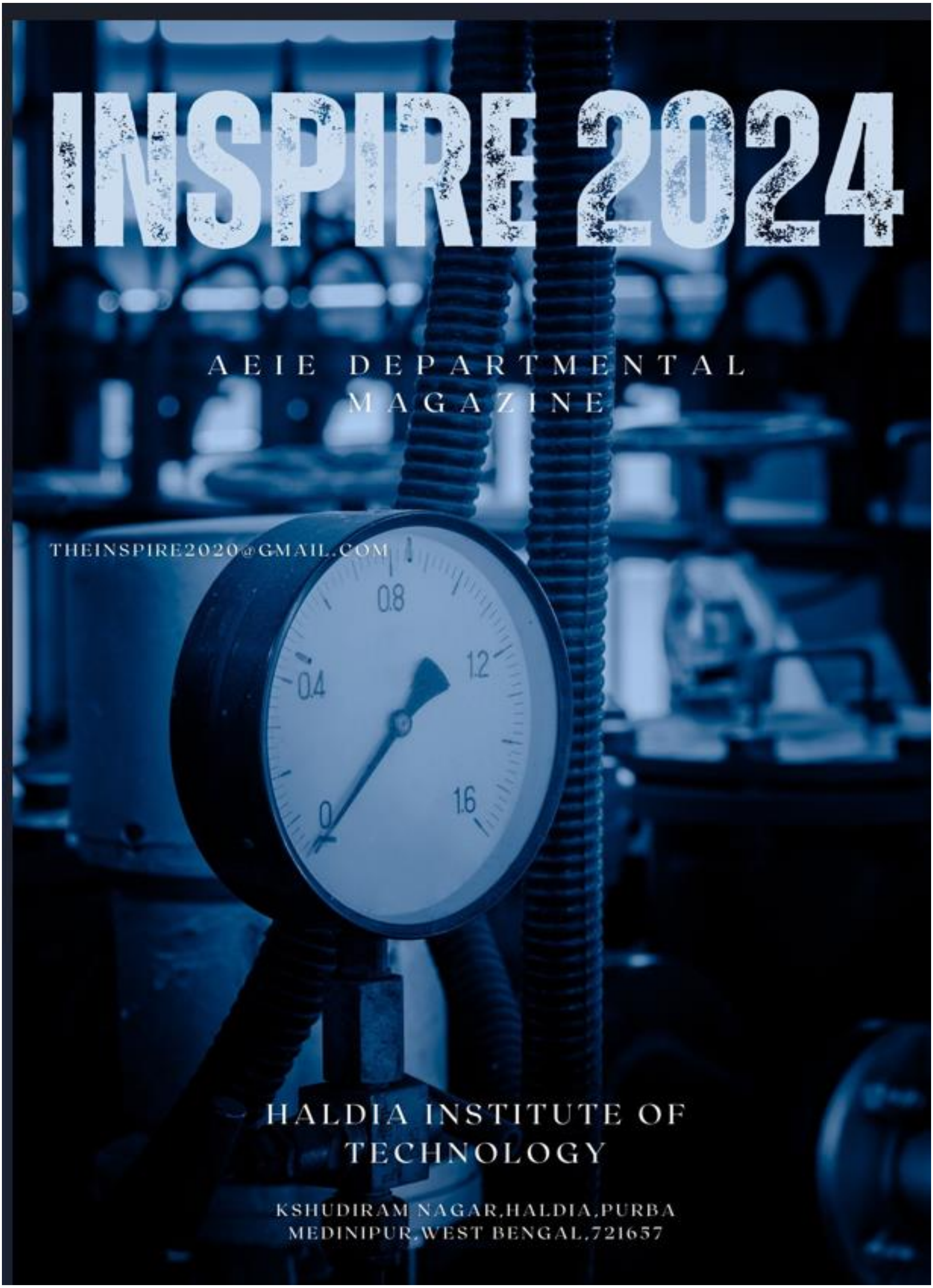

INSPIRE 2024

AEIE DEPARTMENTAL MAGAZINE

THEINSPIRE2020@GMAIL.COM

HALDIA INSTITUTE OF TECHNOLOGY

KSHUDIRAM NAGAR,HALDIA,PURBA MEDINIPUR,WEST BENGAL,721657


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FROM THE DESK OF

Principal, Haldia Institute of Technology

I am happy to know that the Department of Applied Electronics and Instrumentation Engineering is going to publish its annual technical magazine **"INSPIRE"** in **2024.** It is well known that knowledge is such a thing that gets perfection only by expressing and sharing with others. Swami Vivekananda believed education is the manifestation of perfection already in men. So, it has a lot of other features besides conventional classroom teaching. Even if we put efforts into imparting education to match the advancement of technology; it would not be effective if it is not complimented with something where the thoughts of our young generation are reflected.

