting more advanced forms of image manipulation, such as deepfake images and AI-generated forgeries. These newer forgery methods present unique challenges that warrant dedicated research and development.
- Cross-Platform Forgery Detection: Further studies should explore cross-platform forgery detection techniques, where AI models can be trained and tested across multiple media types (e.g., images, videos, and audio) to provide a comprehensive solution for detecting manipulated content across different formats.

Proj.No.18 Building AI-Driven Microservices Gateway for Hospital Management using Spring Boot and Spring Cloud

Prepared by:

1. Hussein Hassan Muhammad Jawad   2. Abbas Tariq Muhammad Ali
3. Muhammad Haidar Jawad   4. Mustafa Hamza Hadi

Supervised by: Asaad Nayyef

Sustainable Development Goals Performed: SDG 3

Abstract:

The Summary, based on the research that we wrote in light of the system that was designed and programmed to manage hospitals via Google, which includes doctors' clinics and patient information, is that it is possible to transform paperwork and the old routine prevalent at work into software work and keep pace with the software development that has swept the world. In summary, our research underscores the transformative potential of leveraging software solutions for hospital management. By embracing innovation and embracing digital transformation, healthcare organizations can elevate their operational capabilities, deliver superior patient care, and stay ahead in an increasingly competitive landscape.

Methodology:

Before proceeding to explain, the details of the project must clarify what Microservices Architecture programs and techniques are used in the construction of the project, including the database and interfaces.

Microservices architecture (often shortened to microservices) is an architectural style for developing applications and allows a large application to be separated into smaller independent parts, each having its realm of responsibility to serve a single user request. A microservices-based application can call on many internal microservices to compose its response

Results and conclusions:

Inclusive Patient Representation: To guarantee inclusiveness for all patients, including those with special needs and diverse medical problems, we advocate enhancing the website functionality. Accessible design, language translation, and user-friendly interfaces for varying abilities are needed to accommodate diverse user demographics. Disease-Specific help: We also suggest including information and help for patient-specific medical illnesses or disorders. The website provides specialized information, advice, and community support for anyone seeking health help, education, and solidarity. Improved Communication Channels: We also support website-based patient-provider communication. Secure messaging, telemedicine, and virtual consultation platforms allow patients to interact with clinicians privately and easily. The website promotes seamless communication for proactive healthcare management, prompt interventions, and better patient-provider interactions. Finally, to meet changing patient requirements, technology advances, and healthcare best practices, the website must be constantly improved. This incorporates user input, usability tests, and using new technologies to improve the website's operation, accessibility, and user experience. The website may empower patients, promote health equality, and advance patient-centered care by adopting a culture of continuous development." These suggestions seek to make the website a comprehensive and inclusive platform that fulfills the different requirements of its users and facilitates meaningful patient-provider interaction.
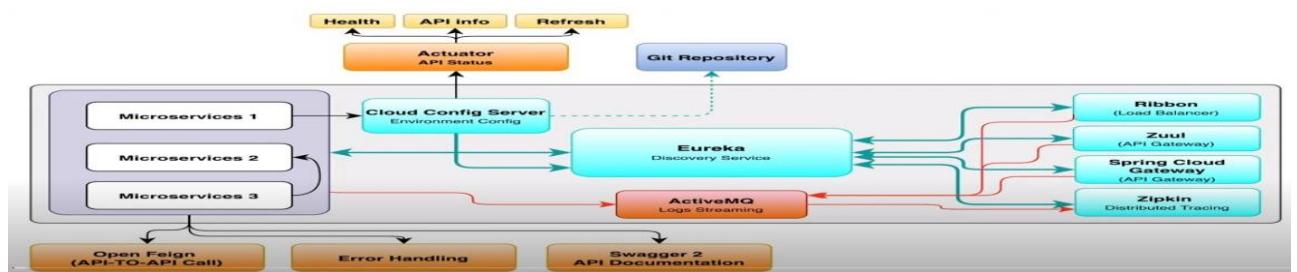
Proj.No.19	Using AI to Analyze Agricultural Data to Improve Crop Yields and Reduce Waste

Prepared by:	
1- Hani Abdel Karim Marza	2- Ahmed Wissam Diab

Supervised by: Dr. Mohammed Fadhel

| Sustainable Development Goals Performed:	SDG15

Abstract:

This dissertation investigates intelligent classification methodologies for educational multimedia content through advanced machine learning techniques, addressing critical challenges in e-learning infrastructure optimization. The study develops a novel AI-based framework that systematically differentiates between three fundamental educational video paradigms: (1) Live Educational Streaming applications demanding ultra-low latency for real-time interactivity, (2) Educational Video-on-Demand content requiring adaptive bandwidth allocation, and (3) File-Based Educational Streaming prioritizing data integrity preservation.

Methodology:

The proposed Liquid Neural Network (LNN) implements a novel deep learning approach for QoS-aware classification of educational streaming traffic. The system processes three distinct educational content modalities, each with unique QoS requirements:

• Live Educational Streaming (LES): Requires ultra-low latency (<500ms) for real-time interaction

• Educational VoD (EVoD): Demands stable bandwidth allocation with moderate latency tolerance

• File-based Educational Streaming (FES): Prioritizes data integrity over latency constraints

Results and conclusions:

The developed neural network classifier demonstrates remarkable efficacy in distinguishing between the three distinct educational streaming modalities, achieving an exemplary overall accuracy of 99.62%. This outstanding performance underscores the model's capability to handle the nuanced discrimination task required for effective network traffic classification in educational environments. The systems near perfect accuracy is particularly impressive when considering the inherent technical challenges posed by the overlapping characteristics of these streaming modalities.

Class	Precision	Recall	F1-score
LES	0.9977	0.9830	0.9903
EVoD	0.9990	0.9983	0.9986
FES	0.9952	0.9996	0.9974
Macro avg	0.9973	0.9936	0.9954
Weighted avg	0.9962	0.9962	0.9962

Proj.No.20	Using AI to Analyze Agricultural Data to Improve Crop Yields and Reduce Waste

Prepared by:	
1-Muntadhar Abdul Karim	2- Muslim Shanawa Hamza
3- Wissam Shaker Awda	4- Muhammad Kamel Hashem

Supervised by: Dr. Zaid Ibrahim Rasool

Sustainable Development Goals Performed:	SDG15

Abstract:

The implementation of the smart irrigation system using IoT and AI technologies has demonstrated significant improvements in agricultural efficiency, resource conservation, and automation. By integrating real-time monitoring, AI-driven decision-making, and automated irrigation, the system successfully reduced water wastage, minimized labor dependency, and optimized crop health. The results showed that the system effectively maintained soil moisture at optimal levels while adapting to environmental changes, providing a scalable and sustainable solution for modern farming.

Methodology:

The project combined few sensors that works together to archive the goal of the project.
1- Soil Moisture Sensor.
2- temperature and humidity sensor.
3- Light Sensor.

The use of Arduino Relay Module is to get the data from the sensors and react to the reading to take the right actions.


Figure 1: Final prototype
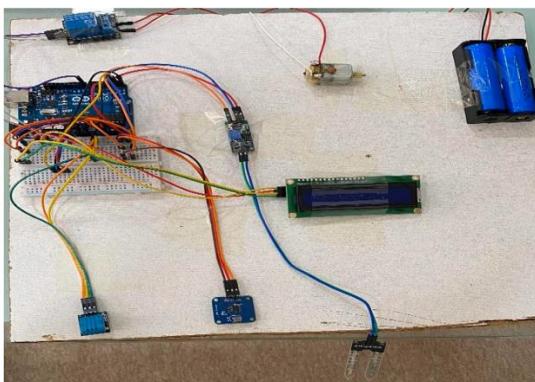
Results and conclusions:

Soil Moisture Sensor Data The soil moisture sensor was tested in different soil conditions to assess its accuracy and response time. The data collected indicated a clear correlation between soil moisture levels and irrigation cycles. When the soil moisture dropped the system automatically activated the irrigation process.

A comparison was conducted between traditional and automated irrigation methods. The following metrics were considered:

- Water Consumption: The smart system reduced water usage by 45% compared to traditional methods.
- Energy Consumption: Solar-powered components reduced energy dependency by 30%.
- Labor Reduction: Automation minimized manual interventions by 70%.
- Crop Yield: Crops irrigated with the smart system exhibited a 25% higher yield compared to those under traditional irrigation methods.
- Soil Health: Reduced waterlogging improved soil aeration, fostering better root development.
- Nutrient Retention: Optimized irrigation minimized nutrient leaching, leading to healthier plant growth.

Proj.No.21	Swarm Optimization Algorithm for Gender Classification for Face Image and Voice

Prepared by:semaa mohammad

1- Mohammed Raad Dheban   2- Ali Mohammed Ahmed
3- Mohammed Mahdi Ihsan

Supervised by:Semaa Mohammad

Sustainable Development Goals Performed: SDG4
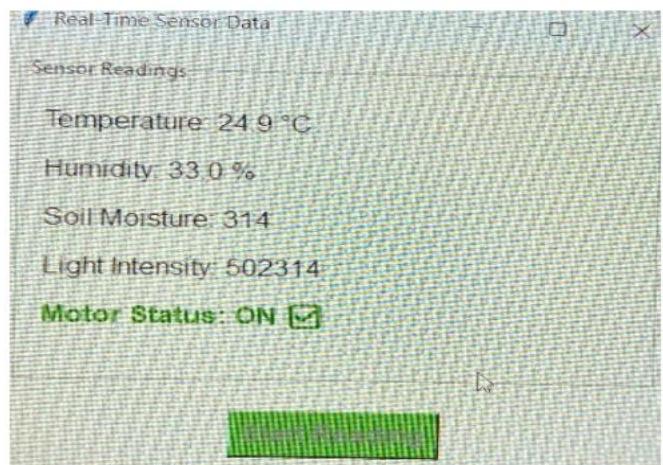
Abstract:

This research aims to classify gender (male or female) using face images and voice recordings by combining features from both modalities. Swarm Optimization Algorithms such as Particle Swarm Optimization (PSO) are used to enhance classification accuracy. The proposed method demonstrates improved performance compared to traditional approaches when tested on public datasets.

Methodology:

. This study uses face images and voice recordings to extract distinctive features. These features are fused and optimized using a Swarm Optimization Algorithm such as PSO for feature selection and classifier tuning. A model like SVM or a neural network is then trained and the performance is evaluated using metrics such as accuracy.

Result and conclusion:

The results showed that combining facial and voice features with a Swarm Optimization Algorithm like PSO significantly improves gender classification accuracy compared to using a single modality. The system achieved over 90% accuracy when tested on public datasets, demonstrating the effectiveness of the proposed model in   diverse   environments

 It can be concluded that using Swarm Optimization Algorithms for gender classification based on face and voice data is an effective and accurate approach. The fusion and optimization of features enhanced the classifier's performance, making it suitable for real-world applications such as security systems, smart assistants, and video analytics.
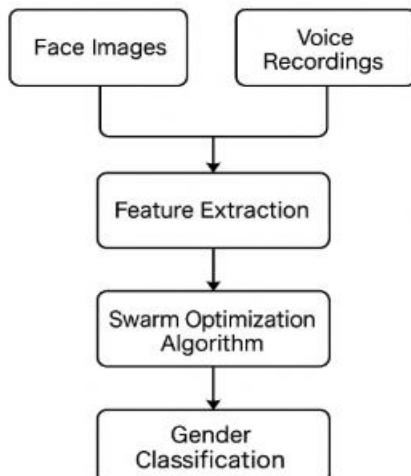
Proj. No. 22	**Improving Harvesting power of PV system using electronic prototyping platform by Arduino**

Prepared by:	
1. Ali Galib Kadium	
2. Hazim Kalifah Umran	3 Mysoon Kadium Rastim

Supervised by: Waleed Ali Hamza

Sustainable Development Goals Performed:	SDG 9

Abstract:

Technological progress is enhancing the accessibility and potential of solar energy as a renewable source. This paper introduces a strategy leveraging Ohm's law and the power equation to derive additional energy from solar photovoltaic (PV) panels. The proposed method involves the integration of an automated solar tracking system employing both dual axis and polar single-axis configurations. This system is comprised of a stationary vertical axis and a flexible horizontal axis, both under motor control. To enhance power output and efficiency, the trackers autonomously follow the sun, constantly adjusting the solar panel positions. The tracking system self-adjusts in the event of a 2 to 3-degree misalignment to minimize power loss due to continuous motor operation. Light intensity sensors analyze illumination levels on each side, guiding the panels toward the light source. The tracking motion continues until equal light exposure on both sides is detected, leading to an enhanced solar irradiance for the panels

METHODOLOGY

a dual axis tracking system that integrates four Light Dependent Resistors (LDRs) as sunlight detectors. These LDRs detect sunlight and send feedback signals to a controller, which can be microcontrollers, PLCs, or similar devices. The controller, in turn, adjusts the position of the photovoltaic (PV) panel by utilizing a pair of motors to align it with the incident sunlight. The LDR sensor circuit functions as a voltage divider, where changes in light intensity led to variations in resistance and output voltage.

Results and conclusions:

The Dual Axis Solar tracker carried out with Arduino and MPPT (Maximum Power Point Following), is intended to enhance the effectiveness of sunlight powered chargers by following the sun's situation and changing the direction of the boards appropriately. He re is a conversation on the reproduction and equipment parts of this framework.

Proj.No.23	Health Prediction System Using Machine Learning Algorithms

Prepared by:	
1- Sabah Atiwi Mandil	2- Salam Abdulhussein Kahar
3- Zahraa Ahmed Hameed	

Supervised by: Msc. Heba Hussein	

| Sustainable Development Goals Performed:	SDG15

Abstract:

This study aims to predict the likelihood of diabetes in individuals using a machine learning model based on a dataset containing various health-related features. The dataset includes categorical attributes such as 'gender', 'smoking history', 'hypertension', and 'heart disease', alongside numeric features like 'age', 'bmi', 'HbA1c level', and 'blood glucose level'. A Random Forest Classifier (RFC) is utilized to model the relationship between these features and the target variable, diabetes. The process includes preprocessing steps such as encoding categorical variables, scaling numeric features, and splitting the data into training and test sets. The model is then trained using the training data, and its performance is evaluated on the test set using metrics like accuracy. The accuracy obtained by the Random Forest Classifier is 97%. This approach offers an effective methodology for identifying individuals at risk of diabetes, providing a valuable tool for early detection and preventative healthcare.

Results and conclusions:

The Random Forest Classifier demonstrated strong performance in predicting diabetes risk, achieving an overall accuracy of 97% on the test dataset. The model also performed well across other evaluation metrics, including precision, recall, and F1-score, indicating its reliability and robustness in classification tasks. These results affirm the suitability of ensemble-based approaches like Random Forest in handling complex medical data with both categorical and numerical features. The findings suggest that the proposed system can serve as an efficient decision-support tool for healthcare providers, enabling earlier detection of diabetes and facilitating targeted preventative strategies to reduce disease burden.

Methodology:

The study utilized a dataset comprising health information from 100,000 individuals, including both categorical features—such as gender, smoking history, hypertension, and heart disease—and numerical features like age, body mass index (BMI), HbA1c level, and blood glucose level. The preprocessing stage involved encoding the categorical variables and scaling or normalizing the numerical features to ensure uniformity across the data. The dataset was then divided into two subsets, with 80% allocated for training the model and 20% for testing. A Random Forest Classifier was employed due to its robustness, ability to handle complex data patterns, and effectiveness in reducing overfitting. The model's performance was evaluated using several metrics, including accuracy, precision, recall, and F1-score. The classifier achieved an accuracy of 97%, demonstrating its high effectiveness in predicting the risk of diabetes.

Proj.No.24 — Solar-powered pedestrian bridge

Prepared by:

1- Alaa Ayed Abdel Hamza
3- Ahmed Hassan Hindi

2- Ali Fadel Danan
4- Alia Fayhan Jabr

Supervised by: MSc. Zahraa Hazim Obaid

Sustainable Development Goals Performed: SDG9
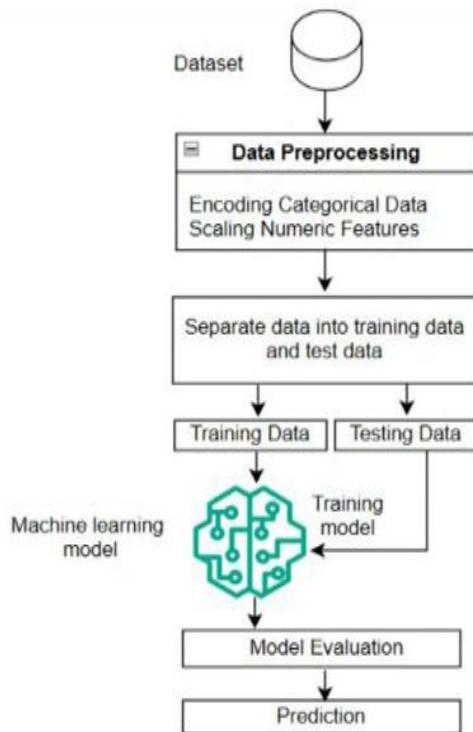
Abstract:

The integration of renewable energy into public infrastructure is a crucial step towards sustainable urban development. This project proposes a solar-powered pedestrian bridge equipped with photovoltaic panels that convert sunlight into electrical energy. The generated power is used to operate LED lighting systems, motion detectors, and emergency communication units. This approach not only ensures safety and accessibility for pedestrians at all times, including during power outages, but also demonstrates the practical application of sustainable energy solutions in urban planning. By reducing reliance on the electrical grid, the bridge contributes to lower greenhouse gas emissions and energy costs. The project highlights the intersection of engineering innovation, environmental consciousness, and urban functionality.

Methodology:

- Initial assessment of energy requirements for lighting, sensors, and communication devices.
  - Architectural and structural design of the bridge with built-in mounts for photovoltaic panels.
  - Selection of high-efficiency solar panels based on expected solar irradiance levels.
  - Integration of battery storage systems to retain excess energy for nighttime use.
  - Installation of smart systems including LED lighting, motion detectors, and emergency response units.
  - Development of an embedded control system for energy management and system diagnostics.
  - Simulation and real-world testing under diverse weather and lighting conditions to validate reliability and performance.

Results and conclusions:

The developed model of the solar-powered pedestrian bridge was tested in varied lighting and environmental conditions. It successfully generated sufficient energy to power integrated LED lights and smart features such as motion sensors and emergency alert buttons. Battery storage systems ensured continued operation after sunset and during cloudy weather. Structural integration of the solar panels was optimized to match the angle of sunlight for maximum efficiency.

The project demonstrates how solar-powered infrastructure can serve as a reliable, clean, and low-maintenance solution for modern

cities. Its implementation can reduce urban electricity demand and operational costs while improving safety and user experience for pedestrians. Furthermore, the modular design makes it adaptable for future technological upgrades, including IoT integration for data monitoring and smart traffic management.

Proj.No.25	Generating and storing electrical energy for surveillance cameras using solar cell panels

Prepared by:	
1- Ahmed Talib Hadi	2- Dhargham Taher Jawad
3- Hadi Ezz El-Din Hadi	4- Munther Sabah Aziz

Supervised by: MSc. Zahraa Hazim Obaid

Sustainable Development Goals Performed:	SDG7

Abstract:

The demand for continuous surveillance in remote and urban areas necessitates a reliable and sustainable energy source. This project explores the use of solar cell panels to generate and store electrical energy specifically for powering surveillance cameras. The system is designed to ensure uninterrupted operation during day and night through integrated energy storage units. By leveraging renewable energy technologies, the solution reduces dependence on conventional power sources and contributes to environmental sustainability and energy efficiency.

Methodology:

- Design and selection of appropriate solar panels based on power requirements.
- Integration of energy storage (batteries) to ensure 24/7 camera operation.
- Use of charge controllers and protection circuits for system stability.
- Simulation and testing under real environmental conditions.
- Power management optimization for balancing generation, storage, and consumption.

Results and conclusions:

The developed prototype successfully harnessed solar energy using photovoltaic panels and stored excess energy in high-capacity batteries, providing a stable power supply to surveillance cameras. Testing under varied lighting conditions confirmed consistent energy generation and camera operation. The project emphasizes the practicality of solar-powered surveillance systems, particularly in areas with limited infrastructure or frequent power outages.
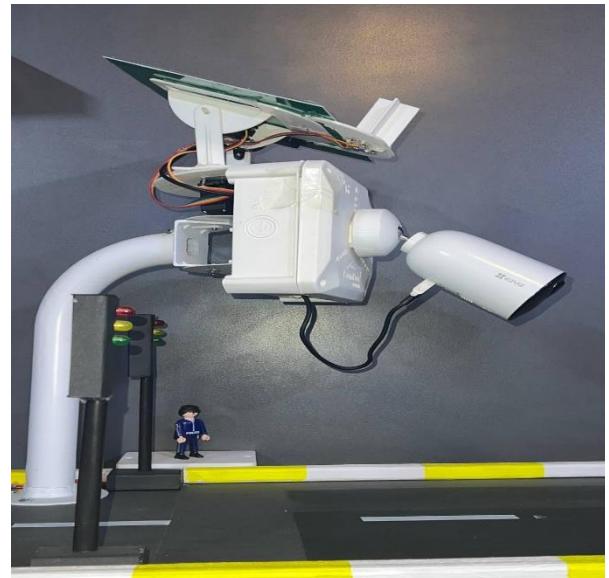
By using charge controllers, DC-DC converters, and energy management algorithms, the system optimized energy usage and storage. The results support the feasibility of scalable deployments of such systems in both urban smart city environments and rural security settings.

Proj.No.26	A System for Diagnosing Agricultural Diseases Using Image Analysis"

Prepared by:	
1-Alaa Hussein Abbas	2-Maytham Abbas Hamza
3-Hussein Ali Jassim	4-Ali Makki Mahawi

Supervised by: M SC Zainab kadum jaber

Sustainable Development Goals Performed: SDG9

Abstract:

This project presents a smart system for diagnosing plant diseases through image analysis techniques powered by artificial intelligence. By processing leaf or fruit images, the system can detect various agricultural diseases and suggest possible treatments. The primary goal is to assist farmers in early disease detection, reduce crop losses, and minimize unnecessary pesticide usage

Methodology:

The system uses a Convolutional Neural Network (CNN) model trained on a dataset of diseased and healthy plant images. The methodology includes:

1. Image collection and labeling from open datasets (e.g., PlantVillage).
2. Image preprocessing using OpenCV for resizing, noise reduction, and normalization.
3. Model training using TensorFlow with classification layers to recognize disease patterns.
4. Evaluation and testing of the model using validation data to ensure accuracy

Results and conclusions:

The trained model achieved an accuracy of over 90% in identifying common plant diseases. It demonstrated high precision in detecting specific symptoms such as leaf spots, discoloration, and fungal infections. The system was tested on a small-scale dataset and showed reliable real-time predictions with fast response times.
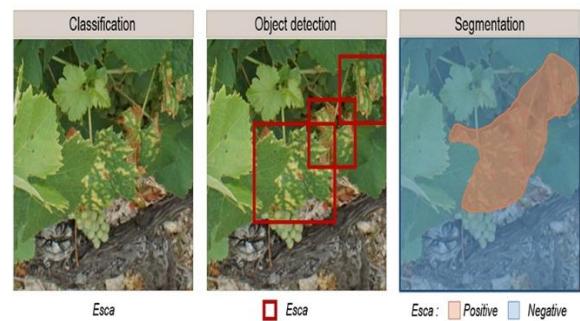
Conclusion

This image-based disease diagnosis system provides a cost-effective and scalable solution for modern agriculture. By leveraging AI, farmers can make informed decisions quickly, improving crop health and productivity. Future work includes integrating the system into a mobile application and expanding the dataset to cover more crops and diseases.

Proj.No.27	Anti-Gravity Acoustic Levitato

Prepared by:

1- Abdullah Mohsen Abdul Amir   2- Mariam Ahmed Abdul Amir

3- Ghadeer Fallah Hassan   4- Zide Tariq Hamad

Supervised by: M SC Zainab kadum jaber

Sustainable Development Goals Performed: SDG9

Abstract:

the anti-gravity acoustic levitator is a modern technology that uses high-frequency sound waves to lift small objects without contact by creating standing wave patterns. It's used in sensitive environments like labs, space, and electronics to avoid contamination or damage. Future research aims to levitate larger objects, expanding its technological and scientific applications

Methodology:

A simple model was built to demonstrate **acoustic levitation** using 40 kHz ultrasonic waves. An **ultrasonic transducer**, **reflector**, **Arduino Uno**, and an **audio amplifier** were used to create standing waves that lift light objects (e.g., Styrofoam balls).