Technical magazines can play a major role in the culture of our thoughts and views toward perfection. **"INSPIRE"** has many features which will in still have many good qualities not only in our young generation but also in all of us involved in this activity. It will try to inculcate creativity, innovation, and confidence in all of them. This magazine is a milestone that marks our growth, unfolds our imaginations, and gives life to our thoughts and aspirations. It unleashes a wide spectrum of creative skills ranging from writing to editing and even designing the magazine. So, it is almost like a dream to get the magazine published.

I congratulate the entire team of "INSPIRE" and the contributing authors for their hard work and dedication in making this dream into reality.

PROF.(Dr.) Subrata Mondal

PRINCIPAL,

HALDIA INSTITUTE OF TECHNOLOGY

FROM THE DESK OF

DEAN, HIT

It is a matter of great pleasure and satisfaction to know that the department of Applied Electronics and Instrumentation Engineering, Haldia Institute of Technology has taken the appropriate initiatives to publish the Technical Magazine, **INSPIRE-2024.** The magazine is poised to encapsulate the contributions of the faculty members, and the students of the department in terms of projects, working models and innovative products developed, research papers published, seminars/workshops/PDP organized, and different other co- curricular and extra-curricular activities.

The publication of such a magazine is very much appropriate in the context of today's highly volatile and tumultuous professional world to remain competitive and market one's unique selling point. Additionally, such an attempt will bolster team work and encourage innovative thinking in different areas of technical education. The proposed magazine will consolidate the credentials of the department and augment its reputation.

I appreciate the initiative taken by the department and congratulate all the members associated with the department. I wish you all success in this endeavor.

PROF. T.K. JANA

DEAN-SCHOOL OF ENGINEERING,

HALDIA INSTITUTE OF TECHNOLOGY

FROM THE DESK OF

DEAN, HIT

I am extremely delighted that the Department of Applied Electronics & Instrumentation Engineering, Haldia Institute of Technology is going to publish its Techno-Cultural Magazine **'INSPIRE - 2024**', covering wide aspects of technological developments/ challenges as well as the latest happening of the department.

In general, the platform of this Techno-Culture Magazine always offers strong connectivity for sharing of new and emerging technological information/ ideas; developments of creative avenues of future-technologists through engineering product development/ analysis, photography, literature, etc.

The practice of sharing information through such magazines will redefine relationships at all levels of society including between teachers and students resulting in the enhancement of creativity and innovation in science education and technological design.

In this auspicious moment, I would like to congratulate all the members of the 'INSPIRE'- the **Techno-Cultural Magazine of Applied Electronics** & **Instrumentation Engineering department** for their heart-full efforts to bring out such a novel concept.

PROF. A.B. MAITY

DEAN-SCHOOL OF APPLIED SCIENCE,

HALDIA INSTITUTE OF TECHNOLOGY

FROM THE DESK OF

HOD, HIT

Very warm congratulation to the magazine editorial committee and associated students and faculty members for successfully publishing this issue of the departmental technical magazine cum newsletter **"INSPIRE-2024"** through extensive collective efforts and adequate guidance. **INSPIRE** has proven to be a cloud of information that inspires and instills confidence in the entire AEIE fraternity to express their original thoughts on technical topics. The magazine plays an instrumental role in providing exposure to the students to develop written communication skills and command over the language. It is a step towards building a professional attitude in them.

The entire journey of creating **INSPIRE** inculcates leadership qualities, ethical attitudes, and social sensitivity among the students. This issue of **INSPIRE** has well-covered topics like reading and evaluating technical papers which is the first step towards research and development. It also talks about career options available to them after graduation. Most importantly it focuses on the student achievements in the current academic year.

The magazine is beaming with enthusiasm and creative ideas giving it a fresh and grand look. On a concluding note, I would like to wish you all the very best for more such initiatives and future endeavors.

Prof(DR).UDAY MAJI

PROFESSOR & H.O.D, AEIE

HALDIA INSTITUTE OF TECHNOLOGY

OVERVIEW OF THE DEPARTMENT

DEPARTMENT OF APPLIED ELECTRONICS & INSTRUMENTATION ENGINEERING

[NBA ACCREDITED]

***Applied Electronics and Instrumentation Engineering** is a specialized branch of Electrical and Electronics Engineering, primarily focusing on the principles, operations, and sensing of measuring instruments, physical parameters used in the design and configuration of the process industry, and automated systems. This is a multi-disciplinary stream and covers subjects from various branches such as electrical, electronics, biomedical, and computers.*

Year of Establishment: 1996

Program Offered and Intake: 60

B. Tech. in Applied Electronics and Instrumentation Engineering

Current intake: 60

MISSION OF HALDIA INSTITUTE OF TECHNOLOGY

- To impart quality and value-based education to raise the satisfaction level of all stakeholders.
- To create competent, creative professionals, and great entrepreneurs who can work as individuals or in groups in multi-cultural global environments.
- To prepare citizens who would grow to be competent enough to contribute significantly with personal integrity & civic responsibility for the betterment of mankind throughout their careers & professions.

VISSION OF AEIE

- To become a dynamic contributor to the community by ensuring excellence in academic and research in the field of Applied Electronics & Instrumentation Engineering & to create an environment that will facilitate the growth of individuals in this field through innovative teaching research & involvement of industry.

MISSION OF AEIE

- To produce quantity engineering graduates with the capacity to serve the arena of science, engineering, teaching, research, entrepreneurship & management.
- To add skill sets such as communication parameters, and ethical inputs & to nurture the characteristics of lifelong learning.
- To ensure the capability of working in a team effectively in different environments & to add tenacity to build a workforce.

PEOs OF AEIE

- PEO 1: To impart technical competency, knowledge, and skill which ensure capability to solve problems in industry, Research & Academics related to instrumentation Engineering & other related disciplines.
- PEO 2: To prepare students for successful careers in national and international public or private sector organizations while equipping them with the knowledge and skills to pursue higher studies and research in Instrumentation Engineering and related disciplines.
- PEO 3: To frame the mindset to enhance technical knowledge through lifelong learning be it in the structured or in the unstructured way. To impart the attributes towards successful adaptation to technological & cultural changes.
- PEO 4: To develop the ability to function effectively in diverse professional roles—individually, collaboratively within a team, or as a leader—while adapting to dynamic environments in academia, industry, and research.
- PEO 5: To fulfill the needs of society through their acquired in an ethical & responsible manner.

PROGRAM OUTCOMES

1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, & an engineering specialization to the solution of complex engineering problems.

2. **Problem Analysis:** Identify, formulate, review research literature, & analyze complex engineering problems reaching substantiated conclusions using the first principles of mathematics, natural sciences & engineering sciences.

3. **Design/development of solutions:** Design solutions for complex engineering problems & design system components or processes that meet the specified needs with appropriate consideration for public health & safety, & cultural, societal, & environmental considerations.

4. **Conduct investigations of complex problems:** Use research-based knowledge & research methods including design of experiments, analysis & interpretation of data, & synthesis of the information to provide valid conclusions.

5. **Modem tool usage:** Create, select, & apply appropriate techniques, resources, & modem engineering & IT tools including prediction & modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer & society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal& cultural issues & the consequent responsibilities relevant to the professional engineering practice.

7. **Environment & sustainability:** Understand the impact of professional engineering solutions in societal & environmental contexts, & demonstrate the knowledge of & need for sustainable development.

8. **Ethics:** Apply ethical principles & commit to professional ethics & responsibilities & norms of the engineering practice.

9. **Individual & team work:** Function effectively as an individual, & as a member or leader in diverse teams, & in multidisciplinary settings.

10. **Communication:** Communicate project management & finance: Demonstrate knowledge & understanding of the engineering & management principles & apply these to one's work, as a member & leader in a team, to manage projects & in multidisciplinary environments.

11. Project management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning:** Recognize the need for, & have the preparation & ability to engage in independent & life-long learning in the broadest context of technological change.

FACULTY MEMBERES

Sl. No.	Name	Designation	Qualification	Area of Specialization
1.	Prof.(Dr). Uday Maji	Professor & H.O.D	M. Tech, Ph.D. (Engg)	Biomedical Instrumentation
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- *Microprocessor Laboratory*
- *Electrical and Electronic Measurement Laboratory*

DEPARTMENTAL LIBRARY

The Department Library has an assortment of 1218 books with a volume of 773 numbers of different books and journals besides the central library facility.

STUDENTS' CHAPTER

The International Society of Automation (ISA)-2015 10th Oct

The International Society of Automation (ISA) is a society that serves automation professionals around the world. Our department opened a student chapter on 10th October 2015, under the ISA Kolkata chapter. Many workshops and seminars have been organized jointly by the department and the ISA student chapter since 2015.

Instrument Society of India (ISOI)-2018

The Instrument society of India (ISOI) is a society of Instrumentation professionals established in the year 1970 with headquarters at the Indian Institute of Science (IISc), Bangalore. Our department has an ISOI chapter under which various seminars, and workshops have been conducted. The department has recently got approval from The Institution of Engineers, India to run the student's chapter to prop up the professional activities.

PHOTOGRAPHY

NAME-RAHUL KUMAR PANDAY

NEXT-GEN INDUSTRIAL SAFETY HELMET

Moumita Bera (Roll No. L21/EIE/43)
Rahul Saha (Roll No. L21/EIE/44)
Rajib Manna (Roll No. L21/EIE/45)
Souvik Kar (Roll No. L21/EIE/46)

Under the supervision of
Dr. Soumya Roy, Associate Professor, Department of Applied Electronics and Instrumentation Engineering.