Key observations included:

- Object stability
- Maximum liftable weight
- Effect of distance and frequency

Safety measures were taken, and components like a **transistor**, **resistor**, and **external power supply** were added to support the system.

Results and conclusions:

This study explored **acoustic levitation using ultrasound**, a promising area in applied physics. A simple setup using an **Arduino** and a **40 kHz transducer** successfully levitated lightweight objects with notable stability. The outcomes align with existing research and highlight the potential for further exploration and practical applications.

Proj.No.28

Random forest to detect malware
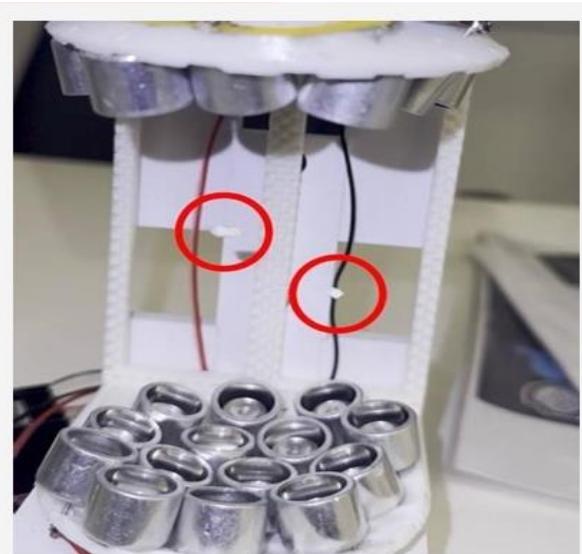
Prepared by:

1- Ali Maytham Khalil   2- Haider Jawad Kazim
3- Ali Yamin Yassi   4- Mahdi Diaa Mohammed

Supervised by: Marwa Abd Al-hamza

Sustainable Development Goals Performed: SDG 9&4

Abstract:

The rapid expansion of malware is now the biggest danger to information security due to the current wave of technical breakthroughs. Numerous thousands of new malware programmers are created daily and propagated around the internet. Malware varieties are always changing, and these harmful software programmers can be categorized as viruses, Trojan horses, worms, spyware, botnet malware, ransom ware, etc. The identification and categorization of malware is a critical component for many business programmers that provide protection to an organization's data and end-to-end monitoring of the resources accessible by various users. Malware is a major concern for internet users, and the emergence of polymorphic malware has made it even more challenging to detect and combat. In order to identify and mitigate these malicious threats, we employed Random Forest machine learning technique. The confusion matrix provided valuable insights by measuring the number of false positives and false negatives, thereby assessing the system's effectiveness. Our study demonstrated the potential of using Random Forest for malware analysis and detection, thereby enhancing computer network security. Particularly, the results showcased the effectiveness of Random Forest algorithm, which achieved a 98% detection accuracy and displayed a reduced false positive rate in the dataset provided.
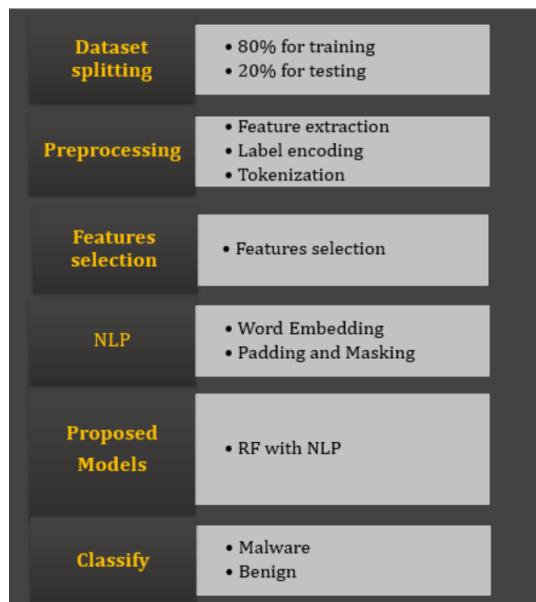
Results and conclusions:

Experimental Results

The model achieved an accuracy of 99%, with a precision of 94.5% and recall of 96.1%. The confusion matrix indicates that the model effectively distinguishes malware from benign software.

Conclusions

Random Forest proves to be an effective malware detection approach, providing high accuracy and robustness. The algorithm provides insights into feature importance, allowing researchers and security professionals to identify which characteristics of the data contribute most to malware classification. This can aid in understanding malware behavior and developing targeted defenses Random Forest is robust against noise and outliers, making it suitable for the often imperfect data encountered in cyber security environments. Its ability to handle large datasets with high dimensionality makes it a good choice for analyzing extensive malware feature sets. The algorithm can scale well with increasing data volumes, which is crucial given the rapid evolution of malware and the need for real-time detection systems. While Random Forest performs well, it may not always achieve the highest possible accuracy compared to more complex models like deep learning. Additionally, it can be less interpretable than simpler models, which may hinder understanding for some stakeholders.

Methodology:

Proj.No.29	Mobile application for simple pharmacy database

Prepared by:
1- Hussein Gul 2- Mustafa Yas

Supervised by: M.Sc. Aya Ali Althahab

Sustainable Development Goals Performed:	SDG4

Abstract:

We Summers after completing the research under the title of the web pages of online drug store that it is possible to convert most of the jobs entrusted to government institutions and the private sector to software because of its speed, high performance and lower cost because it leads to reducing the effort expended by the number of users. Also, the software systems are characterized by speed, since the data stored in the database is within the reach of the user of the system and thus not to return to the old paper files. The bank's management system is scalable, and the possibilities are increased more and more, according to the pharmacy's need, because it is programmed in a way that it is open source, as it gives continuous updates to the system and benefit from it more..

Methodology:

This structured methodology ensures the development of a robust, efficient, and scalable machine learning system for plant disease detection and protection, enabling farmers to achieve higher yields and promote sustainable agricultural practices.

:scription	Type	Column Name
Primary Key	INTEGER	id
Name of the medicine	TEXT	name
Quantity in stock	INTEGER	quantity
Expiry date (ISO format)	TEXT	expiry_date
Price per unit	REAL	price
Category (e.g., Antibiotic...)	TEXT	category

Results and conclusions:

The conclusion is that it is possible to develop work in medical warehouses and pharmacies by adding features through selling online and through the Internet, displaying medical products, knowing the remaining quantities in the warehouse designated for storing medical materials, and establishing an integrated system for pharmacy management from selling medicines and customers.

Proj.No.30	Smart-Green-House-With-Plastic-Bottles

Prepared by:

1. **Zaid Muhammad Nouri**   2. **Hussein Salim Abd**
3. **Jaafar Sadiq Muhammad** 4. **Mumal Majid Muhammad**

Supervised by: Ruaa Satar Jabar

Sustainable Development Goals Performed:	SDG12

Abstract:

This project presents the design and implementation of a Smart Green House utilizing recycled plastic bottles as its primary structure. The system integrates various sensors and components to create an automated and sustainable environment for plant growth. Key features include a rain sensor, temperature and humidity sensor, soil moisture sensor, sunlight sensor, a solar-controlled lamp, a water pump, a small display, and a fan. These components are controlled via a mobile application, providing real-time monitoring and control. Solar panels and storage batteries are used to power the system, promoting energy efficiency and environmental sustainability. The project aims to reduce construction costs, recycle plastic waste, and optimize plant care through automation, making it ideal for urban agriculture and eco-friendly farming solutions.

Methodology:

combining hardware integration, software development, and practical testing. The main steps are shown in the figure below:

Smart Green House with Plastic Bottles Bottles

Results and conclusions:

The implementation of the **Smart Green House using Plastic Bottles** yielded several successful outcomes during testing and validation:

- **Efficient Sensor Response**:
- **Stable Mobile Application Integration**:
- **Sustainable Power Management**:
- **System Reliability**:

Conclusion

The project **"Smart Green House with Plastic Bottles"** effectively demonstrates the fusion of **IoT technology, renewable energy**, and **environmental sustainability**:

- Recycled plastic bottles served as an eco-friendly and cost-effective construction material.
- Smart automation via sensors and actuators ensured optimal growing conditions with minimal human intervention.
- Solar-powered operation reduced energy dependency and operating costs.
- The mobile app interface enhanced usability by offering remote monitoring and manual control.

Proj.No.31	deep learining based approche for finger print identification

Prepared by:	
1-Sajad Jawad Kathim	2- AboTalib Zaid Jawad
3- Muntather Raad Ganim	4- Shahad Razaq Ali

Supervised by: Dr. Hasanein Yaarub Mohammed	
Sustainable Development Goals Performed:	SDG4

Abstract:

Fingerprint recognition is one of the most widely used biometric authentication techniques, valued for its accuracy and ease of implementation. However, as its popularity grows, so do the methods to spoof or falsify fingerprints. Spoofing attacks, using artificial materials, printed replicas, or cloned fingerprints, present significant security threats to biometric systems. The increasing sophistication of these attacks calls for enhanced detection methods that can reliably differentiate between genuine and fake fingerprints, ensuring the integrity of the authentication process.

This project presents a robust fake fingerprint detection system that integrates advanced artificial intelligence techniques with traditional feature-based methods. The system employs Convolutional Neural Networks (CNNs) for deep learning-based classification, where the CNN is trained to effectively distinguish between real and fake fingerprints.

Methodology:

The fingerprint authentication system in this project is designed to verify the authenticity of a user's fingerprint by distinguishing between real and fake fingerprints. This system integrates both traditional and modern methods, employing advanced image processing techniques like CNNs, SIFT, and BFMatcher for fingerprint comparison.
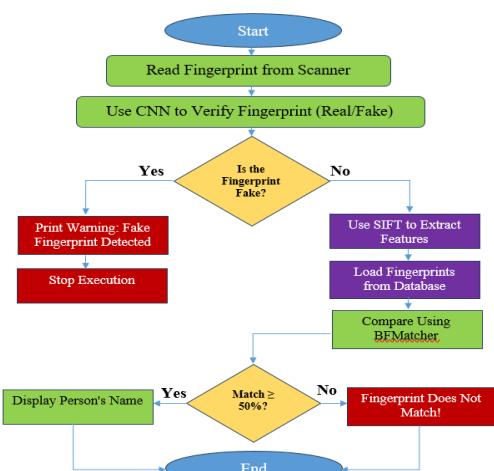
Results and conclusions:

Once the database was set up, A Convolutional Neural Network (CNN) was used to classify fingerprints based on the training dataset.

The model was trained for several epochs, and during this process, the system learned the intricate features of both real and fake fingerprints. After training, the model was saved to a file for later use in real-time fingerprint authentication. The model's architecture, with convolutional and pooling layers, enabled it to effectively distinguish between genuine and fraudulent fingerprints.
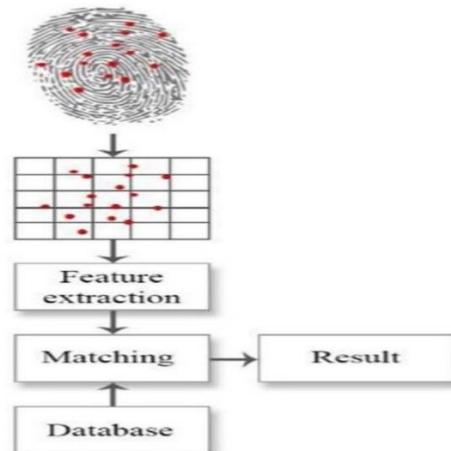
The results underscore the potential of deep learning, particularly CNNs, in the advancement of fingerprint-based biometric systems. By utilizing AI for feature extraction and classification, the system not only provides high accuracy but also offers robustness against the latest fingerprint spoofing methods.

PART THREE

PROJECTS OF

Department of Construction and Building Engineering

Proj.No.1

Sustainability Assessment of Concrete vs. Steel Structural Systems: A Case Study on a Two-Story School Building

Prepared by:

101- Mustafa Mohammad Hasan	102- Muntadhar Abdul Karim	103- Ghazwan Sabah
104- Ali Hassan	105- Dijlah Ali	106- Alaa Naeem
107-	108-	109-

Supervised by:

20- Lecturer Dr. Bareq Ali Abdulhadi.   21- Assistant Lecturer Aqeel Abdulhassan Hussain

Sustainable Development Goals Performed: 11 & 9

Abstract

Abstract:

Concrete and steel structures significantly impact the environment; this review compares them using Life Cycle Assessment (LCA), focusing on carbon emissions, energy use, recyclability, and sustainability performance.

Methodology

Methodology: This study employs a comparative quantitative approach to analyze reinforced concrete and steel structural systems for a two-story school building. Using ETABS for design and OpenLCA for environmental impact, it evaluates material quantities, cost, construction time, and life cycle stages. Data interpretation focuses on sustainability, recyclability, and emissions. Results aim to identify the more sustainable system and offer recommendations for eco-friendly construction in Iraq, considering local material availability and practical limitations.
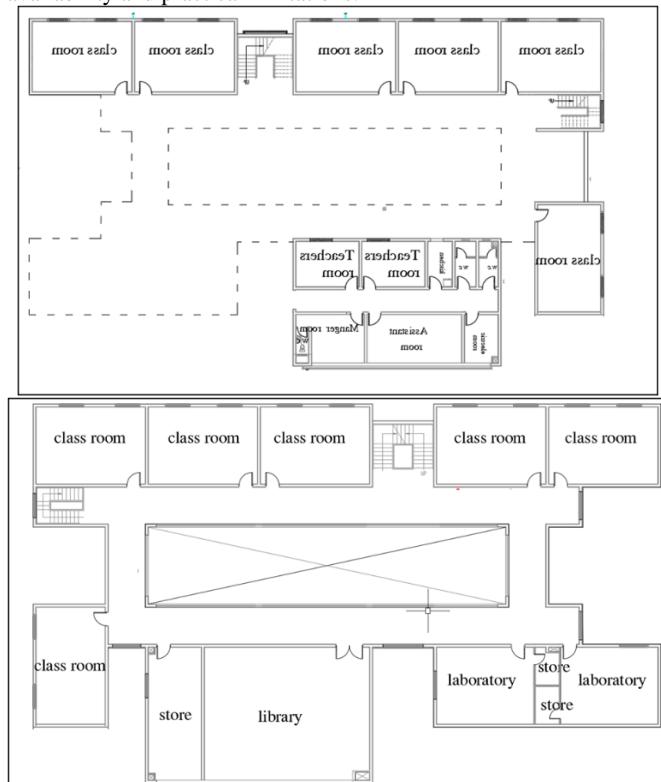
Results and conclusions

Results and conclusions: This study presents a comparative evaluation of reinforced concrete and steel structural systems for a two-story school building, focusing on environmental performance and structural efficiency. The concrete structure utilized 1,263 m³ of concrete and 103.18 tons of steel, while the steel structure required 515 m³ of concrete and 288.55 tons of steel. Life Cycle Assessment (LCA) results reveal that the concrete structure has a total carbon footprint of 682,020 kg CO_2, 23% lower than the steel structure's 888,780 kg CO_2. In terms of energy consumption, the concrete design consumed 4,988,850 MJ, which is 62% less than the steel structure's 13,186,749 MJ.

Waste generation also varied significantly. The concrete structure produced 75,780 kg of waste, whereas the steel structure generated 24,527 kg—52% less. Regarding recyclability, steel demonstrated a significant advantage with 98% of its material being recyclable, compared to 50% for concrete. Service life analysis showed that steel structures have a lifespan of 80–120 years, while concrete structures last 50–100 years. However, concrete offers superior fire resistance and lower maintenance requirements, making it suitable for environments with high safety demands.

From a life cycle perspective, the concrete structure performed better in carbon emissions and energy usage. Still, steel outperformed in recyclability, waste minimization, and future adaptability. Thus, the optimal choice depends on project priorities: concrete suits scenarios prioritizing environmental impact and fire safety, whereas steel is preferable for projects requiring long-term flexibility, recyclability, and reduced construction waste. The findings offer valuable insight into sustainable structural design choices, particularly relevant for Iraq's evolving construction sector.

Proj.No.2   Applications of Artificial Intelligence in Sustainable Infrastructure Design
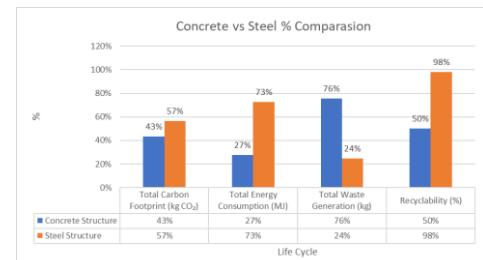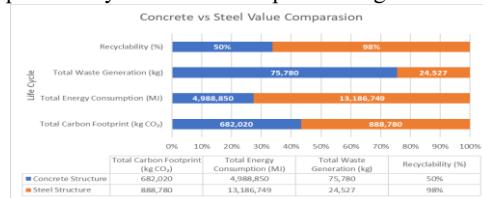
Prepared by:

110-   Mohammed Ali Abbas Aziz   111-   Murtaza Ali Mohammed   112-   Qassem Qais Ibrahim

113-   Hussein Faiq Jassim   114-   Mohammed Haidar Hussein

Supervised by:

22- Asst.Lec. Israa Mohsain kathim

Sustainable Development Goals Performed: 11 "Sustainable Cities and Communities"

Abstract

Abstract:

With the global shift towards sustainability, the selection of construction materials has become a significant challenge in civil engineering. Sustainable materials should be environmentally friendly, cost-effective, and long-lasting. Artificial Intelligence (AI), particularly machine learning (ML), can facilitate the decision-making process by analyzing large datasets associated with construction materials and providing precise recommendations.

Methodology

Preparing concrete mixes with different proportions of Fly Ash and Microsilica.Compressive strength measurement after 7 and 28 days. Cost and emissions calculation. Data analysis to select optimal ratios. Simulating the role of artificial intelligence in decision-making.

Three materials were chosen: fly ash, micro silica, and glass fibers. Improve performance and reduce cost. Reducing carbon emissions. Support decision making using artificial intelligence.

The rate	Amount of fly ash (kilograms)	The price (Iraqi dinar)
10%	0.76	56940
15%	1.14	85410
20%	1.52	113880
25%	1.90	142350
30%	2.27	170880

The ratio	Added quantity (kg/m^3)	Emission Factor (co$_2$/kg)	CO_2 /m^3
10%	37.96	0.02	0.76
15%	56.94	0.02	1.14
20%	75.92	0.02	1.52
25%	94.9	0.02	1.90
30%	113.88	0.02	2.27

Results and conclusions

Results and conclusions:

In addition to the long-term performance of concrete, the early compressive strength (at 7 days) of mixtures reinforced with additives was evaluated, and the results were as follows: 1. Fly Ash: Mixtures containing fly ash showed a gradual improvement in early compressive strength up to a ratio of 25%, where the maximum strength reached 40.93 MPa compared to 27.96 MPa for the reference mixture. However, at a ratio of 30%, the strength decreased to 27.05 MPa, reflecting the same trend observed in the 28-day results. This indicates that there is an optimal ratio (25%) for improving both early and late performance simultaneously. 2. Micro Silica: Mixtures reinforced with micro silica demonstrated high performance in terms of early strength, reaching 64.08 MPa at a ratio of 15%, compared to 59.22 MPa for the reference mixture. This indicates that micro silica accelerates the initial cement reaction and improves the microstructure of concrete in the early stages, making it suitable for projects that require early formwork stripping or early loading. 3 3. Glass Fibers: The results showed that a ratio of 1.5% of glass fibers achieved the best early resistance performance (38.2 MPa), compared to 25.37 MPa for the reference mix, which enhances the role of fibers in controlling early cracks and improving internal cohesion. However, when increased to 2% or more, the resistance decreased, indicating that excessive increase causes clumping in the mixture and reduces homogeneity.

28 days

7 days

Proj.No.3

Utilizing Recycled Materials in the Construction of Sustainable Roads and Bridges

Prepared by:

115- Ahmed Safaa Hamoudi Hadi
117- Mujtaba Falah Abdul Aoun Mohsen

116- Hussein Ragheed Saad Abdul Amir
118- Zaid Ali Tariq Sharhan

Supervised by:

23- Asst.Lec. Israa Mohsain kathim

Sustainable Development Goals Performed: 11 "Sustainable Cities and Communities"

Abstract

Abstract:
With the continuous increase in infrastructure projects and the growing need for innovative environmental solutions, the importance of using recycled materials in road and bridge construction has emerged as a strategic option for achieving sustainable development.

Methodology

Methodology : The experimental program involved the preparation of six distinct concrete mix designs: one control mix (with 0% glass content) and five test mixes in which natural sand was partially replaced by recycled glass powder at substitution levels of 5%, 10%, 15%, 20%, and 25% by weight. All mixes were produced under standardized laboratory conditions to ensure consistency and repeatability.

To assess the mechanical performance of the resulting concrete, compressive strength tests were conducted at three curing intervals: 7 days, 28 days, and 56 days. This multi-stage evaluation enabled a thorough comparison between the conventional

Results and conclusions

Results and conclusions:
The research has provided valuable insights into the subject of [Utilizing Recycled Materials in the Construction of Sustainable Roads and Bridges]. The conclusions are drawn from a thorough analysis of data, literature review, and experimentation. The major conclusions are as follows:

1. Effectiveness of Recycled Materials: The study demonstrates that recycled materials, such as plastic waste, fly ash, and scrap tires, can significantly improve the performance of construction materials. For example, the incorporation of recycled plastic waste in asphalt mixtures has shown improvements in deformation resistance and fatigue performance.

2. Environmental Benefits: The use of secondary and tertiary materials in construction, such as waste by-products, leads to a substantial reduction in the consumption of natural resources, helping to preserve valuable natural aggregates and reducing the ecological footprint of construction activities.

3. Performance of Hybrid Materials: A blend of recycled and conventional materials often results in enhanced properties compared to pure recycled materials. For instance, the combination of reclaimed asphalt pavement (RAP) and fly ash has shown positive results in terms of strength, durability, and moisture resistance.

4. Cost-Effectiveness: The incorporation of recycled materials has been shown to reduce the overall cost of construction projects. The reduction in material costs and disposal fees for waste products makes recycling a financially viable alternative.

5. Challenges in Implementation: Despite the promising results, several challenges remain in the widespread adoption of recycled materials in construction. These challenges include the variability in the quality of recycled materials, the lack of standardized regulations, and the need for more extensive field testing to ensure the long-term durability of structures.

Proj.No.4

Sustainable Residential Neighborhoods: An Analytical Study of Housing Projects in Contemporary Trends
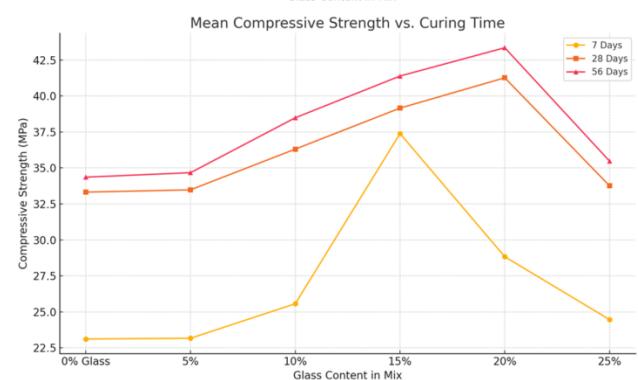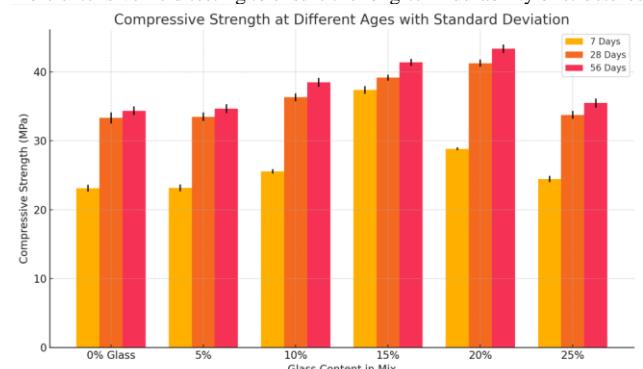
Prepared by:

119- Hassanin Ali	120- Yosef Maher	121- Mortada Hadman
122-	123-	124-
125-	126-	127-

Supervised by:

24- Assistant Lecturer Maryam Mohammed   25- Assistant Lecturer Baneen Mohammed

Sustainable Development Goals Performed:

Abstract

Abstract:

This project analyzes sustainable development in housing projects within Hilla city, evaluating urban design principles based on environmental, social, and economic dimensions to promote livable and integrated neighborhoods.