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Department of Applied Electronics & Instrumentation Engineering
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2024

Abstract: The death rate of construction workers at the construction site is increasing day by day. But still, there are no such chances to reduce this fatality rate. So to provide continuous observation of the labors and to prevent them from any health hazards during working, this system proposes a smart flexible helmet for the construction workers to provide security and rescue measures in case of any panic situations. The proposed system describes a smart low- cost helmet for the construction workers. Specially, safety becomes a main issue when you consider construction and manufacturing business. The project aims to provide a secure and safer working environment for laborers thus reducing the number of deaths happening in construction sites. The helmet includes different sensors such as temperature Sensors, gas sensors, IR sensors, Camera modules, etc. & IoT devices such as ESP32 which is a microchip controller send signals over the Wi-Fi. This project report aims to describe a prototype system and integrate some different IoT technologies and some safety levels for the industry construction site.

***Keyword*-Gas sensor.IR sensor, Camera Module, IOT**

I. INTRODUCTION

The Internet of things describes physical objects that are embedded with sensors, processing ability, software, and other technologies that connect and interchange data with other devices and systems over the Internet or other communications networks. The Sensors are used to sense the activity, orientation, and movement of the workers on the construction site. The death rate of the construction workers at the site has been increasing every year. If the worker working 5th or 10th floor of a large building has a severe heart attack, it takes some amount of time to reach that floor and recover. Within that time, he may be expected to death. In India, Approximately 38 construction workers die on construction sites every year. For example in 2017, there were 67 deaths, 2016 saw 55 deaths, 2015 saw 62 deaths 2014 saw 69 deaths, etc. To provide continuous observing of the laborers and to prevent them from any health hazards during work, this system proposes a smart flexible helmet for the construction workers to provide safety and rescue measures in case of any panic situation. The construction and mine industries are some of the most important industries fir the economy of India. But these industries are always preoccupied with the fact that the people who work there are always in danger of accidents like fire bursts or gas leakages. The laborers face a lot of struggles and difficulties in the workplace due to the unsuitable balance between work and their safety. Besides affecting them physically, they are affected emotionally as well. Among all the other industries the building industry stands as the leading provider of fatalities. Day by day the death rate of the construction labours at the construction site is growing. But still, there are no such medications to reduce this fatality rate. This project is based on using IoT technology to work as a remedy by detecting these accidents. Thus this reduces the response time of the people working there as can take the necessary steps once they identify that an accident has taken place. The number of fatal deaths happening in construction sites is growing every year. The safety and health of people are not guaranteed in construction sites. The workers face a lot of struggles and difficulties in the workplace due to the unsuitable balance between work and their safety. Besides affecting them physically, they are affected emotionally as well.

II. NEED

Working in the forging and mining fields is a risky profession. Employees in such fields are more likely to be harmed or suffer serious injuries than those in the private sector, where injuries are more likely to be severe. Supervisors will be held responsible for all wounds that occur under their supervision thus they must assess the potential for dangerous situations. The problem we're trying to solve with this project is to create a prototype of a safety helmet that will provide enhanced safety attentiveness among mine and forge workers.

III Technical Details

A smart helmet has sensors built into it that can be applied to a person's head during a collision. These data can be used to predict the likelihood of a collision and issue alerts about potential dangers. The smart helmet will be able to change the form of a person's head to make it more comfortable.

III a) Electrical Components Used-

DHT11(humidity sensor),MQ2,MQ135,ATMEGA328P,IR proximity sensor,ESP32,GPS module,ESP32 Camera module,BMP280, MPU6050,Li ion battery charger

III b)Block Diagram-

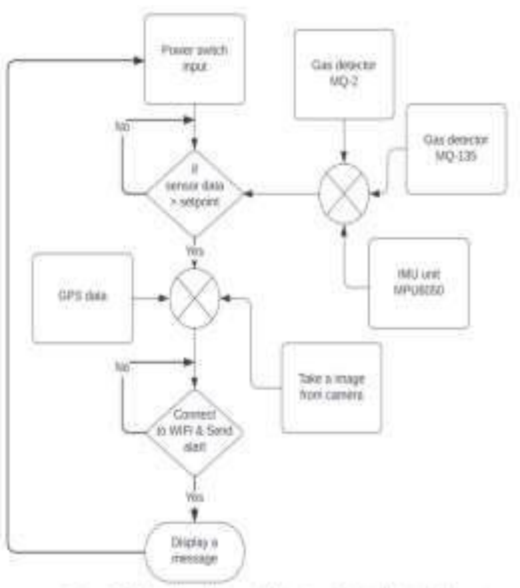

Figure 3.5: Data flow diagram of Next-Gen Industrial Safety Helmet

III c) Working of the Device-

Here's a breakdown of the system based on the block diagram:

- **Power Switch** - This turns the system on and off.
- **Gas Detector** - This block likely refers to a gas sensor, which is the part of the system that detects the presence of gas. The diagram shows two possible sensors, MQ-2 and MQ-135. These are both metal oxide semiconductor (MOS) gas sensors commonly used to detect a variety of gases, including methane, butane, and propane.
- **Sensor Data > Setpoint** - This decision block indicates the system is continuously monitoring the output from the gas sensor and comparing it to a setpoint. The setpoint is a predetermined level of gas concentration. If the concentration of gas exceeds the setpoint, the system proceeds to the next block.
- **IMU Unit (MPU6050)** - This block refers to an Inertial Measurement Unit (IMU). IMUs are microelectromechanical systems (MEMS) devices that measure and report a device's orientation, velocity, and acceleration. The inclusion of an IMU in this system suggests the device may be intended to not only detect gas leaks but also record the orientation and movement of the device while the leak is occurring. This data could help determine the location of the leak.
- **GPS Data** - This block refers to the Global Positioning System (GPS). If the system has GPS functionality, it would be able to determine its location and transmit those coordinates along with the gas leak data.
- **Take a picture from Camera** - This block suggests the system may also include a camera. If a gas leak is detected, the system could take a picture of its surroundings and transmit the image along with the other data.
- **Connect to Wi-Fi & Send Alert** - This block indicates that the system can connect to a Wi-Fi network and transmit an alert when a gas leak is detected. The alert would likely include data from the gas sensor, IMU, GPS (if applicable), and any image captured by the camera.
- **Display Message** - This block indicates that the system can also display a message on a local display, such as an OLED screen, to notify people in the vicinity that a gas leak has been detected.

IV.IMPLEMENTATION:

Implementation is the stage of the project when the theoretical design is turned into a working system. Thus, it can be considered to be the most critical stage in achieving a successful new system and in giving the user, confidence that the new system will work and be effective. The implementation stage involves careful planning, investigation of the existing system and its constraints on implementation, designing of methods to achieve changeover, and evaluation of changeover methods. In our project firstly we designed the circuit development then we connected the ESP32 Wi-Fi module. It can send data through Telegram.

Firstly, we embeded sensors like DHT11,MQ2,MQ135,BMP280,MPU6050 ,ESP camera,ESP32 WIFI Module together. After that, we set up that on the helmet as shown in figure-

V. Result-

VI. Conclusion

Through this study, we developed a smart helmet that was designed to help workers get rid of hazardous events in industries. The design and implementation of a system that can provide security for construction Site and miner workers and take the appropriate action are required. The proposed method is used for beneficial security purposes and industrial purposes. Hence the system is reliable with simple and easily available components, making it light weight and portable. Along with the sensors & WIFI we have included a camera & GPS Module that can give the location of the worker. With all of these protections in place and all of the efforts taken to eliminate all potential hazards at work, we believe we've successfully solved every challenge. Additional sensors and circuits made the safety helmet project more effective by ensuring optimal weight balance.

VII. ACKNOWLEDGEMENT

The authors are thankful to the department of AEIE Engineering at the Haldia Institute of Technology. Special thanks to our honorable project mentor Mr. Soumya Roy(Associate Professor) of the Haldia Institute of Technology of AEIE department for the support & continuous guide for making this project.

VIII. References

[1]. Fan zihhong, "Application of IoT technology in construction engineering safety management", IEEE International Conference on urban engineering and management science (ICUEMS), XuhuiDistrict, Shanghai, 2020, DOI 10.1109/ICUEMS50872.2020.00143

[2]. V.Jayshree, M. Nivetha Kumari, "IoT Based Smart Helmet for Construction Workers", IEEE International Conference on Smart Structure and Systems ICSSS 2020

[3]. Mangala Nandhini. V, Padma Priya G.V, Nandhini. S, Mr. K.Dinesh, "IoT based Smart Helmet for Ensuring Safety in Industries", International Journal of Engineering Research & Technology (IJERT), Department of Computer Science and Engineering Kongu Engineering College Perundurai, Erode

[4]. Leo Louis, "Working principle of Arduino and using it as a tool for study and research" International Journal of Control, Automation, Communication and Systems (IJCACS), Vol.1, No.2, April 2016, DOI: 10.5121/ijcacs.2016.1203, Department of Electronics and Communication Engineering, Gujarat Technological University, Ahmedabad, India

[5]. K.M. Mehta, S.K.Shankar, Karthikeyan N, Nandhinee K, Robin Hedwig P, "IoT Based Safety and Health workers" Department of Computer Science Engineering Hindustan Institute of Technology and Science Padur, Chennai

PHOTOGRAPHY

NAME-RAHUL KUMAR PANDAY

AUTOMATIC VACUUM CLEANER USING ARDUINO

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INTRODUCTION

1.1. BACKGROUND

Automation technology has revolutionized various industries, including manufacturing, transportation, healthcare, and households. Among these, automatic household appliances like robotic vacuum cleaners have greatly simplified daily tasks and enhanced quality of life. The history of vacuum cleaners dates back to the early 20th century, with the first motorized version created in 1901 by Hubert Cecil Booth.

Initially manual and bulky, technological advancements have led to more compact and efficient designs that are now commonly found in homes worldwide. The introduction of robotic vacuum cleaners, such as the Electrolux Trilobite in 1996 and the iRobot Roomba in 2002, marked a significant advancement in cleaning technology. These modern automatic vacuum cleaners utilize advanced technologies like microcontrollers, sensors, and processors to effectively perform their cleaning functions.