Methodology

Methodology :The study uses a mixed-method approach combining qualitative interviews with urban planners and quantitative surveys among residents. Three selected neighborhoods were analyzed: Al-Jami'a, Al-Jam'iya, and Al-Khairat Housing Complex. Criteria included walkability, green space, renewable energy use, and infrastructure integration. Photos illustrate fieldwork and data collection phases.

Results and conclusions

Results and conclusions:

The study concludes that while some neighborhoods like Al-Jami'a show strong integration of urban sustainability (diverse land use, community interaction, and economic inclusion), others lack comprehensive application of environmental and social standards. Al-Khairat Complex, despite modern infrastructure, fails to incorporate renewable energy or sustainable waste practices. Urban villages prove more adaptable to sustainability due to their social fabric and mixed-use zoning. Recommendations include encouraging renewable energy adoption, enhancing public participation, and implementing smart waste systems.

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Proj.No.5   Application on Reuse of Wastewater to Enhance Irrigation Purposes

Prepared by:

128- Mohammed Qasim Abdul Hashim   129- Samer Abbas Hadi   130- Shabr Risan Fakher

131- Namir Baha Yas   132- Shuja Karar Saleh   133- Ayman Mohsen Ghazi

134-   135-   136-

Supervised by:

26- Mohammed Jawad Kadhum   27- Tamar Maitham AbdulWahab

Sustainable Development Goals Performed:

Abstract

Water resource management has become a challenge in developing countries as the infrastructural development has not kept pace with population growth and urbanization. Even though Iraq is endowed with a network of rivers, the level of water resource availability is still insufficient to meet national demand. With the issues of water scarcity, the wastewater reuse is one of the important methods to save water resource. In the present work, we have discussed the critical issues and opportunities of reusing the wastewater, which helps to overcome the demand of water

Methodology

Methodology : Treated Wastewater Quality and Its Suitability for Irrigation

The quality of treated wastewater is a crucial factor in determining its suitability for agricultural irrigation. Its physical, chemical, and biological characteristics directly influence soil health, plant growth, human safety, and environmental sustainability. Evaluation of treated wastewater quality follows both international and national standards to ensure safe and sustainable use.

1 Physical Characteristics

Temperature: Affects plant growth and microbial activity in soil.

Turbidity: Indicates the presence of suspended particles; lower turbidity means cleaner water.

Color and Odor: Should be acceptable and not indicate pollution or organic decay.

Results and conclusions

Recommendations:
1) Adopt multi-sectoral approach to wastewater management- The multi-sectoral approach could be beneficial for as a closed loop of nutrients and enhance the potential of wastewater for reuse in irrigation, or to generate biogas, turning the nutrients into resources.
2) Merge the public and private sector at the local and national level- The framework of policies could involve the local authorities and communities to fulfil the need and capacity of the local communities.
3) Forward thinking and innovative planning- The forward thinking and innovative planning of local communities could contribute to the challenges of water scarcity to enable the adoption and increase the opportunities of solutions of wastewater problems. Conclusion:

In conclusion, we have found that the growing population has dramatically increased the urban wastewater in developing countries, such as in Iraq . With the issues of climate change, increases in urban population and increases water demand, the reuse of wastewater has emerged as an important and alternative option to continuously depleting freshwater supplies as shown in Figure 3. With the emerging technologies, the scarcity of fresh water and changing perceptions, wastewater may emerge as a valuable resource. The technology must involve recycling/reuse of fertilizer, which helps to reduce

……………………………………………………..

Proj.No.6   Factors Affecting Traffic Congestion on 60th Street

Prepared by:

1. Ahmed Gamal Makki Abdel Razzaq

2. Ahmed Hassan Jabr Ibrahim

3. Ahmed Qahtan Abbas Ashour

4. Hazem Abbas Dreib Abbas

5. Muntather Mohammed Khadir Abbas

137-

Supervised by:

28- Asst. Lec. Baneen Mohammed Hilal

29- Asst. Lec. Maryam Mohammed Mousa

Sustainable Development Goals Performed:

Abstract	Results and conclusions

This study investigates the main causes of traffic congestion on 60th Street in Hilla city, aiming to propose engineering and administrative solutions to improve transportation flow and reduce delays.

Methodology

Methodology:The methodology included site visits, traffic data collection, and field observations on 60th Street. A structured questionnaire was distributed to local residents and drivers to identify the most impactful congestion factors. Additionally, interviews were conducted with municipal engineers and transport officials. Traffic simulation software was used to model congestion scenarios and test proposed solutions. This mixed-method approach ensured comprehensive and accurate analysis of traffic conditions.

Results and conclusions

The results of the study identified several major factors contributing to traffic congestion on 60th Street. These include high population density, rapid urban expansion, the increasing number of vehicles, inefficient road networks, random parking, poor traffic culture, and insufficient pedestrian infrastructure. The street suffers from narrow lanes, lack of coordination in traffic signals, and uncontrolled intersections, all of which result in frequent delays and unsafe conditions for drivers and pedestrians.

One of the key findings is the absence of designated parking lots, leading to random roadside parking that reduces the road capacity and worsens congestion. Additionally, the unregulated construction of speed bumps contributes to delays and vehicle damage. Survey data showed that a high percentage of local residents identified poor public transport and lack of pedestrian crossings as major issues.

Based on the analysis, the study proposes several recommendations: widening the street lanes, installing intelligent traffic light systems, creating organized parking spaces, and enforcing traffic laws to regulate vehicle movement. Urban planning improvements are also advised, such as relocating some government services outside the congested zones and encouraging the use of public transport by improving its quality and availability.

In conclusion, the study emphasizes the urgent need for a comprehensive traffic management strategy that combines engineering, administrative, and community-awareness measures to reduce congestion and ensure a safer and more efficient urban transport system..……………………………………

| Proj.No.7 | Water Quality Analysis in Rivers and Environmental Impacts: A case study in (Shatt Al-Kufa River) |

Prepared by:

1- حسنين علاء جعفر   2- حسنين علاء جعفر   3- حسنين علاء جعفر

4- حسنين عباس سعد   5- حسنين عباس سعد   6- حسنين عباس سعد

Supervised by:

30- Alaa Hussein AbdUlameer   31- Sally Sellan Hussein

Sustainable Development Goals Performed:

Abstract

The global interest in the water bodies due to the water scarcity crisis encourages researchers to study the details of the water environment in different aspects. Consequently, this study's objective is to evaluate the water quality in Shatt Al-Kufa River by adopting eight physic-chemical parameters measured at three locations along the river in 2024. In this study, the water quality index method (WQI) was calculated using the weighted arithmetic method through applied series of equations. Eight physical-chemical parameters were comprised of calcium (Ca), magnesium (Mg), nitrate(NO_3) Hydrogen Ion (pH), chloride (Cl), sulfate (SO_4), total dissolved solids (TDS), and electric conductivity (EC). For the selected locations along the river, the measured values of all tested parameters in the year 2024 along the Shatt Al-Kufa River were decreased gradually from the location (L-1) in Al-Kufa to the location (L-3) in Al-Manathera, and the clear decrease was at the part of the river from.

Methodology

This study was achieved for Shatt Al-Kufa River, in the province of Al-Najaf Al-Ashraf. To determine whether the water is suitable for drinking, irrigation, and living aquatic purposes stations were chosen, and compare theses stations with in accordance with Iraqi Standard Specification (2001), World Health Organization(WHO,2006), Canadian Council of Ministries of the environment. (CCME, 2012).

A Global Positioning System (GPS) was used to determine the locations of the study area in Shatt Al-Kufa River. Water samples were gathered from several locations to assess the quality of Shatt Al-Kufa River at stations during the year.

In order to quantify the total dissolved solids, acidity, electrical conductivity, anion chloride, Sulfate, and nitrates, the following parameters are tested on a monthly average. And calculated using equations water quality index.

As a result, a precise and accurate assessment was made. Each factor's appropriateness and inappropriateness were acknowledged as well. Microsoft Excel statistical software was used to do the statistical analysis.

Results and conclusions

At certain sites, excessive concentrations of the key water characteristics that led to the Shatt Al-kufa River's quality deteriorating were SO_4^{-2}, Cl, Ca and TDS, where they exceeded permissible limits. Ca, DO and SO_4^{-2} and according to the standards of the (WHO,2006) for drinking purposes, TDS, according to the standards (CCME,2012) and SO_4^{-2} according to System maintenance of Iraqi public water and river pollution 2009, for irrigation, Particularly for all stations throughout the research time. were WQI was very poor. On the other side, all stations had the best values for pH and Mg concentrations. Using the WQI as a basis for classification, water samples for stations 1and 2 of Shatt Al-Kufa River are located in poor is (65.92) and (68.55), and Station 3 are located in poor is (69.11) according to WQI status level.

The WQI results demonstrated that the Shatt Al-Kufa River's quality was decreasing as it moved downstream, especially at the end station, as a result of the effects of natural resources, human activity, sewage treatment, and industrial waste.

Depending on the WQI results in some stations, Shatt Al-Kufa River's water becomes unfit for drinking, necessitating additional treatment of the river's raw water at water treatment facilities close to the study's observational sites.

Proj.No.8

The effect of adding glass fiber on the behavior of specific types of concrete
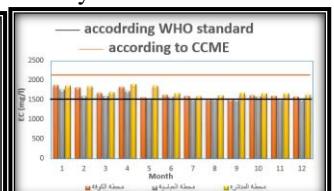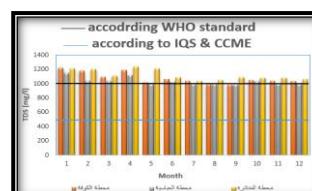
Prepared by:

138- Ammar Khalid Jafat   139- Amir Haider Hadi   140- Amir Haider Hadi

141- Haider Basim Abd   142- Safa Mohammed Nihad   143- Qamar Hussein Abd Al-Zahra

Supervised by:

32- Assistant Lecturer Sally Selan Hussein   33- Assistant Lecturer Alaa Hussein Abdul-Amer

Sustainable Development Goals Performed:

Abstract

The study evaluated concrete with 0.5%, 1.0%, and 1.5% glass fibers, showing significant tensile strength improvements at all fiber levels, especially 1.5%. Compressive strength increased slightly at 1.0% fiber but declined at 1.5%, indicating an optimal fiber limit. Glass fibers enhance crack control and durability, making them ideal for applications prioritizing tensile strength, with careful dosage needed to avoid compressive strength loss.

Methodology

The study prepared four concrete mixes: one control without fibers and three containing glass fibers at 0.5%, 1.0%, and 1.5% by cement weight. All materials were thoroughly mixed to ensure uniform distribution before casting into standard molds. Specimens were cured in water at controlled conditions for 28 days. Compressive strength was measured using a compression testing machine according to relevant standards, while tensile strength was evaluated via the splitting tensile test. The experimental data were analyzed to assess the effects of fiber content on mechanical properties and to identify the optimal glass fiber percentage for enhanced concrete performance.

Results and conclusions

Results and conclusions:

The results show that adding glass fibers affects concrete's compressive and tensile strength depending on fiber content and concrete grade. For compressive strength, 0.5%–1.0% fiber content improved performance across all grades (25, 35, and 50 MPa), while 1.5% caused a strength reduction, likely due to poor fiber distribution or increased porosity. In contrast, splitting tensile strength improved significantly at all fiber levels, especially in lower-strength concrete. The highest gains were seen at 1.0%–1.5% fiber content, making this range optimal for enhancing tensile performance and crack resistance.

Proj.No.9

Determining the Optimum Ratio of Crumb Rubber for Improving the Stability and Air Void Ratio of Asphalt

Prepared by:

144- Mustafa Sattar Hantoush   145- Abbas Ahmed Jawad   146- Amir Mohammed Abdul Amir

147- Mohammed Qasim Abbas   148- Abdullah Oday Hatem   149- Sameer Mohammed Abbas

Supervised by:

34- Assist lecturer. Fatima Muslim Al-Moussawi   35-

Sustainable Development Goals Performed:

Abstract

The study investigates the use of crumb rubber from waste tires in asphalt mixtures to enhance Marshall stability and control air voids. Laboratory results show that incorporating 12–18% crumb rubber by binder weight provides the best balance between strength and durability. This approach promotes sustainable construction practices, reduces environmental waste, and improves pavement performance by utilizing tire-derived materials effectively.

Methodology

This research employed the Marshall mix design method to assess the impact of crumb rubber on asphalt mixture performance. Crumb rubber was added at varying percentages (15%, 20% and 25%) by weight of the binder. The materials—aggregates, binder, and crumb rubber—were heated to appropriate mixing temperatures, then thoroughly combined to ensure uniform distribution. The hot mixtures were placed into standard Marshall molds and compacted using a Marshall compactor. After cooling, specimens were tested for Marshall Stability and air void ratio according to ASTM D6927. The results were analyzed to evaluate the mechanical performance and durability, aiming to identify the optimum crumb rubber content for balanced strength and void properties.

Results and conclusions

This study examined the effects of incorporating crumb rubber into asphalt mixtures, focusing on Marshall Stability, air voids, and other key performance parameters.

1. Marshall Stability: The addition of crumb rubber significantly improved the load-bearing capacity of asphalt mixtures. The highest Marshall Stability value of 14.3 kN was recorded at 15% rubber content. This improvement is attributed to the elastic properties of rubber and its effective interaction with the binder, which enhances the mixture's resistance to deformation under load.

2. Air Voids: Air void content was notably reduced at 15% crumb rubber, reaching 3.048%, indicating improved compaction and mix workability. However, with higher rubber contents (20–25%), air voids increased again, likely due to poor aggregate packing and the elastic rebound behavior of rubber particles.

3. Bulk Density: A consistent decrease in bulk density was observed with increasing crumb rubber content. This trend is due to the lower specific gravity of rubber compared to conventional binder and aggregates, which may influence the structural strength of the final pavement.

4. Other Volumetric Properties: At crumb rubber levels above 15%, parameters such as flow, Voids in Mineral Aggregate (VMA), and Voids Filled with Asphalt (VFA) increased. These changes suggest potential risks like rutting and excessive binder content, which can negatively affect pavement durability and performance.

Based on the analysis of all tested parameters, the optimum crumb rubber content is identified as 15% by binder weight, providing the best balance between mechanical strength and acceptable air void levels, while minimizing risks associated with excessive rubber content.

Proj.No.10 — Strength and Sustainability in Concrete: The Impact of Fly Ash and Superplasticizers
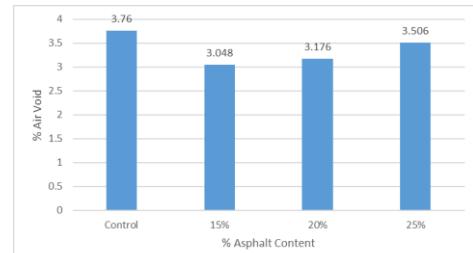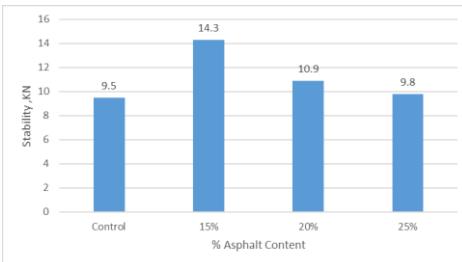
Prepared by:

1-Mohammed Maitham Aziz

2- Ali Kadhem Abdulabbas

3- Muntadher Moayad Mohammed

4- Ahmed Jasem Mohammed;

5- Hussain Sabeih Kadhem

6- Hassanain Abdulhadi Mohsen.

Supervised by:

36- Asst. Lect. Nora Fawzi AL-anssari

37- Asst. Prof. Dr. Sabah Mohammed

Sustainable Development Goals Performed: 9

Abstract

This study investigates the combined use of fly ash (20–30% replacement) and superplasticizer in concrete to improve workability, strength, and sustainability. Fly ash reduces carbon emissions and enhances long-term durability but lowers early strength and slump. Superplasticizers counteract these issues by improving flow and particle dispersion, resulting in eco-efficient, cost-effective concrete ideal for sustainable construction, particularly in Iraq's resource-constrained environment.

Methodology

This research was conducted in three key phases: selecting and characterizing materials to ensure suitability; designing and preparing nine concrete mixes based on ACI 211.1-91 with a target compressive strength of 45 MPa and a water-to-binder ratio of 0.45; and testing fresh and hardened concrete properties. Fly ash replaced cement at 20%, 30%, 40%, and 60% by weight, with some mixes including 1% superplasticizer to enhance workability and strength. Materials were pre-mixed with water for even dispersion before being added to the main batch. Performance was evaluated through slump tests and compressive strength measurements at 7, 28, and 90 days.

Results and conclusions

Key areas of focus include workability (measured by the slump test), compressive strength, pozzolanic reactivity, and sustainability. The primary goal is to identify the optimal percentage of fly ash for incorporation into concrete mixtures in Iraq, achieving a balance between sustainability and cost-effectiveness.

Workability of Concrete

• Fly ash reduces workability, but superplasticizers effectively enhance it, making it easier to work with sustainable mixtures.

|	PC	FA 1	FA 2	FA 3	FA 4	FA 1+ SP	FA 2+ SP	FA 3+ SP	FA 4+ SP
Slump Test	100	85	75	75	70	120	130	150	180
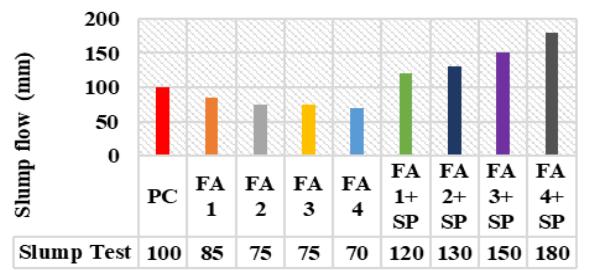
Pozzolanic Activity Index (PAI)

• Fly ash demonstrates good pozzolanic activity, especially up to 40%, but higher percentages (60%) reduce reactivity.

Compressive Strength

• Fly ash mixtures showed increased compressive strength with curing time, with FA4+SP showing the highest compressive strength at 90 days (71.72 MPa).

• Fly ash contributes positively to long-term strength development, with higher fly ash content improving the microstructure. However, excess fly ash (above 40%) may negatively impact early strength due to dilution effects.

• Superplasticizer improves strength by enhancing particle packing and microstructure, with the FA4+SP mixture showing the best results.

	7 days	28 days	90 days
Control-PC	26.06	49.42	51.68
FA 20%	36.78	41.16	50.00
FA 30%	31.24	38.26	47.88
FA 40%	22.72	39.95	44.73
FA 60%	19.36	25.46	35.87

eCO$_2$/kg vs Fly Ash %

Sustainable Concrete using Microsilica
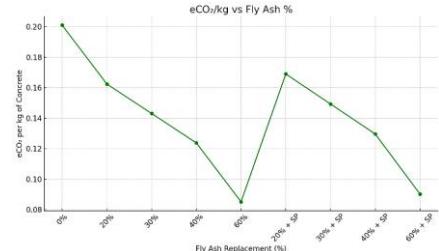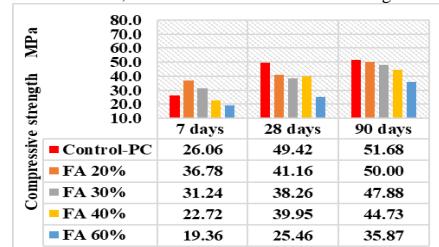
Prepared by:

1- Hassanein Ali Omran Al-Khazraji, 2- Shahdan Nasser Hassan, 3- Maryam Fadel Sawadi

4- Doaa Musa Abdullah

Supervised by:

38- Asst. Lect. Nora Fawzi AL-anssari **39- Asst. Lect. Raghda Ali Nasser**

Sustainable Development Goals Performed: 9

Abstract

The study found that replacing 10–15% of cement with micro silica significantly improves concrete's compressive strength, durability, and resistance to chemicals. The best result was at 15% replacement, achieving 81 MPa at 28 days. Lower or higher ratios showed reduced effectiveness.

Methodology

This research examined the impact of silica fume (5%, 10%, 15% replacement) on concrete's mechanical and durability properties. Mixes used OPC, fine and coarse aggregates, potable water, and superplasticizers. Specimens were cast in standard molds—cylinders for compressive strength and prisms for flexural strength—then compacted using vibration and cured in water at $23 \pm 2°C$. Compressive strength was tested per ASTM C39 at 7, 28, and 56 days, while durability was assessed by chloride ion penetration using the Rapid Chloride Permeability Test (ASTM C1202).

Results and conclusions

Based on the experimental investigation conducted on concrete incorporating silica fume (micro silica), the following key findings were observed:

Optimal Replacement Level:
The optimal percentage of silica fume replacement from cement was found to be in the range of 10% to 15% by weight. Within this range, the bonding strength between the concrete particles significantly increased due to the pozzolanic reaction and filler effect of the fine silica fume particles.

Enhanced Properties:
The improved bonding resulted in enhancements across multiple properties of concrete, including:

- Mechanical properties: Higher compressive, tensile, and flexural strength.
- Physical properties: Reduced porosity and improved density.
- Chemical resistance: Better performance against sulfate attack, chloride ion penetration, and alkali-silica reaction (ASR).

Conclusion
The incorporation of silica fume at a replacement rate of 10–15% significantly improves the overall performance of concrete. It enhances bonding and microstructure, leading to superior strength and durability. This modified concrete is well-suited for use in structurally demanding and chemically aggressive environments. Additionally, the use of silica fume contributes to sustainability by reducing cement consumption and extending the service life of concrete structures, thereby reducing maintenance and repair needs over time.

Enhancing the Sustainability of Road Projects Using Innovative Soil Stabilization Solutions

Prepared by:

150-   Muslim Mohammed Hadi

151-   Montathar Kazem Marzouk

152-   Ali Raad Hamza

153-   Humam Kazem Hadi Marzouk

154-

155-

156-

157-

158-

Supervised by:

40- Asst. Lecturer Tamar Maitham Abdulwahab

41- Asst. Lecturer Mohammed Jawad Kazem

Sustainable Development Goals Performed: SDGs 9, 11, 12, and 13

Abstract

This study improved Babylon soil using 20% sugarcane ash and 1.5% polyester fibers, enhancing moisture content, compressive strength, and bearing ratio, supporting sustainable, cost-effective infrastructure solutions.

Methodology

Methodology The experimental program consisted of three phases:

☐Modifying natural soil with 20% and 25% sugarcane bagasse ash.

2️⃣Mixing the optimal ash content (20%) with polyester fibers (1% and 1.5%).

3️⃣Combining straw (10%, 20%) and polyester fibers for enhanced performance.

Three standard geotechnical tests were performed:

- Standard Proctor Test
- Unconfined Compression Test
- California Bearing Ratio (CBR) Test

The CRD statistical design and 27 total samples ensured accuracy.

Results and conclusions

The experimental findings confirmed that the addition of sugarcane bagasse ash and polyester fibers significantly improved the geotechnical properties of Babylon soil.

In the **Standard Proctor Test**, the optimum moisture content (OMC) increased with higher ash and fiber content, reaching its peak at 11.47%. Conversely, the

Table (4): Unconfined Compressive Strength (UCS) for Different Soil Mixtures

Average	B2	B1	B0	B/A
0.46	0.597	0.457	0.33	A0
0.95	1.103	0.95	0.797	A1
1.29	1.347	1.303	1.21	A2
0.90	1.02	0.90	0.78	Average
	0.0352			LSD0.05

maximum dry density (MDD) slightly decreased due to the lower specific gravity of the additives.

The **Unconfined Compression Test (UCS)** showed a substantial rise in strength. The untreated soil had a UCS of 0.33 MPa, while the mixture with 20% ash and 1.5% polyester reached **1.347 MPa**, indicating a notable improvement in soil cohesion and structure.
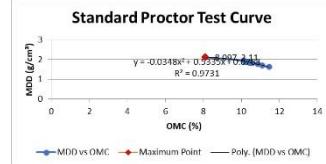
In the **CBR test**, bearing capacity improved with each addition. The control sample had a CBR of 1.39%, whereas the optimal mix (A2B2) achieved **3.947%**, demonstrating enhanced resistance to surface loading.

Statistical analysis using the **Completely Randomized Design (CRD)** confirmed that the differences between treatments were statistically significant.