1.2. OBJECTIVE

The primary objective of this project is to develop an Arduino-based automatic vacuum cleaner capable of independently navigating and cleaning indoor spaces.

The project will focus on achieving autonomous navigation by utilizing ultrasonic sensors to detect obstacles and guide the vacuum cleaner efficiently.

1. Efforts will be made to integrate a vacuum mechanism that can effectively clean various floor surfaces while ensuring reliable operation over extended periods.

2. Emphasis will be placed on designing the vacuum cleaner with cost-effective components to make it accessible to a wide range of users, with a focus on simplicity in design and assembly.

3. A user-friendly interface will be created for easy control and programming of the vacuum cleaner, ensuring ease of setup, operation, and maintenance.

4. The project will also aim to provide scalability and customization through a modular design, encouraging community engagement and enabling further enhancements and improvements to the initial prototype through thorough documentation.

1.3. SCOPE AND LIMITATIONS

1. The Arduino-powered robotic vacuum cleaner is versatile and can be utilized in different fields, providing convenience for household cleaning tasks, educational opportunities for students and hobbyists, and a foundation for research and development in autonomous technologies.

2. Its cost-effectiveness, simple assembly process, and adaptability for customization contribute to its

Appeal, making it a valuable project suitable for a diverse user base.

3. The automatic vacuum cleaner's ability to cater to various needs and interests underscores its significance as a practical tool with broad applications and potential for innovation in the realm of autonomous systems.

1.4. LITERATURE REVIEW

Here is an insight on the Literature Review of this project.

- Commercial robotic vacuum cleaners utilize advanced navigation systems and sensor technologies for autonomous cleaning.

- Arduino boards are widely used in robotics projects due to their versatility, ease of programming, and compatibility with various sensors and actuators.

- Integration of navigation and obstacle avoidance techniques, such as SLAM and path planning algorithms, is crucial for the success of an automatic vacuum cleaner.

METHODOLOGY

2.1. DESIGN METHODOLOGY

The hardware components of the Automatic Vacuum Cleaner Using Arduino form the foundation of its functionality, enabling it to navigate, detect obstacles, and perform cleaning tasks autonomously. This comprehensive overview will detail the key hardware elements involved in the project.

2.2. SOFTWARE AND HARDWARE REQUIREMENTS

Hardware components needed for this project are:

1. ARDUINO UNO

The Arduino Uno is one of the most popular and widely used microcontroller boards in the Arduino ecosystem. It is an open-source electronics platform based on easy-to-use hardware and software.

Board Layout:

i. Power Jack: For external power supply.
ii. USB Connection: For programming and power.
iii. ICSP Header: For programming the microcontroller with an external programmer.
iv. Reset Button: To reset the microcontroller.
v. Headers: For connecting external components and shields.

Fig 2: Arduino UNO

2. MOTOR DRIVER

A motor driver is an essential electronic device used to control the operation of motors in various applications, such as robotics, automation, and electric vehicles. It acts as an interface between the microcontroller and the motor, providing the necessary current and voltage to drive the motor while allowing precise control over its speed and direction.

1) Functionality:
Voltage and Current Amplification: Motor drivers amplify the low-current control signals from a microcontroller to the high-current signals required by motors.
2) Features:
Dual H-Bridge Motor Driver: Capable of driving two DC motors or one stepper motor.
Wide Operating Voltage: 5V to 35V.
Output Current: Up to 2A per channel.
Control: Uses logic inputs from a microcontroller to control the speed and direction of the motors.
Built-in Heat Sink: Helps dissipate heat generated during operation.

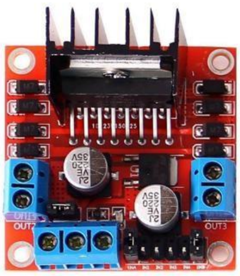


Fig 3: Motor Driver

3. ULTRASONIC SENSOR

Ultrasonic sensors, such as the HC-SR04, are utilized for obstacle detection and distance measurement. These sensors emit ultrasonic.

Waves and measure the time taken for the waves to bounce back, allowing the vacuum cleaner to detect objects in its path. Multiple ultrasonic sensors are strategically placed around the vacuum cleaner to provide 360-degree coverage and enable efficient navigation.

Fig 4: Ultrasonic Sensor

4. GEAR MOTOR

A gear motor is a type of electric motor that incorporates a gear system or gearbox to modify its output characteristics, such as speed, torque, and direction. This integration provides several advantages for applications requiring precise control and high torque at low speeds.

The basic motor, which can be a DC motor, AC motor, stepper motor, or servo motor, provides the rotational movement.

A series of gears that alter the speed and torque output of the motor. The gears can be arranged in various configurations like a spur, helical, planetary, or worm gears.