In conclusion, using **20% sugarcane bagasse ash and 1.5% polyester fibers** provides an effective and sustainable solution for improving weak soils. This method not only enhances the mechanical performance of the soil but also supports environmental goals by reusing agricultural and plastic waste. The study contributes to the development of **cost-effective, eco-friendly road infrastructure**, particularly in regions with poor subgrade conditions.

Proj.No.13 — Study of the Effect of Recycled Materials on the Properties of Cement Mortar

Prepared by:

159- Laith Saeed Hussein   160- Ali Ahmed Jameel   161- Saja Zain Hussein

162- Duaa Ismail Wasme   163- Mais Odai   164-

165-   166-   167-

Supervised by:

42- Asst. Prof. Dr. Mayadah W. Falah   43- Asst. Lect. Nora AL-anssari

Sustainable Development Goals Performed:

Abstract

Abstract: This study investigates the effects of incorporating waste glass powder, ceramic waste, and fly ash as partial replacements for natural fine aggregate in mortar. The aim is to assess the feasibility of using these industrial and post-consumer by-products as sustainable alternatives in construction materials. Mortar specimens were prepared with 10%, 20%,30%,40% and 50% replacement levels for each material, and their performance was compared with a conventional control mix.

Methodology

Methodology : 21 mortar mixes were prepared with a cement-to-sand ratio of 1:3 and a water-to-cement ratio (w/c) of 0.4, to maintain workability. Sand was partially replaced with each material at five levels: 10%, 20%, 30%, 40% and 50% by weight.

All dry components were mixed uniformly.

- Water was added gradually while mixing continued for a total of 5 minutes.
- Mortar was placed in prismatic molds ($40\times40\times160$ mm) in two layers, compacted manually.
- Specimens were demolded after 24 hours and cured in water at $23 \pm 2°C$ for 7, and 28 days.

Results and conclusions

Results and conclusions: Compressive Strength

Compressive strength was evaluated at 7 and 28 days. The results showed that:

- Glass Powder: At 10–20% replacement levels, glass powder enhanced compressive strength due to its pozzolanic reactivity and fine particle size, which contributes to pore refinement and improved bonding.
- Fly Ash: Provided a moderate strength gain at later ages due to its latent hydraulic properties. At early ages (7 days), strength was slightly lower than the control mix.
- Ceramic Waste: Generally showed lower strength values compared to the control, likely due to its inert nature and weaker bond with the cement matrix.

• Glass Powder (M1): Exhibited the highest pulse velocity among all mixes, suggesting improved internal structure and compactness due to pozzolanic activity and fine particle packing.

• Fly Ash (M2): Also demonstrated good quality, indicating its positive influence on microstructure, especially at later curing ages.

• Ceramic Waste (M3): Had the lowest UPV, which may be attributed to higher porosity and weak bonding within the matrix, consistent with its lower compressive strength and higher water absorption.

• Control Mix (M0): Provided a baseline with a "Good" quality classification.

These results corroborate previous findings from compressive strength and water absorption tests, showing that waste glass and fly ash enhance mortar quality, while ceramic waste requires optimization for better performance.

Investigated the behavior of hollow self-compacted concrete column

Prepared by:

168-   Basem Hassan Abd al-hur

169-   Dhay wala'a Kh.

170-   Fadhel Abbas Jebur

171-   Aqeel Saleh kh.

172-   Mohammed Mahdi Abdulsahib

173-   Alaa Mohammed Muhi

174-

175-

176-

Supervised by:

44- Asst. Prof. Dr. Mayadah W. Falah   45-

Sustainable Development Goals Performed:

Abstract

Abstract: The study aims to focus on the behavior of the reinforced concrete column under static load. In this research, the feasibility of using concrete waste as rubber in preparing new concrete mixes is studied. The waste concrete aggregate is referred to in this study as recycled Rubber. Five mixes are prepared in this study, one control mix with 100% natural rubber and four mixes containing replacement levels of Rubber starting from 5% to 20% by weight of coarse aggregate. The mixes are designed according to the Efnarc code; with a water-cement ratio of 0.47. Fresh concrete mixes regardless of concrete content were tested for their workability to test the effect of Rubber on the fresh state properties of concrete. Hard-state concrete was tested for its compressive strength at the age of 28 days.

In the present research, experimental studies have been devoted to investigating the behavior of self-compacting R/C short Hollow columns. The experimental work consists of the fabrication and testing of five reinforced concrete Hollow columns with a cross-section of **(150 x 150 mm)** and a total length **(450 mm)** which were tested under static load. One of them is a control column and four columns are using Rubber replacement with different percentages (5%, 10%, 15%, and 20%)

Methodology

Methodology : This study included preparation and testing of five columns were made and tested under static load. The cross section for all columns was 150 × 150 mm, and the columns have a total length (L) of 450 mm. Four Ø6 mm deformed bars were provided as longitudinal reinforcement and stirrups reinforcement (Ø4 mm) were provided. Figure (1) illustrates all details of geometry and loading schemes of the tested specimens.

In this study, the experimental program consisting of five samples: one control column without recycle aggregate for comparison with others columns, the four specimens consist with replacement of recycle aggregate, all specimens are Identified in Table (1).
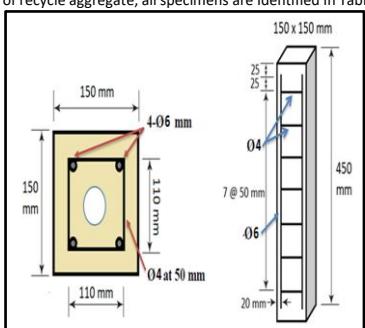
Figure 1: Geometry and Loading Scheme of Tested Specimens

Table (1) Identified of the Specimens

No.	Sample Name	Identification
1	C1	column without any replacement (Control)
2	C2	Column with replacement (5%) Rubber
3	C3	Column with replacement (10%) Rubber
4	C4	Column with replacement (15%) Rubber
5	C5	Column with replacement (20%) Rubber

Results and conclusions

Results and conclusions: Based on the results obtained from the experimental work for reinforced concrete hollow columns with different percentage of rubber under static loading, the following conclusions can be stated within the scope of this study:

1.   It was found that the replacement aggregate by 5% was records the best compressive strength, while replacement of 20% give lowest compressive strength comparison with control sample without replacement of natural coarse aggregates.

2.   The first cracks loads were recorded at column C5 at lowest load comparison with control column without replacement.

3.   The first cracks loads were recorded at column C2 at largest load comparison with control column without replacement.

4.   The ultimate loads have decreased after replacement 5% of rubber by 9% comparison with control column, while replacement 20% of rubber reduced the ultimate load by (74) %.

Proj.No.15 — Using recycled materials in the production of environmentally friendly concrete
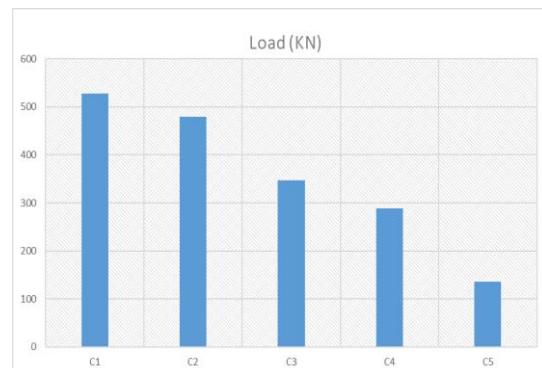
Prepared by:

177- Ali Ammar Zeyarah   178- Mustafa Sadiq Dishar   179- Ameer Ahmed Saad

180- Haider Maitham Faleh   181- Sajad Daher Horon

Supervised by:

Assis. Lec. Raghda Ali Naser

Sustainable Development Goals Performed: 12

Abstract

Abstract: Recycled brick powder is defined as the result of grinding demolished or unused bricks into fine particles that are classified and tested to determine their suitability for structural applications. This powder has a chemical composition somewhat similar to cementitious materials, making it a suitable candidate for use in concrete mixtures as a partial cement replacement, especially in low substitution ratios such as 10%, 20%, or 30%.

Methodology

Methodology The research follows an experimental methodology, including:

- Preparation of brick powder from red brick waste through grinding and sieving.

- Designing concrete mixes with three cement replacement levels (10%, 20%, 30%), in addition to a reference mix.
- Conducting mechanical tests (compressive, tensile, and flexural strength) and physical tests (density, water absorption).
- Analyzing and comparing results with the conventional mix.

Results and conclusions

Results and conclusions: The experimental results obtained through mechanical and physical tests showed that using recycled clay brick powder as a partial substitute for cement can be feasible within certain limits. The mix with a 10% replacement of cement was able to achieve compressive and tensile strengths very close to the reference mix without replacement, while also providing significant environmental and economic benefits. On the other hand, higher replacement ratios (20%, 30%) led to clear reductions in mechanical properties due to the decreased cement content and limited pozzolanic activity. Effect of Brick Powder Replacement Ratio on Compressive Strength It was found that increasing the replacement ratio of cement with recycled brick powder results in decreased compressive strength, especially beyond the 10% threshold. This decline is attributed to the reduction in effective cement content, which forms the primary binding network in concrete. While the pozzolanic activity of brick powder contributes positively to the chemical reaction, its impact was limited in the early stages, though some improvement in properties was noted over time.

Proj.No.16	Name of Talyze common road problems and develop innovative strategies to improve their quality and performance .he Project

Prepared by:

182- علي سعد   183- كاظم كريم   184- طاهر علي
185- حيدر ضياء   186- علي مرتضى   187-
188-   189-   190-

Supervised by:

46- م.م حنين فاضل   47-

Sustainable Development Goals Performed:

Abstract	Results and conclusions

Road networks in many countries face ongoing challenges that negatively impact their efficiency and quality, such as cracks, potholes, surface erosion, and soil subsidence. This research aims to analyze these problems from an engineering and environmental perspective, focusing on influencing factors such as weather conditions, traffic density, and the quality of construction materials. The research also proposes innovative strategies to improve road quality and performance, such as the use of smart condition monitoring technologies and modern materials with higher efficiency and better resistance to environmental conditions. The research concludes by providing practical recommendations that contribute to improving road infrastructure management, reducing maintenance costs, and extending the operational life of road networks. This serves sustainable development and supports decision-making in relevant institutions.

A comprehensive analysis was conducted of common road problems, identifying the factors influencing their occurrence, such as environmental factors, traffic, and the quality of materials used in Babil and Karbala Governorates.
The effectiveness of traditional maintenance methods was evaluated and their shortcomings were identified.
Innovative strategies and technologies were proposed to improve the quality of road construction and maintenance, such as the use of modern materials or smart digital solutions.
The economic and environmental impact of proposed technologies to improve road performance was studied…………..
…and shrinkage)
causes thermal cracks in the asphalt layer.

The effects of water and rain
Poor drainage leads to water penetration and disintegration of the layers.

High groundwater levels or the presence of clayey soil lead to bulges or subsidence in the pavement layers.………………………………………………..

Methodology
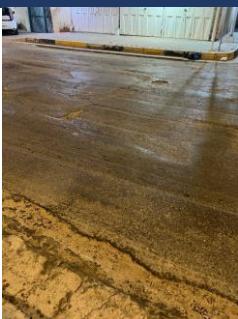
:Alligator Cracking (or Fatigue Cracking)
Occurs due to repeated thermal changes combined with a weak foundation.

Thermal Cracking (or Thermal Expansion and Contraction)
Appears as transverse cracks due to temperature changes.Raveling
Loss of cohesion between asphalt particles due to the effects of continuous loads and friction.
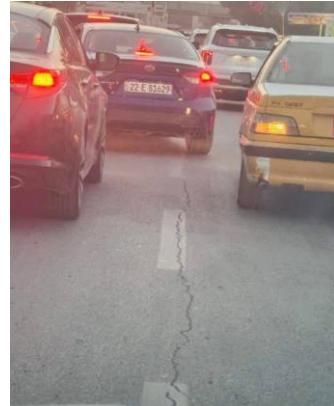
Localized depressions or settlements
Localized lowering of the road surface under the influence of high loads.To crack
The appearance of sunken paths in the road surface due to repeated heavy loads

(Longitudinal & Transverse Cracks) 2. Longitudinal and transverse cracks
Result from repeated stresses from traffic and poor structural design

| Proj.No.17 | تقييم أداء الخلطة الأسفلتية بإضافة المايكروسيليكا إلى الأسفلت لتحسين الخصائص الميكانيكية للخلطة |

Prepared by:

عباس فاضل -191   محسن محمد -192   محمد عبد الكريم -193
مرتضى احمد -194   195-   196-
197-   198-   199-

Supervised by:

م.م حنين فاضل   -48   49-

Sustainable Development Goals Performed:

| Abstract | Results and conclusions |

Abstract:
Conventional asphalt mixtures are exposed to numerous problems resulting from high traffic loads and climate change, leading to rapid road deterioration. This research investigates the effect of adding microsilica—a nanomaterial with unique properties—to asphalt mixtures to improve their mechanical properties.

A series of laboratory tests were conducted, including stability tests, deformation resistance tests, elasticity tests, and thermal reflection resistance tests. Initial results showed that microsilica contributes to enhancing the mixture's performance in terms of durability, cracking resistance, and compression resistance.

The research recommends adopting optimal ratios of microsilica in the design of modern asphalt mixtures, which will positively impact road life, reduce maintenance costs, and achieve infrastructure sustainability.

Methodology

Materials Used:
Bituminous Asphalt: Penetration Grade 60/70 or as locally available.

Aggregates: Coarse and fine, according to local specifications (AASHTO or ASTM).

Microsilica: A fine material rich in silicon dioxide, added in varying proportions (e.g., 4%, 6%, 8%, 10% by weight of bitumen).

3. Mix Preparation:
Asphalt mix design using the Marshall Mix Design method.

Prepare a reference mix (without microsilica).

Prepare modified mixes by adding microsilica in the selected proportions.

Maintain the optimum asphalt ratio for all mixes, or adjust it if necessary based on interaction with microsilica.

4. Laboratory Testing:
A series of mechanical tests will be conducted to evaluate the performance of the mixes, including:

Marshall Stability and Flow Test
……………………………………………………..
……………………………………………………..
……………………………………………………..
……………………………………………………..
……………………………………………………..

………
……………………………………………..

Eccentric Retaining Wall Design

Prepared by:

200- **Ahmed Fahdil Abdul Hamza**	201- **Rulla Mahdi Mohammed**	202- **Isra Salma**
203- **Saba Abdul Razzaq**	204- **Ibrahim Hasan**	205- **Zainab Sa'ad**

Supervised by:
Prof. Dr. Najah M. L. Al- Maimuri

Sustainable Development Goals Performed: **Infrastructures**

Abstract

The project involved designing an 11 m high eccentric cantilever retaining wall challenged by groundwater at 6.9 m, compromising stability. To address this, 115 piles and drainage systems were added. The final design achieved safety factors of 3 for overturning and 19.7 for sliding, ensuring full stability.

Methodology

1- Geometrical Design
2- Vertical and horizontal forces calculations using the equation of earth pressure theory.
3- Check design against overturning moments using equilibrium equations.
4- Check design against bearing capacity using Meyerhof's theory.
5- Check against settlement limitations.
6- Design of piles foundation (the structure constitutes positive and negative skin frictions piles.
7- Design of Drainage system by using Manning's Equation.
8- Design of filter using sieve analysis and a standard procedure.
9- Design of well points system required to protect the project from the groundwater threads.

Results and conclusions

Results and conclusions:

Proj.No.19 — Using Management Triangle to Measure the Performance of Construction of University New Campus Project
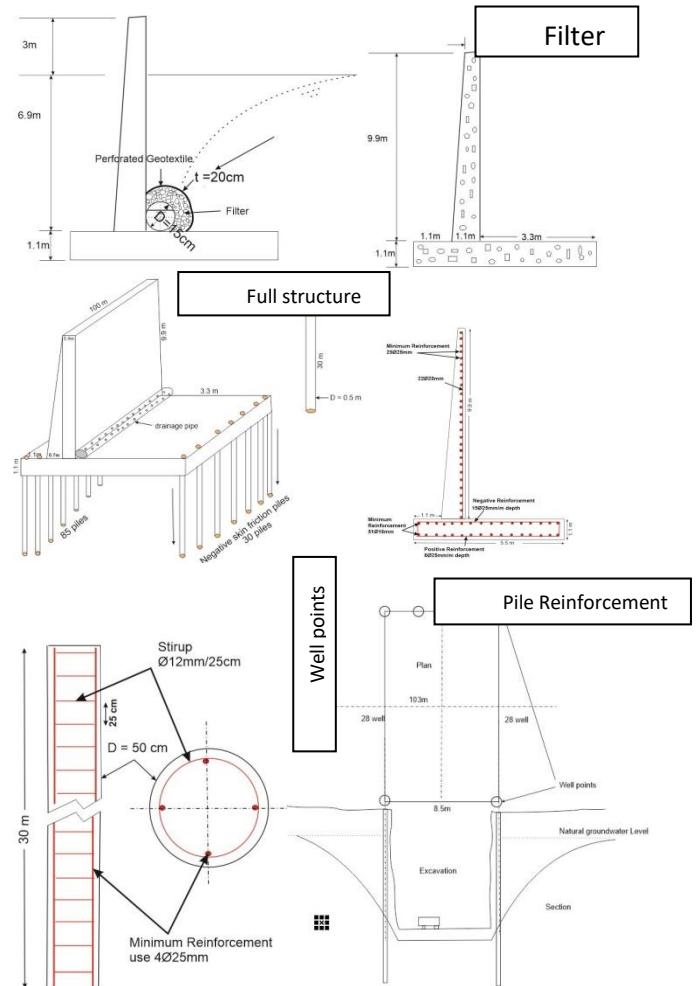
Prepared by:

| 206- | Mohammed Khlaif Flaifel | 207- | Luqman Abbas Hani | 208- | Esraa Adel Mahdi |
| 209- | Karar Fawzi Hammadi | 210- | Haider Mohammed Hasan | 211- | |

Supervised by:

50- Aqil Abd al-Hassan   51- Bareq A. Abdulhadi

Sustainable Development Goals Performed:

Abstract

Abstract:
This study introduces a mathematical tool using the management triangle to evaluate project performance based on time, cost, and quality priorities. Applied to ten construction projects in Hilla, Iraq, results show quality as the top priority, followed by time and cost, with an average deviation of 19.7 indicating unbalanced priorities.

Methodology

Methodology The methodology of this research includes two main parts:

Theoretical part: A literature review is conducted to introduce the traditional management triangle, focusing on time, cost, and quality.

Practical part: A field survey is carried out on an actual construction project to measure the three key components—time, cost, and quality—allowing the proposed method to be practically applied and analyzed.

Results and conclusions

Results and conclusions:
Following are the conclusions that can be obtained from this study:

1- The triangle of management can be used to represent numerically the performance of the construction projects. From this representation the priorities of time saving, cost saving and quality satisfaction can be obtained for each project. The deviations from the ideal case (achieving ideal time, cost and quality requirements) can be obtained also.

2- An application is made on ten construction projects executed in Iraq-Hilla . Results showed that quality is the first priority followed by time and the last priority is the cost requirement. The mean value of the deviation in all construction projects is 19.7 which is reflecting the unbalancing in priorities.

Proj.No.20

Assessing the Impact of Recycled Concrete Aggregate on the Mechanical Properties of Hot Mix Asphalt Mixtures
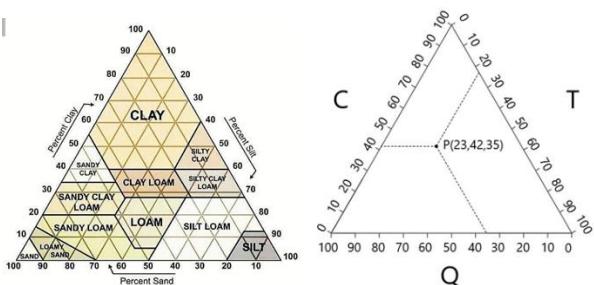
Prepared by:

212-	Yasir Hasan Hendi	213-	Mazin Hatem	214-	Wurood Faris Sattar
215-	Mohammed Hussein	216-	Sajad Dhahir	217-	Ali Khudair
218-		219-		220-	

Supervised by:

52- Senior Lecturer Tameem Mohammed H.   53- Assistant Lecturer Fatima Muslim

Sustainable Development Goals Performed:

Abstract

Recycling concrete waste not only addresses waste disposal challenges but also reduces the need for quarrying virgin aggregates. Incorporating recycled concrete as a hot-mix asphalt (HMA) aggregate presents a cost-effective and environmentally friendly solution, particularly advantageous for the construction of low-volume roads.

Recycled Concrete Aggregate (RCA) differs from natural aggregate due to the presence of residual cement paste and contaminants, which contribute to its low density and high porosity. These characteristics often result in poor engineering properties, which is the primary reason RCA is generally not recommended as an aggregate for Hot Mix Asphalt (HMA).

In this study, the performance of HMA mixtures incorporating RCA was quantitatively evaluated based on volumetric properties. Asphalt mixtures were prepared with four different RCA content levels (0%, 20%, 40%, and 60%) by weight of the total aggregate. The mix design results revealed that RCA is highly absorptive. As the percentage of RCA increased in the mix, the optimum asphalt content also increased linearly, resulting in reduced stability, flow, and density, along with a higher air void content.

Methodology

RCA is major part of industrial waste. In general, after appropriate processing more the major part of materials meets the technical properties for reuse information about RCA to promote its usage as providing confidence in increase a road construction aggregate regarded as an impact. RCA terms of its engineering material with limited economic potential, can be identified as potentially having suitable material characteristics for a surface coarse aggregate and may provide an ideal solution to minimize the problems of raw materials exhaustion while providing other benefits. Since the last decade, Iraq various economic and environmental campaign especially in the construction field. Witnessed wide development industry to reduce costs there is an increasing pressure on the end improve the quality of our environment. The fact is that both of these goals can be achieved at the same time. This project focused on utilization of RCA in hot mix asphalt for surface layer.

For this purpose, the waste concrete was crushed manually and tested to determine their properties, to be used as coarse aggregate in the mixtures through blending with four different percentages of RCA (0%, 20%, 40%, & 60%) then the prepared specimens tested by Marshall test to determine their volumetric properties (Stability, Flow, Air voids, and Bulk sp.gr)

Results and conclusions

- Total air voids content increases by increasing the percent of RCA in the mix, that can be explained through higher absorption of bitumen by RCA particles in comparison with virgin aggregate particles, causing high air content in the mix.
- Stability value decreases by increasing the percent of RAC in the mix, due to low cohesion powers between the particles in the recycled mixtures, as a result of decreasing the free bitumen in the mix by adding RCA.
- Bulk specific gravity decreases by increasing the percent of RAC in the mix, due to increase the air content by increasing the percent of RCA.
- Flow values initially increased at (20% & 40%) of RCA, then it starts to decrease at 60% of RCA and it will continue to decrease by increasing the percent of RCA.

In term of conclusion

1. Total air voids content increases by increasing the percent of RCA in the mix. At 20% RCA the air voids increased by 6.6%, at 40% RCA air content increased by 11.11%, and at 60% RCA the mentioned value increased by 24.44%.

2. Stability value decreases by increasing the percent of RAC in the mix. At 20% RCA stability value decreased by 10.9%, at 40% RCA stability value decreased by 16.83%, and at 60% RCA the mentioned value decreased by 23.76%. All the values of stability in the recycled mixtures at (20%, 40% & 60%) RCA are within the limits of Iraqi standards (SCRB, R/9 2003).

3. Bulk specific gravity decreases by increasing the percent of RAC in the mix. At 20% RCA density value decreased by 2.6%, at 40% RCA density value decreased by 3.91%, and at 60% RCA the mentioned value decreased by 2.6%.

4. Flow values initially increased by (15.38%) at (20% & 40%) of RCA, respectively. At 60% RCA flow value increased by 7.7%. All the flow values in the recycled mixtures at (20%, 40% & 60%) RCA are within the limits of Iraqi standards (SCRB, R/9 2003).

Proj.No.21

Study of the effect of marble cutting plant waste as an alternative to coarse aggregate on some properties of concrete.

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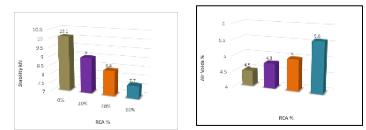
Prepared by:		
1- Farhan Attia Saguf	2- Ahamd Mohamed Najim	3- Farkad Abass Hamza
4- Azhar Ali Daily	5- Hussain Talib Hussain	6- Aziz Raheem Hadi
7-	8-	9-

Supervised by:	
1- Assist Lect. Merzah K . Imran	2- Assist prof. Dr Omran Issa Mohammd

Sustainable Development Goals Performed:

Abstract

Abstract:

……………………………………………..

In This experimental study presents the variation in the strengths (compression and tension) of concrete when replacing aggregates by waste marble from 0% to 80% in steps of 0%, 20%,40%,60% & 80%. They were tested the mix at each of the ages 7, 14, and 28 days . C30 grade of concrete mix design is taken for study.

……………………………………………..

Methodology

Various materials to be used in this research include Cement,Coarse Aggregate,Waste Marble Aggregate ,Fine Aggregate and Admixture. To investigate the effect of waste marble on concrete, five different specimens were casted , cure and tested at an interval of 7 days, 14 days and 28 days. After the evaluation of their strength the results were compared to control mix concrete A design mix C30 grade was adopted to prepare test samples.
. Experimental variables were: Compressive strength.and Splitting tensile strength.

Results and conclusions

This research is an experimental approach to substitute natural aggregates by the waste marble aggregates; the concern is more scientific than economical and environmental. The results obtained demonstrated the performance of various concrete mixtures which may help to understand the behaviour of these marble aggregates From our project we have obtained the maximum compressive and tensile values for 40% replacement of aggregate with marble. Analysis of these results has revealed that the appropriate incorporation of marble waste aggregates can lead to interesting characteristics in terms of strength, indeed the use of marble aggregates resulted in a considerable increase in the compressive and tensile strength.

It can be concluded that, marble waste as coarse aggregate can be used to improve the mechanical properties of conventional concrete. From the economic and environmental point of view this waste can be successfully used as coarse aggregates in concrete production.The marble waste can be used as alternative aggregates for concrete and for many other purposes such as bricks manufacturing, road construction and landfills.

PART FOUR

PROJECTS OF

Chemical Engineering and Petroleum Industries Department

Proj.No.1		**Prepared by:** Biogas
	3.منتظر حيدر علي	composition (methane and CO₂) was measured, and digestate was analyzed for
Supervised by: Dr. ABBAS JAWAD SULTAN		ilizer

Sustainable Development Goals Performed:	Goal 12: Responsible Consumption and Production

Abstract:

Anaerobic digestion (AD) is a biochemical process that converts organic food waste into biogas and digestate under oxygen-free conditions. This process involves four key stages—hydrolysis, acidogenesis, acetogenesis, and methanogenesis—that break down complex matter into methane (CH_4) and carbon dioxide (CO_2).

From 1,000 kg of food waste (80% moisture), the process yields approximately 153 m³ of biogas (60% CH_4 and 40% CO_2), with an energy potential of 920 kWh. It also produces 64 kg of solid digestate and 800 kg of liquid effluent, both useful as biofertilizer.

Biogas yield efficiency depends on factors like waste composition, ~80% VS degradation, temperature, pH, and retention time. This highlights AD as a sustainable, waste-to-energy solution for renewable energy generation and organic waste management.

Methodology:

- This study focuses on biogas production from food waste using a Continuous Stirred Tank Reactor (CSTR). The methodology includes:

- Feedstock Preparation: Food waste (fruits, vegetables, dairy, meat) was collected, sorted to remove non-biodegradable materials, and shredded for better digestion.

- Reactor Operation: The CSTR operated at mesophilic temperature (35–40°C) with continuous stirring to ensure uniform mixing.

- Anaerobic Digestion Stages: The process included hydrolysis, acidogenesis, acetogenesis, and methanogenesis to convert waste into methane and carbon dioxide.

- Process Control: Key parameters such as pH (6.5–7.5), retention time (20–30 days), and carbon-to-nitrogen ratio (20:1–30:1) were monitored and maintained.
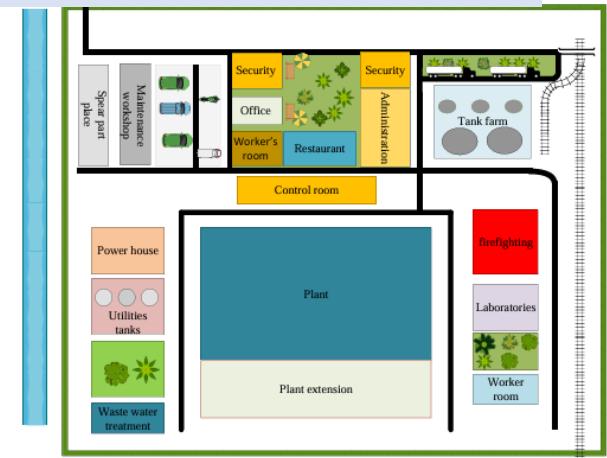
Results

The reactor and heat exchanger were designed based on standard chemical engineering principles, including thermal, mechanical, and economic considerations. Presents the design of a Continuous Stirred Tank Reactor (CSTR) and a Shell and Tube Heat Exchanger. The CSTR has a 0.5 m³ volume and operates at 1.1 bar, with a 2025 estimated cost of $17,282. The preheater is a horizontal exchanger with counter-current flow, 2 m² heat transfer area, and an estimated cost of $105,431. Both designs considered key factors such as dimensions, pressure, heat transfer, and updated cost estimates.

Prepared by:		
3.منتضر عقيل عبدالرزاق	2. كرار اسماعيل عباس	1.ياسين خضير عباس
		4. كاظم جاسم ابراهيم
Supervised by: Dr. Khalid Omran Ali		

Sustainable Development Goals Performed:	Goal 7: Affordable and Clean Energy

Abstract: This research explores the enhancement of refinery furnace efficiency through the implementation of various design parameters. Key factors affecting furnace performance, such as combustion efficiency, heat losses, and thermal flow management, were analyzed. A case study on material and energy balance was presented, with calculations estimating operational efficiency and heat loss reduction. Additionally, the environmental impacts of furnace operation, including greenhouse gas emissions, thermal pollution, and waste management, were examined along with mitigation strategies. The study recommends the adoption of heat recovery technologies, low-emission combustion systems, and the integration of clean energy sources to improve furnace efficiency and minimize environmental impact.

Methodology:

This study adopts a combination of theoretical analysis, process simulation, and case study evaluation to assess the impact of different design parameters on furnace efficiency.

1. Literature Review:
*   A comprehensive review of past studies related to refinery furnace efficiency, including design advancements, energy-saving techniques, and CFD-based optimization models.
2. Material and Energy Balance Calculations:
*   Development of a material balance model

*
*   to quantify fuel input and product output.
*   Establishment of an energy balance model to determine heat losses and efficiency metrics.

3. Case Study Analysis:
*   Selection of an industrial refinery furnace as a reference system.
*   Performance assessment based on real operating data and comparison with proposed modifications.

Results:

this established a comprehensive energy balance model for a refinery furnace operating under steady-state conditions. The total energy input from fuel combustion was calculated as 54.35 GJ/h, with 85% of this energy (46.2 GJ/h) effectively utilized in heating crude oil from 150°C to 370°C. The remaining energy was lost through:

Flue gases: 10% (5.43 GJ/h)

Radiation and convection: 5% (2.72 GJ/h)

The energy balance clearly demonstrates the furnace's efficiency and highlights areas for potential improvement. Strategies such as waste heat recovery, air preheating, and enhanced insulation materials can significantly reduce energy losses and enhance thermal efficiency. By addressing these losses, the refinery can optimize fuel consumption, reduce emissions, and lower operational costs.

PRODUCTION OF DIMETHYL ETHER (DME) (50,000 TON/YEAR)

Prepared by:	
	اس عبدالحسن عطشان
	مفر علي
Supervised by: Dr. Abass Jwad Sultan	

Sustainable Development Goals Performed:	Goal 7: Affordable and Clean Energy

Abstract: Dimethyl ether (DME) is an organic compound with the formula of CH3OCH3 , used primarily as a propellant. It is miscible with most organic solvents and it has a high solubility in water. Recently, the use of DME as a fuel additive for diesel engines has been investigated due to its high volatility (desired for cold starting) and high cetane number. A feasibility study on the production of 99 wt% dimethyl ether (DME) is to be performed. The plant is capable of producing 50,000 tons of DME per year. The goal is to design a grass-roots facility, which safely and efficiently produces DME. The production of DME is via the catalytic dehydration of methanol over an amorphous alumina catalyst treated with 10.2% silica. A methanol conversion of about 80% is achieved in the reactor.

Methodology:

ethodology

In this study, dimethyl ether (DME) is produced via the methanol dehydration method due to its high yield, cost-effectiveness, and ability to produce DME with purity up to 99.99%. The process starts with mixing fresh and recycled methanol, followed by preheating through a feed-effluent heat exchanger (FEHE) and complete vaporization in a furnace. The vapor then enters a fixed-bed gas-phase reactor operating at 250–400 °C and up to 20 bar, where methanol is partially converted to DME and water. The reactor effluent is used to preheat the feed and generate steam for downstream distillation. The hot vapor enters the first distillation column (COL-1) at 10 bar to separate high-purity DME as a top product. The bottom stream (methanol and water) proceeds to the second column (COL-2), where methanol is recovered and recycled, and water is removed as a by-product. The methodology ensures thermal efficiency by heat integration and is illustrated in Figure

Results:

The
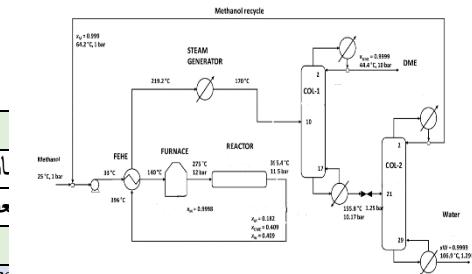
material balance for the production of dimethyl ether (DME) was based on a production capacity of 50,000 tons per year and 330 working days, yielding a DME output of approximately 135.87 kmol/hr at 99% purity. The primary reaction converts methanol (MeOH) into DME and water in a 2:1:1 molar ratio, with a methanol conversion of 80%. Accordingly, the fresh MeOH feed to the reactor was 339.67 kmol/hr, resulting in outlet streams of 135.87 kmol/hr of DME, 135.87 kmol/hr of H_2O, and 67.93 kmol/hr of unreacted MeOH. In the first distillation column, DME was separated at 99% purity with 1.37 kmol/hr of MeOH as an impurity in the top stream, while 66.56 kmol/hr of MeOH and 135.87 kmol/hr of water were recovered in the bottom stream. The second column separated 95% of the water (129.08 kmol/hr) as bottom product, while the remaining 6.79 kmol/hr of water and all the MeOH (66.56 kmol/hr) were recycled. This led to a recycle ratio of 19.6%, reducing the required fresh MeOH feed to 273.11 kmol/hr. After mixing with the recycled MeOH, the total feed to the reactor remained at 339.67 kmol/hr. The system was confirmed to be balanced, with all inlet and outlet moles accounted for, ensuring a stable and continuous production process.

Production of anti-viral, anti-bacterial and anti-infectious solid surface paints

Prepared by:		
	3. سكينة فريد	1. امير قحطان
	4. زيد خالد	2. كرار مكي

Supervised by: Assistant Professor Dr. Fawzi Abdel Rahman Hamadi Al-Qaessi

Sustainable Development Goals Performed:	Goal 3: Good Health and Well-being

Abstract:

The growing global demand for cleaner and safer environments has led to the advancement of anti-viral, anti-bacterial, and anti-infectious surface paints that actively inhibit the growth and transmission of harmful microorganisms. This research investigates the formulation of these innovative coatings, which utilize modern technologies such as nanoparticles (e.g., silver, copper, titanium dioxide) and photocatalytic agents to create self-sanitizing surfaces with long-lasting antimicrobial properties. These paints are designed not only to be effective against a wide range of pathogens—including SARS-CoV-2, E. coli, and Staphylococcus aureus—but also to minimize cross-contamination risks in healthcare facilities, public spaces, and homes. The study emphasizes the materials and mechanisms that enhance their antimicrobial performance, along with experimental evaluations of their efficiency and safety. With further development, these coatings are expected to play a transformative role in public health by enabling the widespread adoption of smart, self-cleaning, and hygienic surfaces.

Methodology:

This study focuses on developing antiviral and antibacterial surface coatings by formulating paints that combine resins with nanomaterials such as silver nanoparticles, copper oxide, titanium dioxide, and graphene. The production process involves selecting raw materials, mixing them for uniform dispersion, and adjusting properties like viscosity and adhesion. The coatings undergo rigorous laboratory testing to evaluate their antimicrobial effectiveness against bacteria like E. coli and Staphylococcus aureus, as well as viruses such as SARS-CoV-2. Tests also assess physical properties including hardness, chemical resistance, and durability under environmental stresses like humidity and UV exposure. Following successful lab validation, the coatings are produced industrially with strict quality control and safety certifications, then applied in real-world settings such as hospitals and public spaces to reduce microbial contamination and improve hygiene.

Material Balance Results

| Unit	Input (Kg/day)	Output (Kg/day)	Notes
Feed Tank (T-101)	7000	5950	60% Alkyd resin (4200 kg) 10% TiO₂ pigment (700 kg) 10% Cobalt Naphthenate (700 kg) 5% Formaldehyde (350 kg)
Weight Tank (WE-101)	5950	5950	Mixture from feed tank
Mixer (M-101)	5950	5950	Continuity maintained
Ball Mill (BM-101)	5950	5950	No loss
Mixer (M-102)	5950 + 1050 (Solvent Toluene) = 7000	7000	Added 15% Toluene (1050 kg)
Hopper (HO-101)	7000	7000	Final product

| Prepared by:		
	3. محمد حسين	1. كرار رزاق
	4. مرتضى حسين	2. حسين عزيز
Supervised by: Assist .Pro. Dr.Alaa Dhari Jawad		
Sustainable Development Goals Performed:	Goal 7: Affordable and Clean Energy	

Abstract

The utilization of solar energy for industrial process heating offers a sustainable alternative to fossil fuels, addressing both energy efficiency and carbon emission reduction goals. Industrial processes—especially those requiring low to medium temperature heat (up to 400°C)—present a significant opportunity for solar thermal integration. This research investigates the technical feasibility, performance potential, and economic viability of incorporating solar thermal systems into industrial operations. Technologies such as flat-plate collectors, evacuated tube collectors, and concentrating solar systems (e.g., parabolic troughs and linear Fresnel reflectors) are examined for their capacity to meet varying thermal demands.

Methodology:

This study utilizes a direct solar thermal system based on parabolic trough collectors to heat a heat transfer fluid (HTF) up to 390–400 °C, suitable for industrial applications. A single-tank thermocline thermal energy storage (TES) system with mixed media (rock and sand) is integrated to reduce costs and ensure energy availability during non-solar hours. The TES delivers hot HTF at 275 °C to the power block, enabling the production of superheated steam at 325 °C and 40 bar for electricity generation via a Rankine cycle. This approach offers improved efficiency, cost-effectiveness, and reliable thermal performance for continuous process operation.
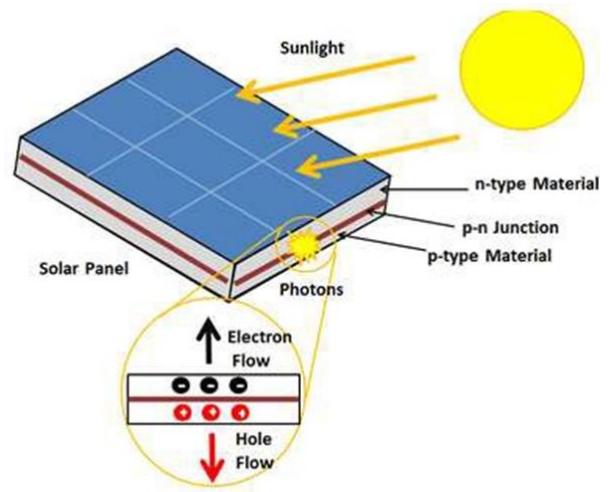
Condenser Design

Horizontal centrifugal pump was designed to operate at an outlet pressure of 10 MPa, with an equivalent pipe length of 22 meters and inlet/outlet diameters of 0.016 m and 0.041 m, respectively. The total head was calculated to be 43 meters, and the mechanical design was completed. The updated cost of the pump for the year 2025 is approximately $141. The condenser was designed as a shell-and-tube heat exchanger to condense steam using cooling water, with a heat duty of 2.03 MW and a required heat transfer area of 18.3 m². Cupro-Nickel tubes were selected with an outer diameter of 20 mm and a length of 4 m, totaling 74 tubes. Heat transfer coefficients for both tube and shell sides were calculated, along with the mechanical thickness of the shell and head. The total estimated cost of the condenser in 2025 is approximately $12,162.
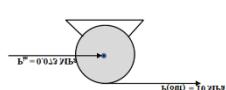
Environmental Effect

Solar energy is clean during use but its production involves energy use and hazardous materials. Large plants may affect land, water, and wildlife. Still, it remains a more sustainable alternative to fossil fuel

	Prepared by:	
	3.حسين ايسر	1. احمد محمد عبدالزهرة
	4.جعفر حسن محمد	2. حسين فالح

Supervised by: Dr. Mahdi Shenshel Jafar	
Sustainable Development Goals Performed:	Goal 6: Clean Water and Sanitation

Abstract: This project examines the use of Biomembrane Technology to treat wastewater from electric power plants, which consume large amounts of water and discharge pollutants like chemicals, heavy metals, and organic materials. These pose serious environmental and health risks, making treatment essential for sustainability. The study reviews physical, chemical, and biological treatment methods. While physical and chemical methods are partially effective, Biomembrane Technology, especially Membrane Bioreactors (MBRs), stands out for combining biological degradation with filtration, achieving high efficiency and water reuse potential. The project covers pollutants, treatment technologies, mass and energy balances, equipment design, environmental impacts, and plant layout. It supports SDG 6 (Clean Water and Sanitation) by promoting sustainable, low-energy, and efficient wastewater solutions.

Methodology:

The design methodology for the submerged Membrane Bioreactor (MBR) system involved calculating the required membrane area based on the target flowrate and net flux, including a safety factor to account for fouling and aging. Commercial membrane modules were selected and configured for submersion in the bioreactor's aerobic zone, ensuring proper aeration and scouring to maintain membrane permeability. The aeration system was designed separately for biological treatment and membrane cleaning, calculating the necessary airflows and blower power requirements.

A variable-speed blower was specified to deliver sufficient air at the required pressure, integrated with a PLC control system for monitoring and optimization through dissolved oxygen feedback. This systematic approach ensured an efficient, scalable, and operable MBR design.

Equipment Design

The submerged MBR system treats 1 m³/h with a membrane area of 60 m² using three modules, operating 20 hours/day at ≤0.5 bar TMP. Aeration includes 5.35 m³/h for biological treatment and 15 m³/h for membrane cleaning, supplied by a 25 m³/h blower with 0.6 kW power, controlled via PLC with oxygen sensor feedback, using fine and coarse bubble diffusers for efficient operation.

Results and conclusion:

The wastewater treatment system is based on an MBR unit with a capacity of 1000 L/h, comprising initial pretreatment that removes about 5% of total suspended solids (TSS), followed by biological treatment which reduces 91% of BOD_5 and 75% of ammonia, producing around 0.77 kg of sludge daily. The treated water then passes through membrane filtration removing 95% of remaining BOD_5, 98% of TSS, and 50% of ammonia, followed by a disinfection stage that achieves 99.9% microbial inactivation with additional BOD_5 reduction. Influent pollutant concentrations start around 200 mg/L TSS, 85 mg/L BOD_5, and 8 mg/L ammonia, and are reduced to less than 4 mg/L TSS and below 1 mg/L BOD_5 and ammonia in the treated effluent, ensuring high-quality water that meets environmental standards.

Oxide Nanoparticle Synthesis Using Pulse Laser Ablation And Optical Physicochemical Analysis

Prepared by:		
3. عبدالله داخل عبود	2. علي عباس جابر	1. حيدر جواد كاظم

Supervised by:Nooruldeen Saad Abis	
Sustainable Development Goals Performed:	Goal 9: Industry, Innovation, and Infrastructure
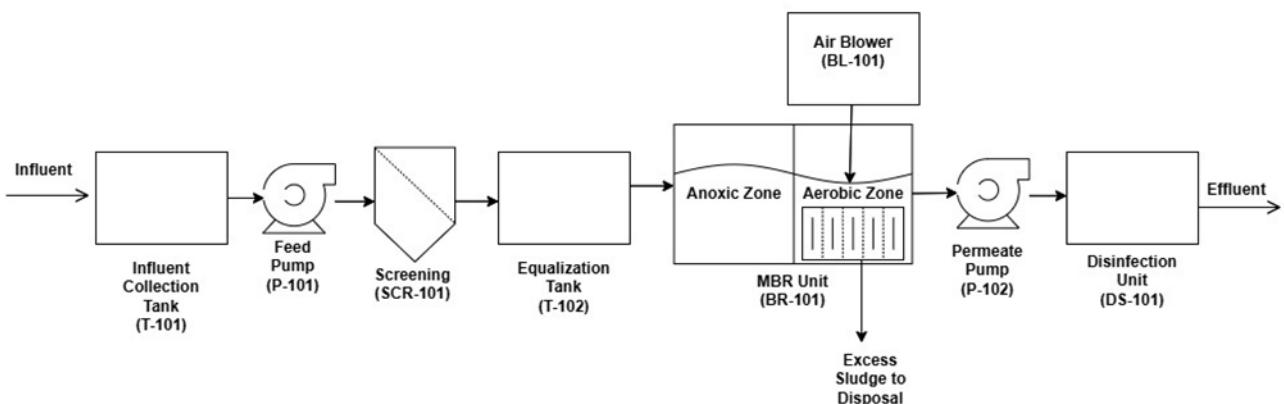
Abstract :

This research focuses on synthesizing oxide nanoparticles (NPs) using the Pulse Laser Ablation in Liquid (PLAL) method, a clean and versatile technique. It examines how process parameters affect NP formation and analyzes their structural, optical, and chemical properties, emphasizing quantum effects and surface defects. Mass and energy balances were performed to evaluate process efficiency, and a site selection strategy was proposed for scaling up production. The study advances sustainable, precise synthesis of oxide NPs for applications in biomedicine, photonics, and energy.

Methodology :

Nanoparticles of metal and metal oxides were synthesized using the Pulsed Laser Ablation in Liquid (PLAL) technique, where a solid target immersed in deionized water or aqueous solution was irradiated by a pulsed Nd:YAG laser (wavelengths 1064 nm and 355 nm, pulse duration 3-6 ns, repetition rate 10 Hz). The target was rotated to ensure uniform ablation, producing plasma that cools to form nanoparticles suspended in the liquid. Laser parameters such as pulse energy, wavelength, and number of pulses were adjusted to control nanoparticle size and yield, with size monitored by spectroscopic analysis of atomic emission lines. The produced nanoparticles were collected on substrates for characterization by Atomic Force Microscopy (AFM) and Scanning Electron Microscopy (SEM) to examine morphology and size. Additionally, optical emission spectroscopy, laser-induced fluorescence, and laser-induced breakdown spectroscopy were used to analyze plasma properties and elemental composition. This PLAL method enables chemical-free, controlled synthesis of pure metal and metal oxide nanoparticles with tailored size and structure.
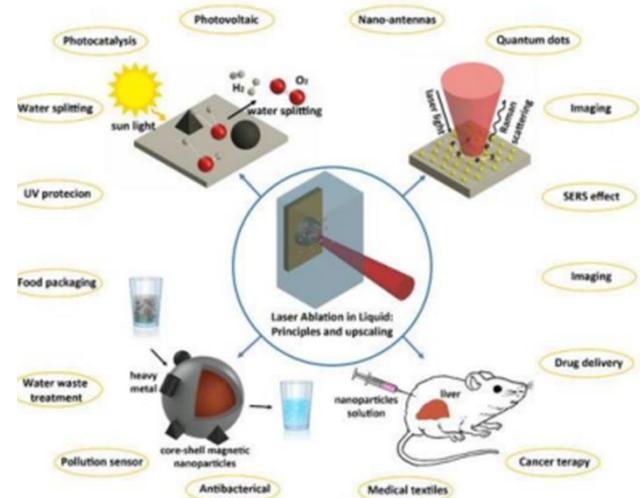
Results and conclusions :

The material and energy balances for pulsed laser ablation of a zinc target in water were analyzed, showing that 0.15 g of zinc was ablated in 30 minutes, producing a nanoparticle concentration of 3 g/L. The total laser energy input was 1800 J, corresponding to an energy consumption of 12,000 J per gram of nanoparticles produced. Laser-to-plasma conversion efficiency ranged from 20–30%, with 50–60% energy lost due to heat and scattering, resulting in about 540 J of effective energy for nanoparticle generation. Theoretical models, including the Bernoulli equation, accurately predicted water jet velocities, and higher laser pulse energies increased plume thickness and length. Although PLAL is more energy-intensive than conventional chemical synthesis, it produces high-purity nanoparticles without chemical reagents and offers potential efficiency improvements through advanced laser parameters and heat recycling techniques.