Fig 5: Gear Motor

5. SERVO MOTOR

Servo motors are rotary or linear actuators that provide precise control over angular or linear motion. They consist of a DC motor, gearbox, control circuitry, and feedback mechanism, typically in the form of a potentiometer or encoder. Servo motors operate based on feedback from the position sensor, allowing them to accurately maintain a desired position or move to a specified angle.

In some vacuum cleaner designs, servo motors may be employed to adjust the height or angle of the cleaning brush. This functionality allows the vacuum cleaner to adapt to different floor surfaces and cleaning requirements, ensuring optimal cleaning performance across various environments.

Fig 6: Servo Motor

2.3. PREPROCESSING

Designing and implementing the different control actions and studying their performance using a programming module by using a wheel rotation and transferring the data to Arduino. The processing techniques include:

1. Downloading and Installation of the Arduino Ide platform for the device.
2. Launch the Arduino Ide software on a device.
3. Sketching the Code in IDE.
4. Connecting the Motor board with the Arduino UNO Board and attaching the sensor near the wheel to measure the speed.
5. Arduino connected with the wheel to control the speed of the wheel.
6. Uploading the Code to the Board.

IMPLEMENTATION

1.1. SYSTEM ARCHITECTURE

- - Define the system architecture of the automatic vacuum cleaner
- - Select components based on suitability, performance, and cost
- - Design the physical structure, electronic subsystems, and software architecture of the vacuum cleaner

1.2. TRAINING AND TESTING

1. **Functional Testing**: Conduct thorough testing of your automatic vacuum cleaner to ensure all components are functioning correctly. Test navigation, obstacle avoidance, cleaning performance, battery life, and user interface functionality.
2. **Calibration**: Fine-tune sensor parameters, motor control algorithms, and cleaning routines based on real-world testing results. Adjust sensor thresholds, motor speeds, and control parameters to optimize performance and reliability.
3. **Iterative Improvement**: Continuously iterate on your design, incorporating feedback from testing to identify and address any issues or areas for improvement. Make adjustments to the hardware and software as needed to enhance the performance and usability of your vacuum cleaner.

1.3. SAFETY ISSUES

1. **Obstacle Detection**: Concerns may arise regarding the effectiveness of obstacle detection systems in preventing collisions with furniture, pets, or small children, potentially causing property damage or injury.
2. **Stair Safety**: Automatic vacuum cleaners may pose a safety risk near stairs or drop-offs if not equipped with reliable cliff sensors or safety features to prevent falls.
3. **Electrical Safety**: There may be concerns about the risk of electric shock or fire hazards associated with the use of electrical components and batteries in the vacuum cleaner.

RESULT ANALYSIS AND DISCUSSION

6.1. RESULTS AND ANALYSIS

The "Result and Analysis" section of the Automatic Vacuum Cleaner using Arduino project focuses on evaluating the performance, functionality, and effectiveness of the designed system. This involves detailed testing, performance metrics, user feedback, and comparison against initial objectives and expectations.

Code Writing and Uploading:

```
#include <AFMotor.h>
#include <NewPing.h>
#include <Servo.h>
#define TRIG_PIN A0
#define ECHO_PIN A1
#define MAX_DISTANCE 200
#define MAX_SPEED 100 // sets speed of DC  motors
#define MAX_SPEED_OFFSET 20
NewPing sonar(TRIG_PIN, ECHO_PIN, MAX_DISTANCE);
AF_DCMotor motor1(1, MOTOR12_1KHZ);
AF_DCMotor motor2(2, MOTOR12_1KHZ);
AF_DCMotor motor3(3, MOTOR34_1KHZ);
AF_DCMotor motor4(4, MOTOR34_1KHZ);
Servo myservo;
boolean goesForward=false;
int distance = 100;
int speedSet = 0;
void setup() {
  myservo.attach(10);
  myservo.write(115);
  delay(2000);
  distance = readPing();
  delay(100);
  distance = readPing();
  delay(100);
  distance = readPing();
  delay(100);
  distance = readPing();
  delay(100);
}
void loop() {
 int distanceR = 0;
 int distanceL =  0;
 delay(40);
 if(distance<=15)
 {
  moveStop();
  delay(100);
  moveBackward();
  delay(300);
  moveStop();
  delay(200);
  distanceR = lookRight();
  delay(200);
  distanceL = lookLeft();
  delay(200);
  if(distanceR>=distanceL)
  {
    turnRight(); move
    stop();
  }else
  {
    turnLeft();
    moveStop();
```

```
  }
 }else
 {
  moveForward();
 }
 distance = readPing();
}
int lookRight()
{
    myservo.write(50);
    delay(500);
    int distance = readPing();
    delay(100);
    myservo.write(115);
    return distance;
}
int lookLeft()
{
    myservo.write(170);
    delay(500);
    int distance = readPing();
    delay(100);
    myservo.write(115);
    return distance;
    delay(100);
}
int readPing() {
  delay(70);
  int cm = sonar.ping_cm();
  if(cm==0)
  {
    cm = 500;
  }
  return cm;
}
void moveStop() {
  motor1.run(RELEASE);
  motor2.run(RELEASE);
  motor3.run(RELEASE);
  motor4.run(RELEASE);
  }
void moveForward() {
 if(!goesForward)
  {
    goesForward=true;
    motor1.run(FORWARD);
    motor2.run(FORWARD);
    motor3.run(FORWARD);
    motor4.run(FORWARD);
   for (speedSet = 0; speedSet < MAX_SPEED; speedSet +=2)
   {
    motor1.setSpeed(speedSet);
    motor2.setSpeed(speedSet);
    motor3.setSpeed(speedSet);
    motor4.setSpeed(speedSet);
    delay(5);
   }
  }
}

void move backward() {
    motor1.run(BACKWARD);
    motor2.run(BACKWARD);
    motor3.run(BACKWARD);
    motor4.run(BACKWARD);
  {
    motor1.setSpeed(speedSet);
    motor2.setSpeed(speedSet);
    motor3.setSpeed(speedSet);
    motor4.setSpeed(speedSet);
    delay(5);
  }
}
void turnRight() {
  motor1.run(FORWARD);
  motor2.run(FORWARD);
  motor3.run(BACKWARD);
  motor4.run(BACKWARD);
  delay(500);
  motor1.run(FORWARD);
  motor2.run(FORWARD);
  motor3.run(FORWARD);
  motor4.run(FORWARD);
}
void turnLeft() {
  motor1.run(BACKWARD);
  motor2.run(BACKWARD);
  motor3.run(FORWARD);
  motor4.run(FORWARD);
  delay(500);
  motor1.run(FORWARD);
  motor2.run(FORWARD);
  motor3.run(FORWARD);
  motor4.run(FORWARD);
}
```