Removal of Heavy Metals from Industrial Wastewater in Petroleum Refinery

Prepared by:		
3.ابراهيم صلاح علي	2. فرح زيد سامي	1. زينب حيدر محمد

Supervised by: Dr. Abbas Khaleel Ibrahim Al-Gburi

Sustainable Development Goals Performed:	SDG 14: Life Below Water
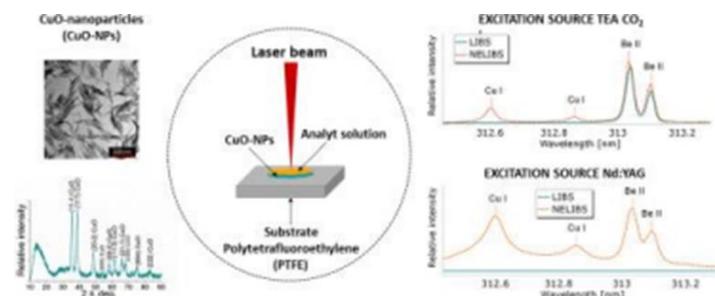
Abstract:

The treatment of heavy metals in petroleum refinery wastewater (PRWW) is vital due to the toxic and persistent nature of metals like arsenic, cadmium, and lead. Traditional methods are often costly and environmentally damaging, leading to a shift toward more sustainable techniques. This study reviews key treatment methods such as chemical precipitation, adsorption, membrane filtration, and bioremediation, highlighting their effectiveness and environmental impact. It emphasizes the development of cost-effective, eco-friendly solutions to help refineries meet regulations and minimize their ecological footprint.

Methodology:

The methodology of this study involves a comparative analysis of treatment technologies used to remove heavy metals from petroleum refinery wastewater (PRWW). A systematic literature review was conducted to identify common contaminants and evaluate the performance of methods such as chemical precipitation, membrane filtration, coagulation–flocculation, and air flotation. Each method was assessed based on removal efficiency, operational cost, sludge generation, and environmental impact. Particular focus was given to chemical and membrane-based techniques due to their widespread use and potential for sustainability. The study also considered the feasibility of applying these methods at industrial scale, aiming to support cleaner production and compliance with environmental regulations.
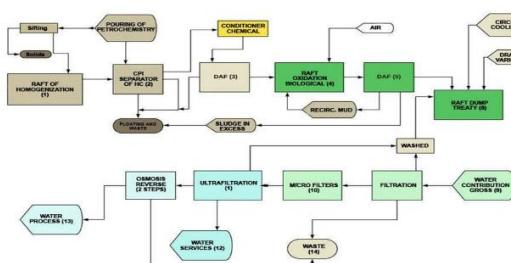
Results and conclusions

The primary wastewater stream generated from the oil refinery is characterized by a high content of organic and inorganic pollutants. The average flow rate of this stream was recorded as 10.68 m³/h. The Total Suspended Solids (TSS) concentration was found to be 55.2 mg/L, while the Total Dissolved Solids (TDS) reached a significantly higher value of 4800 mg/L. The Chemical Oxygen Demand (COD) of the stream was measured at 452 mg/L, indicating the presence of oxidizable organic compounds. Furthermore, the Biological Oxygen Demand (BOD$_5$) was determined to be 145 mg/L, suggesting a considerable amount of biodegradable organic matter. The Oil and Grease (O&G) content in the wastewater was found to be 14.6 mg/L, reflecting the nature of the stream as a byproduct of petroleum processing activities.

Recycling of polymer product for Sustainability of raw material

Prepared by:		
3.مصطفى قاسم علي	2. سجاد محمد زويد	1. قاسم عباس حسن
Supervised by: Dr. Anwar Qasim Saeid		

Sustainable Development Goals Performed:	Goal 13: Climate Action

Abstract:

Waste LDPE samples were degraded between 475–600°C using thermal and catalytic pyrolysis with silica-alumina catalyst. Liquid product yield increased with temperature up to 550°C for both methods, with catalytic pyrolysis reducing the reaction time. Different catalyst ratios (4:1 and 8:1) were tested, where the 4:1 ratio gave higher yields while the 8:1 ratio caused a decrease. FT-IR analysis confirmed the presence of various functional groups in the liquid products, consistent with GC-MS results. The maximum product yield was achieved at 550°C using the 4:1 catalyst ratio.

Methodology:

In the practical part of this project, waste low-density polyethylene (LDPE) bottles were collected, cleaned, dried, and shredded into small pieces. Six 15 g samples were pyrolyzed at varying temperatures ranging from 450 °C to 600 °C using a controlled oven. During pyrolysis, the plastic decomposed into liquid, solid, and gaseous products, which were then separated and weighed using a sensitive balance. Mass and heat balances were calculated based on the material outputs and energy inputs, and the results showed that increasing temperature favored higher liquid yield with reduced solid residue. Physical property comparisons between LDPE and the resulting liquid fuel were conducted. Additionally, a continuous pyrolysis reactor was designed, including reactor volume estimation and heat transfer analysis. The design extended to a jacketed vessel, where internal and external heat transfer coefficients, as well as the overall heat transfer coefficient, were calculated using thermodynamic and fluid mechanics equations. Results were validated using mass and heat balance diagrams to confirm the efficiency of the system.

Results and Conclusions:

The reactor cost, with a volume of 0.5464 m³ and dimensions of 0.8861 m in diameter and length, was calculated considering material and pressure factors, resulting in an adjusted cost of approximately $900.67 in 2017. The results showed that the pyrolysis of LDPE requires a long time to complete below 500°C, with liquid product yield increasing as temperature rises, reaching a maximum at 550°C. Catalytic pyrolysis enhanced the product yield, with the highest yield obtained at a 4:1 catalyst-to-LDPE ratio using silica-alumina catalyst at 550°C. The pyrolysis products mainly consist of alkanes, alkenes, aldehydes, ketones, and carboxylic acid functional groups. For future work, it is suggested to produce fuel oil from LDPE or polypropylene water bottles using vacuum pressure in the same process, convert gaseous and vapor products into light fuel fractions via catalytic processes, use fractional distillation to separate these fractions, and explore fuel oil production from rubber and resin wastes.
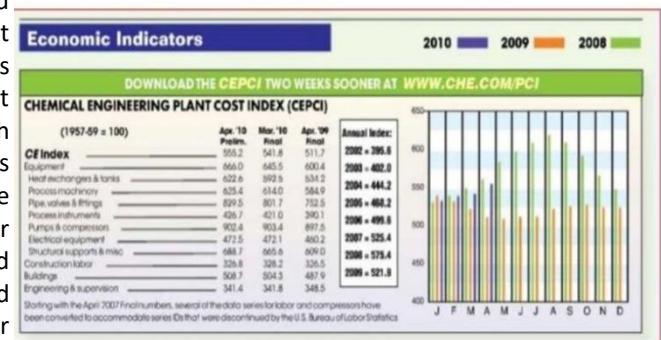
This study evaluates the environmental benefits of recycling one tonne of plastic waste in the EU compared to incineration and landfilling. It includes all stages from collection to recycling and credits the savings from replacing virgin materials and conventional energy. Different polymers have specific recycling rates and disposal mixes

PART FIVE

PROJECTS OF

Department of Biomedical Sciences

Proj.No.1   Detection of Liver Fibrosis Based on Deep Learning Techniques

Prepared by:

10- شمس الدين نصير عبد الجبار   11- احمد جواد عبد الحسن   12- علي رياض سعدون
13- محمد فريد علي نوري   14- نبأ موفق جبار   15- عباس ساطع محمد

Supervised by:

3- م.م زينب ستار جبار   -4

Sustainable Development Goals Performed:

Abstract	Results and conclusions

Abstract: This study presents an AI-based LRCN model using US/SWE images for liver fibrosis classification, achieving 98.18% accuracy and demonstrating strong potential for improving non-invasive clinical diagnostics.

Methodology

Methodology: This study developed a multi-class LRCN model to classify liver fibrosis stages (F0–F4) using US/SWE images. The model combines CNN for spatial feature extraction and LSTM for temporal analysis. It includes pre-processing steps, feature extraction through five Conv blocks, and classification via fully connected and LSTM layers. Trained with Adam optimizer and early stopping, the model showed improved accuracy, especially during testing, using both 80%-20% and 90%-10% train-test splits.

Results and conclusions: This study presents an AI system for classifying liver fibrosis stages (F1–F4 and normal) using Ultrasound Shear Wave Elastography (US/SWE) images. A hybrid Long-Term Recurrent Convolutional Network (LRCN), combining CNN and LSTM, was used to enhance accuracy by capturing both spatial and temporal features. Using 835 images with an 80/20 train-test split, preprocessing steps like auto-cropping, grayscale conversion, resizing, and CLAHE improved image clarity. While the CNN alone extracted spatial features well, the LRCN achieved higher accuracy and lower loss, confirmed by ROC and AUC metrics.

Implemented in Python with TensorFlow/Keras on an NVIDIA RTX4090, the system handled data scarcity in early/severe fibrosis stages effectively. Overall, the LRCN model outperformed CNN, showing strong potential for improving non-invasive liver fibrosis diagnosis in clinical settings.

Proj.No.2 — Developing A Device To Treat Muscle Laziness Using EMG Signals
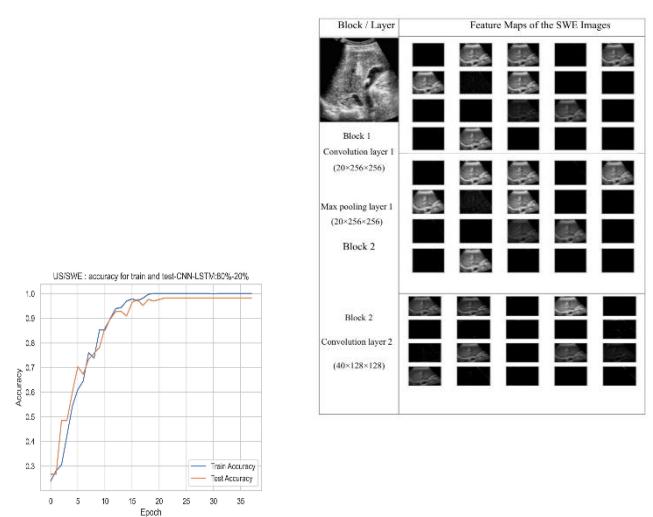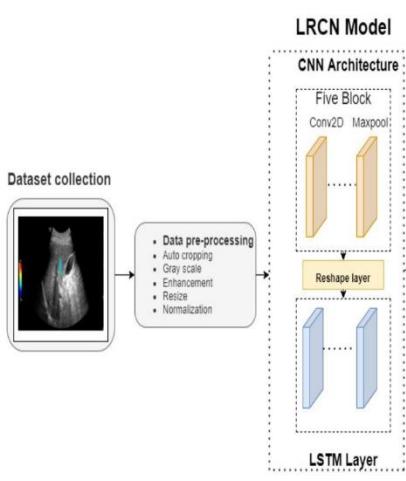
Prepared by:

16- Fatimah Ayad Abdulmohsen. 17- Zahraa Ahmed Mohsen Kamel. 18- Morsalin Saad Shakir.
19- Noor AlHussein Arkan Ali. 20- Abdullah AlKarrar Mohammed.

Supervised by:

5- Asst. Lect. Hiba Diaa Abdulameer.

Sustainable Development Goals Performed: SDG-9, SDG-3

Abstract

Abstract: A portable EMG-based device detects abnormal muscle signals and provides multi-level stimulation, aiding rehabilitation in stroke, sarcopenia, and nerve injuries, with confirmed effectiveness across three clinical cases.

Methodology

Methodology: The EMG-based stimulation device is built using Arduino Uno, an EMG sensor module, LCD display, stimulation unit, and safety circuits. It monitors surface EMG signals and delivers targeted electrical pulses to stimulate inactive muscles. The system operates in Manual or Auto Mode, with stimulation triggered either by the user or automatically based on threshold detection. A custom board manages power regulation and intensity control. The compact casing supports safe, portable, and low-cost rehabilitation use.

Results and conclusions

Results and conclusions: An EMG-based muscle stimulation device was tested in three cases—stroke, sarcopenia, and ulnar nerve injury—over 8 weeks. All patients showed improved EMG amplitude and muscle function. Gains ranged from 54% to 137%, with restored grip or movement. Therapy was safe, fatigue-managed, and well-tolerated. The device proved adaptable, effective across conditions, and promising for low-resource rehabilitation, highlighting its potential as an affordable alternative to conventional therapy.

Proj.No.3	Design of an Arduino-Based Smart Glove for Sign Language Translation
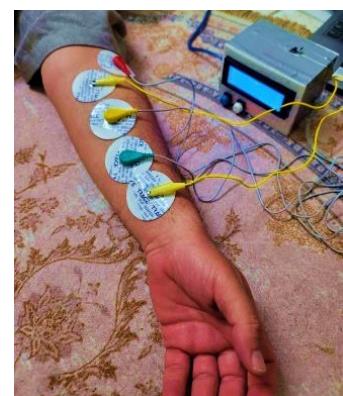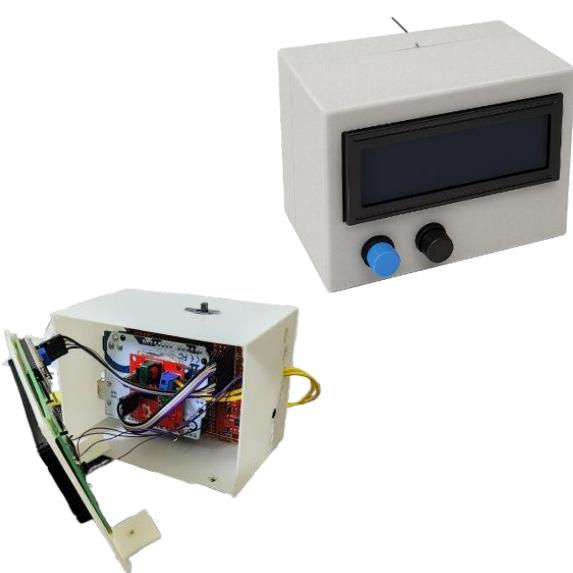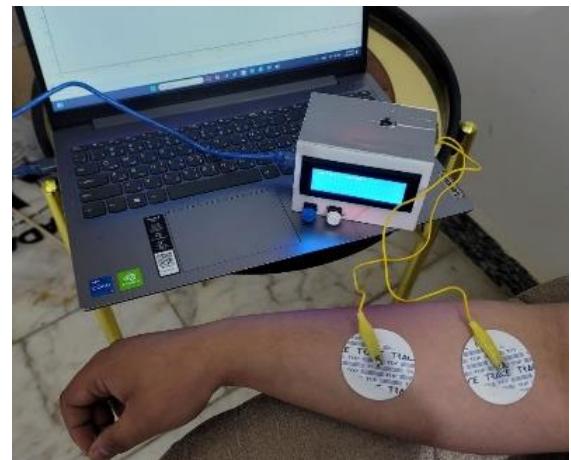
Prepared by:

21- Modaffar Naseer Shehab.   22- Hussein Rassool Abbas.   23- Noor AbdulKareem Ameen.
24- Nirjaes Abbas Abtaan.   25- Shawok Kamil Dawood.

Supervised by:

6- Asst.Lect. Hiba Diaa Alrubaie.

Sustainable Development Goals Performed: SDG-9, SDG-3

Abstract

Abstract:

This project presents a smart glove that translates American Sign Language into speech and vice versa using flex sensors and an ESP32 microcontroller, enhancing communication for the deaf and mute community.

Methodology

This project developed a smart glove system to translate sign language into text using flex sensors, an MPU6050 motion sensor, and an Arduino Uno Wi-Fi board. The glove includes an LCD display, audio module, and custom 3D-printed casing. It captures hand gestures, processes them, and outputs real-time translations. Designed for comfort and accuracy, the glove was tested on users with communication impairments across various environments to evaluate performance and usability.

Results and conclusions

Results and conclusions: four real-world case studies evaluating a smart glove system for individuals with hearing and/or speech impairments. The glove uses flex sensors and motion detection to translate sign language into speech or text.

Case 1: A 35-year-old man with acquired hearing and speech loss used the glove at work. It achieved 100% accuracy in translating common gestures, improving communication and confidence despite a limited vocabulary.

Case 2: A 22-year-old woman with congenital deafness used the glove in a semi-supervised setting. It translated daily and emergency gestures in under 1 second, enhancing her independence.

Case 3: A 10-year-old girl used it in a mainstream school to engage socially and academically, including asking questions and requesting meals.

Case 4: A 42-year-old mute man with a finger amputation used adapted gestures, which the glove still recognized accurately, showing adaptability to physical impairments.

The glove proved reliable, fast, and user-friendly across varied settings—work, home, and school. Despite its limited vocabulary, it demonstrated strong potential as an inclusive communication aid for users of different ages and abilities.
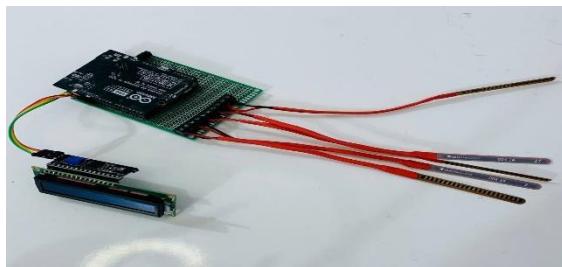
Proj.No.4   Diagnostic tests for brain tumor using machine learning.

Prepared by:

26- Ali Hadi Salah   27- Zainab Hassan Eidan   28- Duaa Rady Ismail
29- Hawra Kareem Nemeh   30- Wed Ibrahim Gharib

Supervised by:

Dr. Haider Jabbar Abdul Nassar

Sustainable Development Goals Performed: SDG-9, SDG-3

Abstract	Results and conclusions

Abstract:

This study uses machine learning to classify brain tumors from 3,064 MRI images into Meningioma, Glioma, and Pituitary types. Features were extracted using Gabor filters and statistical measures. SVM and KNN classifiers were tested, showing effective and accurate tumor classification. The results support the use of computer-aided diagnosis systems to improve speed and accuracy in brain tumor detection.

Results and conclusions:

Results from the machine learning models for brain tumor classification show that both SVM and KNN were trained and evaluated on the dataset. The SVM achieved 89% accuracy, while KNN outperformed it with 95%. Confusion matrices and performance plots supported these findings. Overall, MATLAB simulations demonstrate that traditional machine learning methods effectively classify brain tumors from MRI images.

Methodology

Methodology: A machine learning system was developed to classify glioma, meningioma, and pituitary brain tumors from MRI images. It uses statistical and texture features with SVM and KNN classifiers, trained and tested on labeled data. Performance metrics guide a comparison to identify the better model, aiming to assist radiologists in early, accurate diagnosis.

Prepared by:

31- Ali Aqeel Hadi.   32- Ghadeer Murtadha Ali   33- Hawraa Qasim Farhan
34- Mustafa Abdul-kareem Abbas   35- Teeba Abdul-Ameer Jaafer

Supervised by:

7- Dr. Ameen M. Al-Juboori   SDG-3

Sustainable Development Goals Performed:

Abstract

Abstract:

This project designs a lightweight orthotic arm controlled by EMG signals to help individuals with muscles weakness regain partial movement of the elbow and arm for improved independence in daily activities.

Methodology

Methodology:

The exoskeleton was designed, assembled, and tested through a structured methodology. Initially, the mechanical design was modeled using CAD software, followed by fabrication with stainless steel. The control system was developed using Arduino and programmed to track elbow motion using EMG and gyroscope sensors. The device was tested in flexion and extension modes on normal subjects to evaluate range of motion and system responsiveness.

Results and conclusions

Results and conclusions:

In recent years, the number of individuals suffering from physical impairments due to strokes, spinal cord injuries (SCI), or motor neuron disorders has increased significantly. These conditions often result in the loss of functional movement, particularly in the upper limb. Rehabilitation therapies supported by advanced assistive technologies have been proven to enhance patient recovery. In this context, a flexible, lightweight, and wearable exoskeleton was developed to provide both assistive and rehabilitative functions, primarily targeting elbow joint movements. The device utilizes surface electromyography (EMG) signals for control and includes a low-noise actuation mechanism, making it suitable for home- based use. Designed using 316 medical-grade stainless steel, the orthotic arm ensures a high safety factor, excellent corrosion resistance, and

a relatively low production cost.

Proj.No.6 — Investigation of Bioactivity Properties of Bioactive Glass-Ceramics for Bone Regeneration

Prepared by:

36- Mohammed murtadha enad 37- Zainab najah mohammed 38- Ali jassim hanidi
39- Haider arkan khalifa 40- Hajar Hussein abdul rahman

Supervised by:

Dr.Amir N.Saud

Sustainable Development Goals Performed: SDG-3

Abstract

Manganese-doped bioactive glass scaffolds enhanced hydroxyapatite formation, antibacterial activity, degradation rate, and pH response, demonstrating promising potential for advanced bone tissue engineering applications.

Methodology

This study synthesized 45S5 bioactive glass ceramics doped with Mn and La_2O_3 using the sol-gel method.

Samples were shaped, sintered, and immersed in simulated body fluid (SBF) to assess bioactivity. Characterization included XRD, SEM, FTIR, DTA, and antibacterial testing.

Hydroxyapatite formation, structural morphology, and biodegradability were evaluated over 1, 7, and 14 days to determine the material's potential for bone regeneration applications.

Results and conclusions

XRD revealed crystalline phases like sodium calcium silicate. After immersion in SBF, hydroxyapatite (HA) peaks appeared and increased over time, showing good bioactivity, especially in Mn-doped samples.
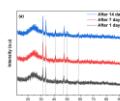
FTIR confirmed silicate and phosphate bonds. Manganese disrupted the silicate network and enhanced phosphate formation. After SBF immersion, stronger P–O peaks indicated HA layer growth.
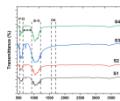
SEM/EDS showed a uniform HA layer on Mn-doped samples, while undoped glass had scattered HA particles. EDS confirmed calcium and phosphorus presence, supporting HA formation
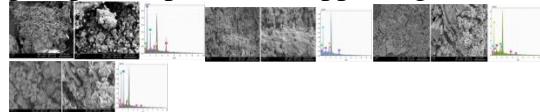
In conclusion, manganese addition enhanced the material's thermal and structural properties and promoted better HA formation, making it a strong candidate for bone regeneration applications.

| **Proj.No.7** | Manufacturing a rehabilitation chair for people with disabilities |

Prepared by:

41- Abdullah Ali Khalaf Hashem

42- Abdullah Abdulkarim Mahdi Kazem

3- Ali Laith Fadhel Abdulhussein

43- Ahmed Al-Ameen Arkan Ali Munji

44- Mohammed Raad Hashem Obais

Supervised by:

Dr. Mohammed Hamza Daham

Sustainable Development Goals Performed:　　　　SDG-9, SDG-3

Abstract

This project developed a low-cost rehabilitation chair for people with disabilities, especially amputees. It features a treadmill for walking exercises, a seat for rest, and integrated EMG sensors to monitor lower limb muscle activity in real time. Data is sent via Bluetooth to a mobile app for visualization and analysis. The chair is foldable, adjustable, and designed for easy use and transport, offering a multifunctional solution to support physical therapy and enhance mobility.

Methodology

 The project followed key stages: the rehabilitation chair was built using iron, motors, supports, and hydraulics for stability. A motorized treadmill with adjustable speed was controlled wirelessly. EMG sensors on the lower limbs captured muscle signals, which were processed by an Arduino and sent via Bluetooth (HC-05) to a custom mobile app. Developed using MIT App Inventor, the app displayed real-time graphs, stored data, and provided audio feedback on muscle improvement. Device setup photos are included below.
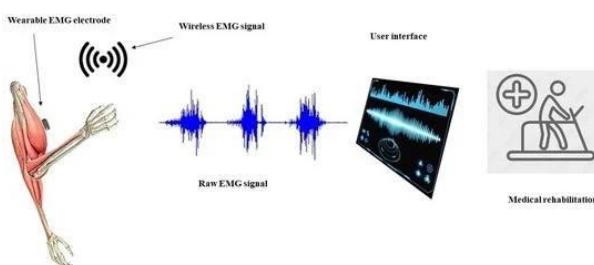
Results and conclusions

The rehabilitation chair was successfully developed with a treadmill, foldable seat, EMG sensors, and a Bluetooth-connected mobile app. Testing confirmed its effectiveness in tracking muscle activity and providing real-time feedback, leading to improved balance, gait, and mobility in amputees. Users reported greater confidence and motivation. The project highlights the value of EMG integration in personalizing therapy and monitoring progress. Future work will focus on enhancing the app and applying machine learning for automated analysis.

	A	B	C	D	E
1	رقم القمة	زمن التقريبي	سعة تقريبية	شكل القمة	التفسير
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3	2	1:17:08	عالية ٩٠μV	حادة ومركزة	نشاط عضلي قوي
4	3	1:17:12	متوسطة	مزدوجة	استرار التقلص
5	4	1:17:16	منخفضة	مشتتة	ارتخاء نسبي
6	5	1:17:20	عالية جدًا ١٠٠μV	طويلة	ذروة التقلص عضلي
7	6	1:17:25	متوسطة	منتظمة	نشاط مستمر
8	7	1:17:30	منخفضة	قصيرة	بداية استرخاء عضلي

Mathematical Modeling of Open-Loop Pancreas System

Prepared by:

45- Esraa Hadi Ali. 46- Tiba Hadi Idan 47- Mohammed Hassan hadi
48- Zainab Ali Jabr. 49- Manar Abdulameer Saheb

Supervised by:

8- Dr. Mujtaba A. Flayyih

Sustainable Development Goals Performed: SDG-3, SDG-4

Abstract	Results and conclusions

Abstract:

This study simulates an open-loop artificial pancreas using the Bergman Model to evaluate glucose-insulin dynamics in healthy and diabetic individuals under fasting and meal intake conditions.

Methodology

Methodology:

We developed a nonlinear glucose-insulin model using Bergman's equations and simulated it in MATLAB/Simulink. The model included different meal inputs (Gaussian, Step, Pulse) and was tested under fasting and fed conditions. The numerical solution used the Runge-Kutta 4th order method. Results were evaluated using parameters like peak amplitude, area under the curve, and return time.

Results and conclusions:

This project evaluates an open-loop artificial pancreas using the Bergman Minimal Model through simulations of healthy and diabetic individuals under fasting, pulse, step, and Gaussian meal inputs. Healthy subjects showed quick insulin responses and glucose regulation, while diabetics exhibited weak or no insulin activity, leading to dangerous glucose spikes and slow recovery. Gaussian meals produced smooth hormonal changes in healthy cases, but step meals caused severe hyperglycemia in diabetics. Metrics like peak value, AUC, and return time highlighted the system's failure in diabetic control, underscoring the necessity for closed-loop feedback designs. This study offers a useful simulation framework for advancing biomedical control systems.

Figure 3.8: Glucose response with Gaussian meals inputs for healthy person.

Figure 3.20: Glucose response with Gaussian meals inputs for diabetic patient.

Proj.No.9	Medical monitoring and tracking system for Alzheimer disease based on IoT
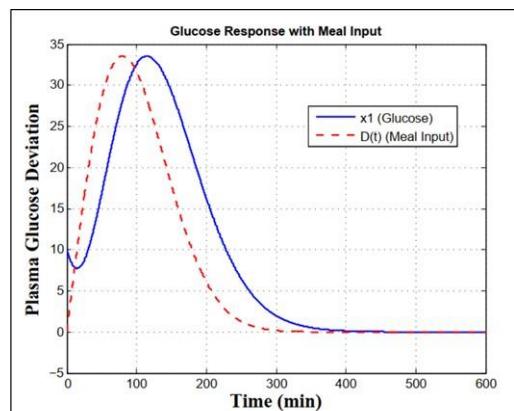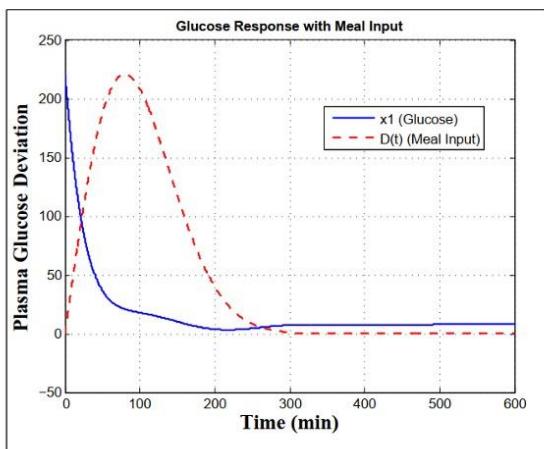
Prepared by:

احمد فاضل عبد الحسين- 50   فاطمة ثامر هادي- 51   زهراء احمد محسن شاكر- 52
حوراء مهند رضا- 53   فاطمة عباس فاضل- 54

Supervised by:

م.م. زينب ستار

Sustainable Development Goals Performed: SDG-3, SDG-9

Abstract

Abstract: This project presents an IoT-based monitoring system for Alzheimer's patients, enhancing safety and caregiver support. It tracks vital signs (heart rate, temperature, oxygen) and real-time location via GPS, sending alerts through a mobile app or web interface during emergencies or when the patient exits a safe zone.

Methodology

Methodology: The system uses an ESP32 microcontroller with sensors for temperature, motion, and oxygen levels, a Neo-6M GPS module for tracking, and components like lithium batteries, an LCD display, buzzer, and voltage regulator housed in a plastic case. Sensor data is transmitted via Wi-Fi to the Blynk platform, displayed in a mobile app, and triggers audio alerts and instant messages during health emergencies or location deviations.
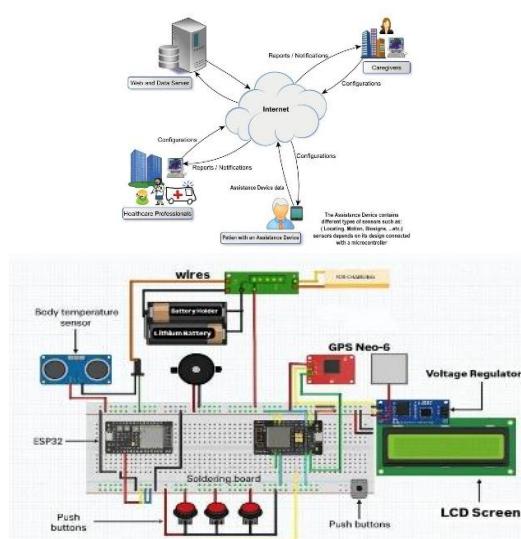
Results and conclusions

Results and conclusions: This IoT-based system provides an effective solution for monitoring Alzheimer's patients by continuously tracking vital signs such as heart rate, SpO2, and body temperature, and accurately displaying the patient's real-time location through the Blynk app. It issues instant audio-visual alerts during medical emergencies or if the patient strays from a predefined safe zone. The integration of ESP32, biosensors, GPS, and the Blynk platform ensures reliable data flow, system responsiveness, and seamless communication between hardware and software. This smart system enhances patient safety, reduces caregiver burden, and represents an innovative model in telehealth. It also offers potential for future development by integrating AI technologies, additional medical devices, and more interactive user interfaces.

Proj.No.10	Design Orthosis for Correction or Assist Scoliosis Defect

Prepared by:

55- Narges Nasser Kadhim.   56- Taif Baher Mahdi.   57- Mariam Hadi Abd Al-Ameer

58- Noor Mohammed Khudair.   59- Ali Mousa Obayes

Supervised by:

9- Dr. Ali K. Kareem.

Sustainable Development Goals Performed: SDG-9, SDG-4

Abstract

Abstract:

This project focuses on designing and evaluating a custom orthosis for scoliosis management. Built using patient-specific measurements and materials like Gypsona, plastic, and metal, the device was assessed through X-rays post-fitting. Initial results show notable spinal curvature reduction, indicating improved alignment and comfort.

Methodology

Methodology:

The patient assessment was conducted at the Bionic Center on 09-12-2024, involving necessary measurements and immediate mold fabrication. Materials such as Gypsona, gypsum, plastic tubes, metal bars, Surfoum, a suction unit, clamps, and an oven were used during the process. The orthosis was fabricated and fitted on the same day, followed by scheduling the first X-ray. A three-month follow-up X-ray indicated improvement, with a second evaluation planned for six months later.

Results and conclusions

Results and conclusions:

A personalized orthotic brace significantly reduced a 15-year-old patient's spinal curvature from 30° to 6° within three months. Designed using lightweight materials like Gypsona and plastic, the brace offered comfort, better alignment, and improved compliance. Aesthetic and patient-specific adjustments enhanced adherence, especially important for adolescents. Radiographic evaluation confirmed the effectiveness, supporting its role in non-surgical scoliosis management. Continued follow-up will assess long-term stability of the correction.
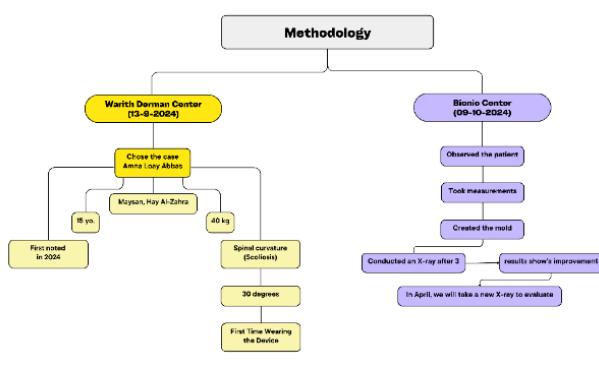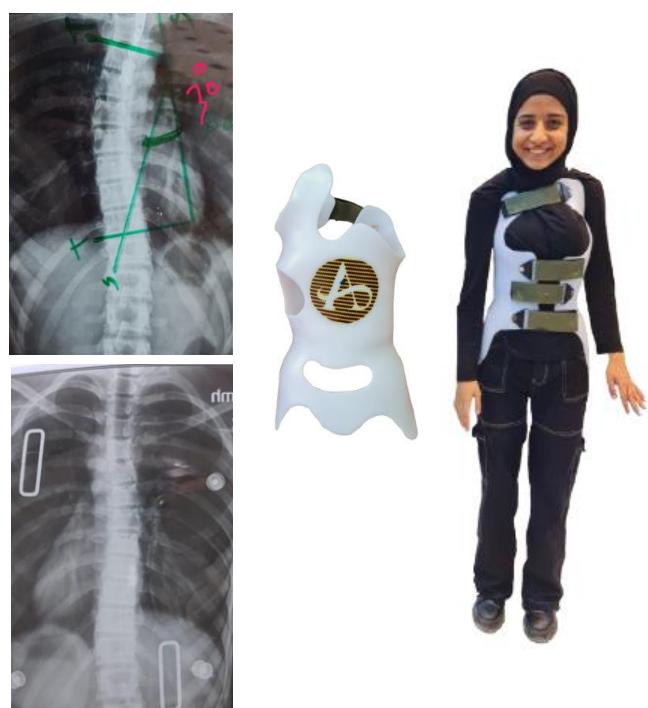
Proj.No.11	Preparing vegetable biomaterials and studying its impact on human health

Prepared by:

60- Ahmed Imad Waheed

61- Mohammad al-Baqir Muqdad Abdul Sattar

62- Mohammed Ahmed Ali

63- Jaafar Miri Abdul Zaid

64- Ghaith Hatem Rahim

Supervised by:

10- Dr. Mohammed Hamza Daham

**Sustainable Development Goals Performed:**   SDG-9, SDG-3

Abstract	Results and conclusions

Abstract:

The abstract is that the dye we came with represents a simple component, partially from natural, sustainable resources. This pigment can increase the shelf life and weathering resistance, and prevent face discoloration problems that ordinary glass faces.

Results and conclusions:

In conclusion, exchanging the ordinary lime glass and treating lime glass that faces issues like discolouration, heat shock, and weathering exchange takes its toll in when replaced with ordinary glass covered with semi-natural Pigment From naturally occurring chlorophyll based on low viscosity epoxy resin with nano silica Which replaces the complex lime glass, which is a wide variety of compounds. In addition to its simplicity, the pigment we came with has better optical, physical, and mechanical properties that reinforce the properties of glass.

Methodology

Methodology: We abstract the chlorophyll from spinach with pure alcohol, then mix the low viscosity epoxy resin in a ratio of 1:2. Then we add 1.5 grams of nano-silica to enhance the physical properties of the pigment and test the mechanical, topography, and optical properties in XRD and SEM tests, along with other tests.
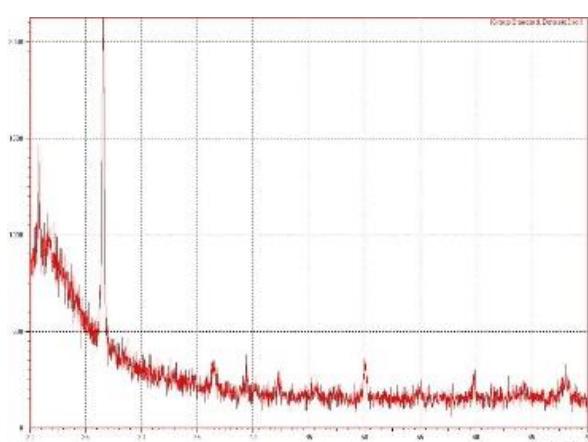
Proj.No.12 — Quantifying Cognitive Performance in Athletes: A Hybrid System Approach Using FNIRS Technology and Electrodermal activity (EDA) meter.

Prepared by:

65- Ayam Muhammad Jassim.   66- Haider Bahjat Malik.   67- Mustafa Maher Kamel.
68- Noor Thaher Abd Al-Kazem.   69- Zainab Ahmed Fadel.

Supervised by:

11- Mr. Mahir Rhaman Al-Hajaj.

**Sustainable Development Goals Performed:**   SDG-9, SDG-3

Abstract

Abstract: This research uses fNIRS and EDA technologies to measure athletes' cognitive and physiological performance, comparing their data to evaluate effectiveness. Results support deeper insights for optimizing training strategies.

Methodology

Methodology: a custom-built device with an Arduino Nano R3 microcontroller and EDA sensors, and the Mendi headset employing fNIRS technology. The wearable Arduino-based system records and stores electrodermal activity (EDA) to assess physiological responses. The Mendi headset non-invasively measures brain oxygenation and activity via fNIRS, providing real-time neurofeedback through a smartphone app. Together, these systems allow comparative analysis of physiological and neurological responses during athletic performance.

fNIRS headband and EDA device.
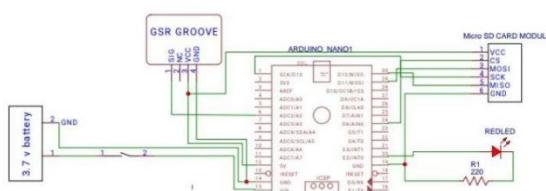
The schematic of the EDA circuit.

Results and conclusions

Results and conclusions: The hybrid fNIRS-EDA system accurately measured athlete cognitive performance in a field environment, demonstrating its ability to track brain activity and physiological stress responses. Combined data revealed a strong correlation between mental and physical states. Statistical analysis of fNIRS data showed a significant difference between Grade 1 and Grade 4 students. While visually distinct, observed performance differences in EDA data were not statistically significant, suggesting natural variation. Further research with larger samples is recommended.
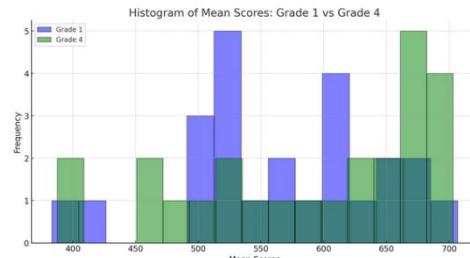
The histogram of the EDA data.
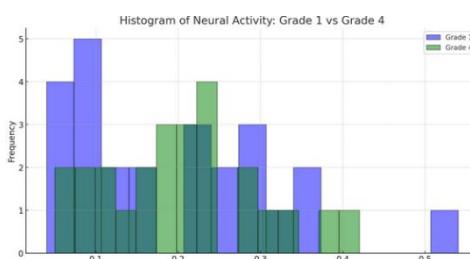
The histogram of the fNIRS data.

Skin Conductance Patterns and Their Association with Concentration Levels in 100-Meter Running Trials

Prepared by:

70- Jihan Khaled Kazim.   71- Mortada Jawad Karim.   72- Rokaya Jalil Muslil.
73- Tabark Haidar Naji.   74- Zainab Fadel Obaid.

**Supervised by:**

12- Mr. Mahir Rhaman Al-Hajaj.

Sustainable Development Goals Performed: SDG-9, SDG-3

Abstract

Abstract: This study examines the link between skin conductance and concentration during 100-meter sprints in first- and fourth-year students, revealing significant physiological and performance differences influenced by experience level.

Methodology

Methodology: The methodology involves designing a skin conductance device using Arduino Uno, a sensor, lithium battery, and SD card module to analyze concentration patterns during sprints.
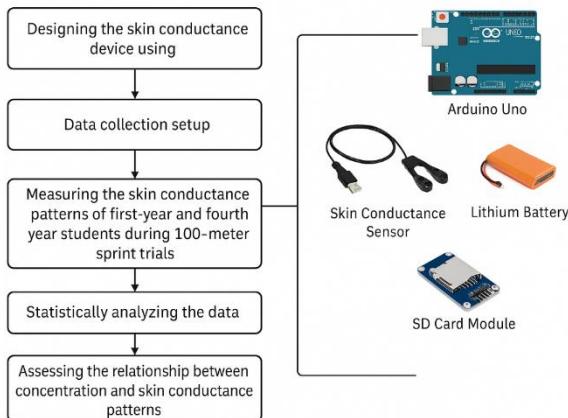
Designated methodology for measuring skin conductance patterns during 100-meter sprints.
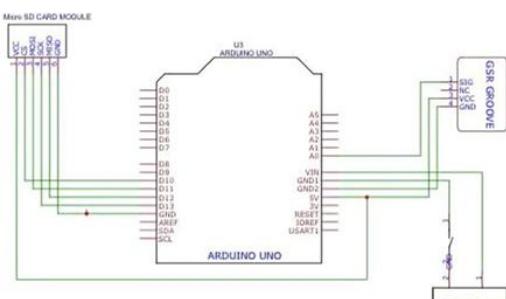
The schematic of the circuit connections.

Results and conclusions

The wearable prototype.

Results and conclusions: Statistical analysis revealed significant performance differences between first- and fourth-grade students. Mann-Whitney U (U=267440.0, p=3.14×10⁻⁸) and Kolmogorov-Smirnov (p=1.56×10⁻²⁹) tests confirmed distinct score distributions, with greater variability observed in fourth graders. The findings indicate notable developmental and educational differences between grades. Variations in performance likely reflect age, learning environments, and teaching methods. Further research with larger samples is needed to explore contributing factors such as study habits and socio-economic status.
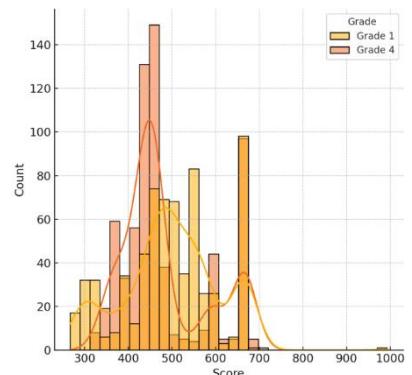
The histogram shows the distribution of scores for both grades, including the Kernel Density Estimate (KDE) for a smoother curve.

Prepared by:

75- Mohammed Thaer Obied.   76- Hassan Abbas Khalil   77- Maream Basil Saad
78- Furqan Emad Razaaq   79- Ola Ahmed Gawad

Supervised by:

Dr. Alaa Mohammed Hussein   13-

Sustainable Development Goals Performed: SDG-3, SDG-4

Abstract

Abstract: In this study, ZnO nanoparticle coatings were applied to AZ31 magnesium alloy using electrophoretic deposition (EPD) to improve surface hardness and antibacterial properties. Coatings were deposited from a 50 g/L ethanol-based suspension at 20 V for 1, 2, and 4 minutes. The sample coated for 4 minutes showed surface characteristics close to natural bone, with a contact angle of 5.4°, indicating hydrophobicity. Overall, EPD proved effective for creating biocompatible coatings with enhanced mechanical and antibacterial performance.

Results and conclusions

Results and conclusions: This study demonstrated the successful deposition of ZnO biocoatings on magnesium alloy via electrophoretic deposition (EPD) for biomedical use. Under optimal conditions (20 V, 4 min), the coatings were uniform, crack-free, and 10–17 µm thick. They improved surface hardness, adhesion, and antibacterial properties while reducing the release of toxic ions, especially at lower pH. These enhancements support the potential of ZnO-coated magnesium implants in biomedical applications.

Methodology

Methodology: In this process, magnesium alloy served as the cathode and counter electrode, both placed 15 mm apart in a ZnO suspension. A custom holder-maintained electrode spacing and eased sample handling. Electrophoretic deposition (EPD) was conducted in a glass beaker with magnetic stirring to ensure particle dispersion. A DC power supply provided adjustable voltage (0–60 V), with optimal deposition at 20 V for 2, 4, and 6 minutes using a 1 g/L ZnO-ethanol suspension. pH was monitored using a PH-100 meter. ZnO was ultrasonically dispersed before coating. After deposition, samples were air-dried for 24 hours at room temperature.

Proj.No.15   The Structure and Properties behavior of antibacterial Composite Biocoatings onto Ti-6Al-4V Surface by Electrophoretic Deposition.

Prepared by:

80- Hasanain Hayder Jawad   81- Noor ALeslam Maher   82- Shams Ahmed Salim
83- Tabarek Salam Dakhil   84- Zainab Mohammed Ahmed   85- Zainab Mohammed Mahdi

Supervised by:

Dr. Alaa Mohammed Hussein Wais

Sustainable Development Goals Performed: SDG-3, SDG-4

Abstract

Ti-6Al-4V was coated with HAP and TiO via EPD to enhance hardness, biocompatibility, and antibacterial properties. Results showed improved surface characteristics suitable for biomedical implant applications.

Methodology

The EPD process used Ti-6Al-4V as both substrate and counter electrode, placed 15 mm apart in a suspension. A custom holder ensured constant distance and easy sample handling. The suspension contained TiO_2, HAP, and ethanol, stirred magnetically for uniformity. Deposition was done at 20V for 2, 4, and 6 minutes. After coating, samples were air-dried for 24 hours. TiO_2 was initially dispersed using an ultrasonic bath for better mixing.

Results and conclusions

Results and conclusions: This study successfully deposited TiO_2 and TiO_2/HAP coatings on Ti-6Al-4V alloy using electrophoretic deposition (EPD) to improve biomedical properties.

Results showed the coatings were uniform and crack-free at 20 V for 4 minutes, enhancing surface morphology and hardness. The presence of TiO_2 and HAP increased microhardness, improving wear resistance and durability.

The coatings demonstrated strong adhesion to the substrate, reducing the risk of implant loosening. They also acted as a protective barrier, limiting the release of harmful metal ions, with ion release increasing at lower pH levels.

Antibacterial properties were improved, helping to reduce infection risk in implants. The average thickness of the TiO_2/HAP coating was about 18 µm, ensuring effective layer formation.

Overall, TiO_2 and TiO_2/HAP coatings via EPD enhance biocompatibility, surface hardness, adhesion, and antibacterial performance of Ti-6Al-4V implants, making them promising for biomedical applications.

Proj.No.16   Bone Cement Enhanced with Bioactive Glass
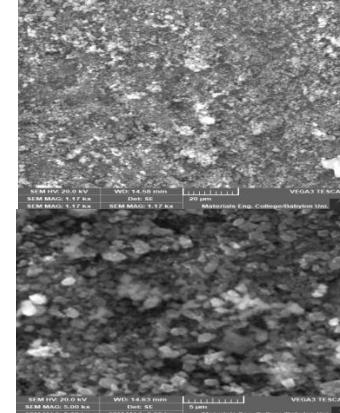
Prepared by:

86- Hassan Ayed Mohammed.   87- Mohammaed Rashad Ali   88- Noor Alhuda Hussam Taimol
89- Safa Habib Abdullah   90- Fatima ali Muhsin

Supervised by:

Dr. Amir N. Saud

Sustainable Development Goals Performed: SDG-3, SDG-9

Abstract	Results and conclusions

Abstract:
Bone cement is a critical material in orthopedic surgeries for implant fixation.
This project investigates the enhancement of bone cement by incorporating bioactive glass (BG) to improve mechanical properties and bioactivity.
Tests were conducted on different formulations to assess compressive strength and structure integrity.

Results and conclusions:
The incorporation of bioactive glass showed a noticeable effect on compressive strength.
Formulations P-N-BG1 and P-N-BG2 showed improvement compared to control samples. However, higher concentrations (BG3) reduced strength slightly.
The bar chart below illustrates the compressive strength values across samples.

Methodology

Methodology:
The experimental methodology included preparation of standard PMMA bone cement, followed by incorporation of different percentages of bioactive glass (BG1, BG2, BG3).
Mixtures were poured into silicone molds and allowed to cure. Samples were later subjected to mechanical and structural testing.

Compression strength

Proj.No.17   DESIGN AND IMPLEMENTATION OF A PROTECTION SYSTEM FOR LINAC SYSTEM.
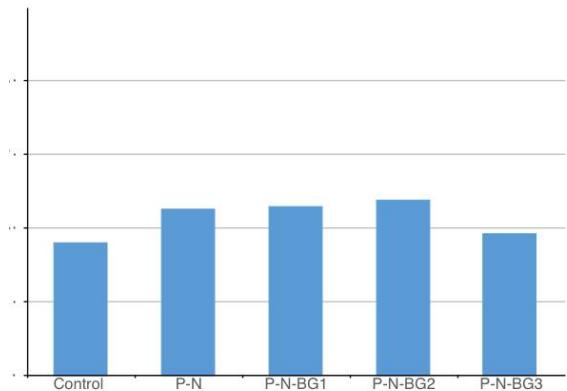
Prepared by:

1- Saif Haider Aziz   2- Sajjad Najm Abd Al-Zahra   3-Ali Ahmed Kamel
4-Hassan Ali Abdullah   5-Ali Karim Kazem

Supervised by:

Prof. Dr. Ibrahim A. Murdas

Sustainable Development Goals Performed: SDG-9, SDG-3

Abstract

Abstract:This project developed an intelligent system to monitor patient movement and breathing during radiotherapy using a Linear Accelerator (LINAC). The system aims to enhance treatment accuracy and patient safety by detecting and minimizing unwanted motion during radiation sessions.

Methodology

The project employed precise, compact electronic components chosen for medical-grade sensitivity and programmability. Key elements included an ESP32 microcontroller for control and Wi-Fi connectivity, pressure and motion sensors to monitor breathing and movement, and visual/audible alert devices (LCD display, RGB LEDs, buzzer). A 3D-printed enclosure housed the system, designed for easy mounting near the patient. Wiring and assembly were completed using standard tools to ensure reliable integration.
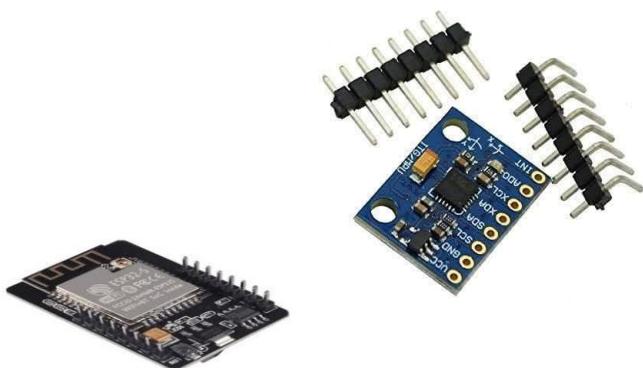
Results and conclusions

Results and conclusions:
The project developed a smart system to monitor patient breathing and movement during radiotherapy with a LINAC machine. Using a belt equipped with a pressure sensor, MPU6050 motion sensor, and ESP32 controller, the system detects sudden movements and responds by triggering sound and light alerts, stopping the device to protect healthy tissue. An LCD displays patient and breathing status, while a mobile app sends real-time alerts to medical staff. This innovative system enhances radiotherapy accuracy and patient safety by reducing risks from patient motion.

Proj.No.18	Design and implementation of anti-sleep and health monitoring system for drivers to avoid accidents

Prepared by:

91- Elaf Baseem Mahdi   2-Ahmed Jalil Shabib   3- Amir Abbas Mohsen
4- Mohammed Aziz Abbas   5- Ali Abdel Nasser Saleh

Supervised by:

Asst. Lec. Zainab Sattar Jabbar

Sustainable Development Goals Performed: SDG-9, SDG-3

Abstract

Abstract:
This study proposes a low-cost IoT-based drowsiness detection system integrating smart glasses (blink sensor, Arduino Nano), audible and haptic alerts, vehicle receiver via nRF24L01+, achieving 85% accuracy and <1-second response.

Methodology

System design begins by selecting a compact infrared-based eye-blink sensor for real-time eyelid movement data. Software development involves programming the Arduino Nano for signal acquisition, robust drowsiness detection via blink duration analysis, and alerting. Upon detecting drowsiness, the controller activates the vibration motor and buzzer to issue immediate haptic and audible warnings to the driver. The system achieves sub-second response with low power consumption, making it suitable for vehicular deployment.

Results and conclusions

The IoT-based anti-sleep system uses smart glasses with an infrared blink sensor and Arduino Nano to detect drowsiness by monitoring eyelid closure. Prolonged blinks (>3 seconds) trigger buzzer, vibration, and a wireless command to slow and stop the vehicle. It achieved 85% accuracy with fast response (<1s) and reliable performance day and night. Tested over five days, the system was stable, low-power, and easy to install using common components. Future upgrades aim to integrate AI, biometric sensors, and smart vehicle features for improved safety and personalized monitoring.

Proj.No.19   DESIGN AND IMPLEMENTATION OF IR LASER SYSTEM FOR BONE FRACTION DETECTION

Prepared by:

92- Mahmoud Yhya Abed   93- Mustafa Yahya Ali   94- Marwan Basem Ghanem
95- Ahmed Saleh Mahdi   96- Haider Mohammed Kazim

Supervised by:

Prof. Dr. Ibrahim A. Murdas

Sustainable Development Goals Performed: SDG-9, SDG-3

Abstract

The project presents a non-invasive system for detecting bone fractures using infrared (IR) light, relying on 32 photodetectors and emitters to analyze changes in light transmission through tissue. The system was tested on industrial models and detected fractures as small as 1 mm with high accuracy, demonstrating its potential as a portable and safe tool for detecting fractures without radiation.

Methodology

The system comprises a linear array of 32 IR emitters (820 nm) paired with 32 matching IR photodiode detectors, mounted on opposite sides of the scanning region (e.g. a limb).


IR emitters   IR Detectors

Emitters are driven sequentially, and detectors measure transmitted or scattered light as voltage variations.
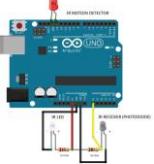

IR Emitter and IR receiver circuit

A microcontroller network coordinates timing, data acquisition, and USB streaming to a host PC, where a MATLAB application reconstructs a 2D intensity map and applies feature-extraction algorithms to localize potential fractures.

Results and conclusions

An infrared bone fracture detection system was developed using 32 emitters and detectors, along with signal processing circuits and microcontrollers. Tests confirmed that the emitters and detectors operated accurately and that data was transmitted to the computer seamlessly. The system was able to detect gaps ≥2 mm in synthetic materials, but struggled with gaps smaller than 1 mm.
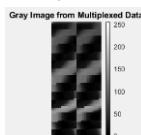
Heat maps (in MATLAB) clearly demonstrated fracture areas, but the system faced challenges such as sensitivity to ambient light and difficulty penetrating more than 25 mm of tissue. Further improvement is needed for clinical use.

This project designed a non-invasive IR laser system to detect bone fractures using 32 IR emitters (820 nm) and detectors in a parallel array. The system measures transmitted IR light through tissue and bone, with data processed via microcontrollers and MATLAB to generate 2D intensity maps highlighting fracture regions. The approach offers a potential alternative to traditional imaging methods like X-rays.

Proj.No.20   Design of upper Limb arm bond with EMG and Robot

Prepared by:

97- Mostafa Mohmead.   98- Mohmead abdulkareem.   99- Yassir Khudier.
100- Kefaa Sattar.   101- Zahraa Abdullah.

Supervised by:

Dr. Ali K. Kareem

Sustainable Development Goals Performed: SDG-9, SDG-3

Abstract

This research focuses on the design and development of an upper limb prosthetic controlled by electromyographic (EMG) , who suffers from a congenital disability in his left hand. The project was implemented using biomedical engineering techniques, where EMG signals were recorded and analyzed through an Arduino microcontroller to control the movement of the prosthetic limb.

Methodology

This project focuses on designing, developing, and testing an upper limb prosthetic controlled by EMG signals.

EMG data from surface electrodes on specific muscles guide the design, which is modeled for functionality and fabricated using 3D printing. The prosthesis is then evaluated for accuracy,

responsiveness, and usability, ensuring effective interaction between the user's neuromuscular system and the device.
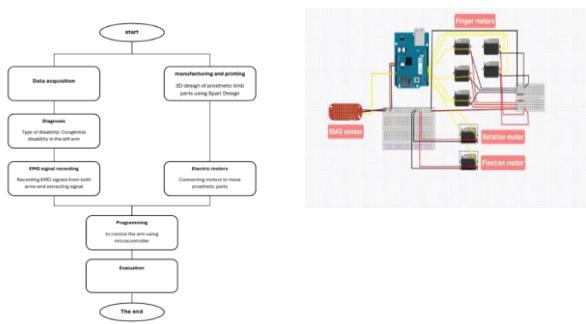
Results and conclusions

Results:

Healthy arm: 100–350 µV (rest), 750–980 µV (contraction).

Amputated arm: 50–300 µV (rest), 700–980 µV (contraction)

conclusions : The integration of EMG signals with robotic arm control represents a key advancement in assistive technology, enabling real-time translation of muscle activity into robotic movement. This provides natural, intuitive control for individuals with upper limb impairments. Operating at low voltages, the system ensures safety and reliability. It shows strong potential in prosthetics and rehabilitation, with future development expected to enhance precision, adaptability, and comfort. Incorporating machine learning could further improve signal interpretation and allow complex, multi-joint movement. Overall, EMG-based robotic arms offer promising solutions for restoring mobility and independence for people with disabilities advancing personalized and responsive assistive devices.

PART SIX

PROJECTS OF

Department of Medical Devices Engineering

Alarm system for ALzheimer's patient based on WiFi technology

نظام انذار لمرضى الزهايمر يعتمد على تقنيةWIFI

Prepared by:

102- Zahraa Abd Al-Hussain Takleef	103- Hawra fouzi hadi	104- Mohammed Raed Hashem
105- Youssef Sabah Hassouni	106- Mohammed Nazim Shaker Jadoua	107- Ameer Kareem Badr
108- Mohammed Baqer Hamid	109-	110-

Supervised by:

14- Bayan Mahdi Al-Sabbar   15-

Sustainable Development Goals Performed:

| Abstract	Results and conclusions

Abstract:

This research introduces a WiFi-based alarm system for Alzheimer's patients, integrating GPS, ESP32, and Telegram alerts to ensure real-time monitoring, accurate tracking, and rapid emergency response for caregivers.

Methodology

Methodology :

The system operates by first connecting the ESP32 to WiFi, initializing the SD card and sensors, and starting audio reminder timers. In a continuous loop, it checks reminder timers, monitors the fall detection sensor, and triggers a buzzer and Telegram alert if a fall occurs. It also monitors an emergency button, sending location-based alerts when pressed. Audio playback is maintained using audio.loop(), ensuring real-time monitoring and immediate feedback.

Results and conclusions:

The developed alarm system, built with an ESP32 microcontroller and various sensors, was successfully tested for fall detection, emergency alerts, and medication reminders. The MPU6050 accurately detected falls, triggering a buzzer and instant Telegram alerts with location data. An emergency button sent alerts immediately upon pressing, while the MP3 player reliably delivered scheduled audio reminders. WiFi connectivity and Telegram integration were stable, ensuring real-time communication. The system functioned reliably even under overlapping events, proving its multitasking capability. This low-cost IoT solution enhances safety for Alzheimer's patients, offering both automated and manual alerts, and supports caregivers through timely, remote notifications.

Proj.No.2 — Smart Drug Injection System by Using Arduino

أنظمة حقن الأدوية الذكية بإستخدام الأردوينيو
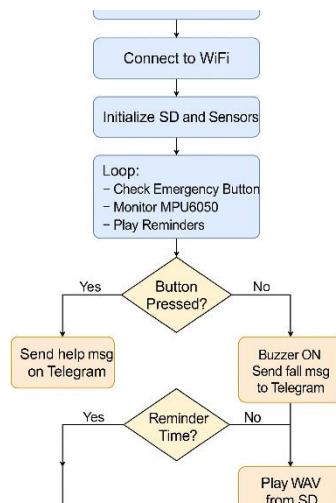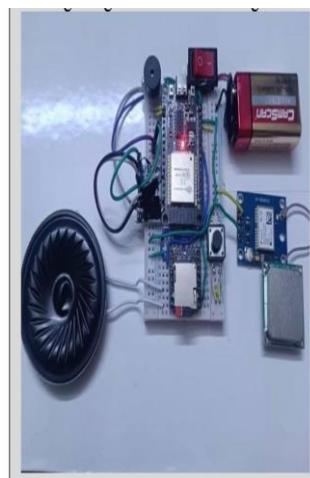
Prepared by:

111- Alaa Samer Ghazi   112- Ali Saad Hadi   113- Ahmed Abdu Alsada Hadi

114- Mortaza Mohammed Kazim   115- Ghaith Jabber Ali   116- Taiba Mohammed Hamid

117- Mohammed Khalid Turki

Supervised by:

16- MSC. Elaf Hussian

Sustainable Development Goals Performed: Goal 3: Good Health and Well-being

Abstract

An automatic anesthesia injector system using Arduino delivers precise doses based on patient health conditions, minimizing human error, ensuring safety, and improving efficiency during surgeries and critical treatments.

Methodology

The Smart Drug Injection System uses an Arduino microcontroller to automate drug delivery with high precision. Sensors monitor patient vitals like heart rate and temperature. Based on programmed thresholds, the Arduino controls a motor via an L298N driver to inject the correct drug dosage. An LCD displays real-time data. This system minimizes human error, ensures accurate dosing, and enhances safety and efficiency in medical treatments, especially during anesthesia or critical care.

Results and conclusions
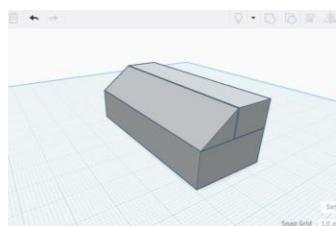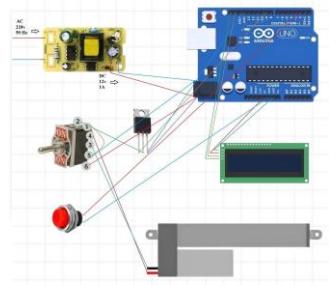
Results:
The development of smart drug injection systems using Arduino has been explored in various studies aiming to enhance medication delivery through automation and real-time monitoring. These systems typically integrate sensors, Arduino microcontrollers, and actuators to deliver precise drug dosages based on patient conditions.

One common implementation is a "smart syringe pump" designed for controlled dosing, often used in telemedicine and critical care. It utilizes DC motors, vital sensors (e.g., heartbeat, temperature, respiration), and a real-time clock (RTC) to ensure accurate injection timing.

Another example involves multiple automated injections, using Arduino Uno, relay modules, water pumps, and load cell amplifiers for fluid control, plus internet connectivity for remote access. These systems reduce human error, ensure consistency in treatment, and enhance patient safety, making them valuable tools for modern healthcare, especially in critical and remote settings.
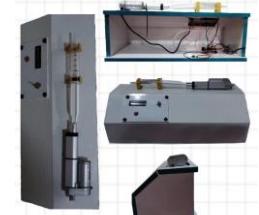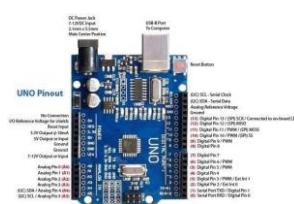
Conclusion:
Arduino-based smart drug injection systems represent a significant advancement in medical technology, offering automated and precise control over medication delivery. Research shows that such systems increase accuracy, reduce human error, and improve patient safety.

Key features include real-time monitoring, customizable injection schedules, and wireless communication, enabling remote control and supervision in both hospital and home care. Flow and temperature sensors ensure safe dosage, while real-time clocks support scheduled delivery.

Their low cost, small size, and flexibility make them ideal for use in telemedicine and resource-limited environments. Arduino's adaptability also allows easy integration of additional features or sensors.

These systems are suitable for both routine drug administration and critical applications like anesthesia or pain management. As the need for efficient healthcare grows, smart injection systems offer a promising solution to deliver reliable, automated medical treatment in diverse clinical environments.

Third Eye for the Blind

العين الثالثه للمكفوفين

Prepared by:

3- **Abbas Ali Mihoul**　　　4- **Hussein Riad Hussein**　　　5- **Farah Mohammed Jawad**

6- **Umm Al Banin Ali Hamza**　　7- **Auras Salam Ali**　　　8- **Zainab Majeed Hussein**

Supervised by:

1- **Dr. Zeyad Taha Yaseen**　　　　　　　　2-

| Sustainable Development Goals Performed:	Goal 10: Reduce Inequality Within and Among Countries

Abstract

Abstract:

The Third Eye for the Blind is an innovative device that helps the visually impaired detect upper-level obstacles using sensors, GPS, GSM, and audio alerts, enhancing their safety, independence, and navigation experience.

Methodology

Methodology:

This project followed a structured methodology that involved hardware and software integration.

The system was designed using Arduino boards, ultrasonic sensors, GSM/GPS modules, and MP3 players. The methodology began with component selection, followed by circuit design and code implementation.

The prototype was tested in various real-life scenarios to ensure accurate obstacle detection and emergency location alerts, prioritizing usability, safety, and cost-efficiency for visually impaired individuals.
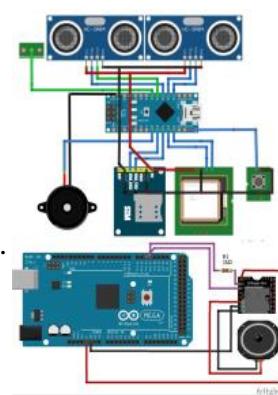
Results and conclusions

Results and conclusions :

The implementation of the "Third Eye for the Blind" project resulted in the successful creation of a smart wearable assistive device tailored for visually impaired individuals. The system effectively detects obstacles at three distance levels (1.5m, 1m, 0.5m) and responds with accurate pre-recorded audio alerts. Field testing demonstrated the device's capability to help users navigate safely in both indoor and outdoor environments. When obstacles were encountered, the ultrasonic sensor reliably measured the distance, triggering the Arduino to play specific voice alerts through the MP3 module. Additionally, the SOS emergency feature functioned as intended; upon pressing the button, the GPS module retrieved the user's coordinates and sent a distress SMS using the GSM module.
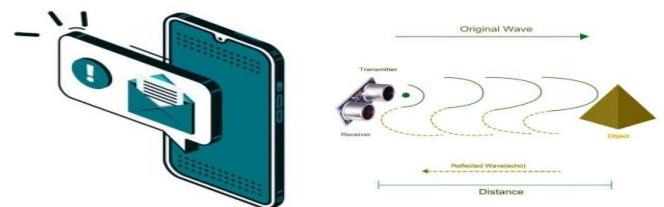
These results confirmed that the device can significantly increase the safety and independence of visually impaired users, especially in unfamiliar areas. The system operated reliably in various environmental conditions and required minimal training for use, fulfilling the project's goal of affordability and ease of use.

In conclusion, the "Third Eye for the Blind" project proves that low-cost, open-source technologies like Arduino can be effectively used to develop assistive tools for the visually impaired. This prototype lays a solid foundation for future enhancements such as integration with voice assistants, solar power, facial recognition, and mobile applications. With further improvements and extended testing, this innovation has the potential to become a practical solution for improving the quality of life for blind individuals.

Prepared by:

118- مرتضى عباس عيدان	119- ضرغام جميل رحمان	120- علي غالب عبد العظيم
121- امير مازن ابراهيم	122- ايات امير عباس	123- الاء محي كصب
124- كرار حيدر محمود	125-	126-

Supervised by:

17- **DR. Tarik Raoof Al_Khateeb**   18-

Sustainable Development Goals Performed:

Abstract

Abstract:

This system enables real-time, non-invasive vital sign monitoring with personalized feedback via a smart application, enhancing health management, early detection, and remote support for individuals and healthcare professionals.

Methodology

Methodology: The patient monitoring system was developed using an ESP32 microcontroller integrated with ECG, GSR, and DHT11 sensors. The system collects real-time data on heart activity,

stress levels, temperature, and humidity. Sensor data is processed and displayed on a 4x20 LCD screen, while also being transmitted wirelessly via Wi-Fi or Bluetooth for remote monitoring. Custom firmware and threshold-based algorithms enable data analysis, alerts, and secure communication.

Results and conclusions

Results and conclusions:

The patient monitoring system effectively measures and displays key physiological signals—ECG and GSR—in real time. The ECG signal reflects the heart's electrical activity, while the GSR signal indicates emotional or stress responses through changes in skin conductance. Both signals are clearly visualized on a user-friendly interface, allowing healthcare professionals to monitor patients accurately and respond promptly when needed.

In addition, the system captures temperature (29°C) and humidity (20%), offering a comprehensive view of the patient's condition and environment. The integration with mobile devices supports remote monitoring, making the system valuable in telemedicine and home care settings.

The design uses low-cost, non-invasive sensors, ensuring accessibility and affordability. Data is transmitted securely, maintaining patient privacy and reliability. Overall, the system enhances continuous health monitoring, early detection of abnormalities, and timely intervention—making it a practical and efficient tool for improving healthcare delivery and patient outcomes.

Smart prescription drug alert system

Prepared by:

127-	Hussein Hamid Jabbar	128-	mortada Ayad Abd Almunim	129-	Maryam Ahmed Faisal
130-	Taqwa Abdulla Hassen	131-	Huda Abd Alkadhim	132-	Tadin Ryan Dayim
133-	Rokua Mohammed Ali	134-		135-	

Supervised by:

19- Dr. Zahraa hashim kareem   20-

Sustainable Development Goals Performed:

Abstract	Results and conclusions

Abstract:
Our system is simple, cost-effective, and uses smart alerts to ensure medication adherence. It's easy to use, locally sourced, and more efficient than traditional complex systems.

Methodology

Methodology : A smart prescription drug alert system was developed to improve medication adherence, especially for epilepsy patients. The system utilized locally available components and smart alert technology to deliver timely reminders. A group of patients tested the system over a set period, and their adherence rates were monitored and compared to previous behavior. User feedback was collected to assess usability, efficiency, and impact on caregiver burden, helping evaluate the system's effectiveness and practical application in healthcare settings.
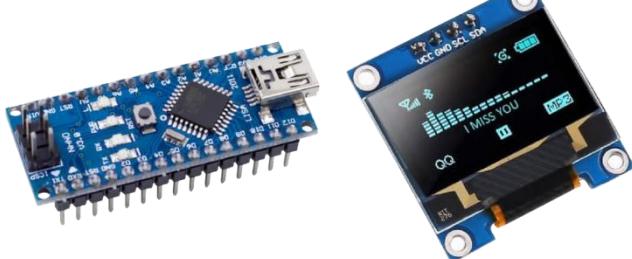
Results and conclusions

Results and conclusions:

The smart prescription drug alert system has shown strong effectiveness in improving medication adherence, particularly among patients with epilepsy. By providing timely and clear reminders, it helps patients consistently take their medications, leading to improved health and treatment outcomes. Unlike traditional systems that can be expensive, complicated, and difficult to manage, this system is simple, cost-effective, and easy to maintain. It also reduces the burden on caregivers and promotes patient independence. With its components readily available in local markets, the system is well-suited for use in various healthcare environments. Overall, it offers a practical, efficient, and scalable solution to medication management.

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