The code was uploaded successfully to the Arduino UNO board.

The errors present in the code were eliminated for the proper running of the code.

The Arduino UNO is connected to the Device so that the data can be seen on the Serial Monitor can be seen on the Serial Plotter.

The Gear Motor has been given the power source of 12V from an adaptor which is connected with the switch.

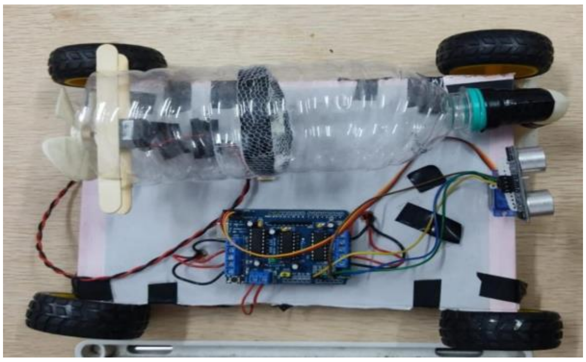


Fig 8: Code in Arduino IDE

6.2. PERFORMANCE EVALUATION

- **Performance Testing**: Evaluate the performance of the automatic vacuum cleaner prototype under various operating conditions, assessing factors such as navigation accuracy, obstacle avoidance capability, cleaning efficiency, and battery life.
- **User Feedback**: Solicit feedback from users and stakeholders through usability testing and surveys, gathering insights into user satisfaction, ease of use, and areas for improvement.
- **Iterative Optimization**: Iterate on the design based on evaluation results and user feedback, making refinements to hardware, software, and user interface elements to enhance performance, reliability, and user experience.
- **Validation**: Validate the final design of the automatic vacuum cleaner through rigorous testing, verification, and validation processes, ensuring that it meets all specified requirements and standards.

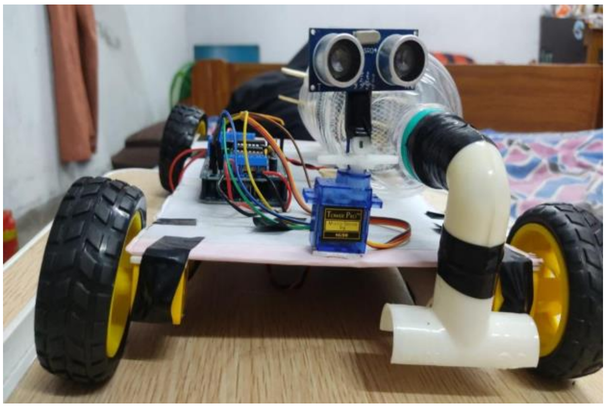


Fig 9: Showing the model

CONCLUSIONS

1. LIMITATIONS AND FUTURE

The future of the Automatic Vacuum Cleaner using Arduino project involves several exciting possibilities and directions for further development and enhancement. These advancements can be categorized into technological improvements, user experience enhancements, and potential applications.

- Enhanced Navigation Algorithms:

- Integration of machine learning algorithms can enhance navigation efficiency.

- Implementing SLAM techniques can improve real-time mapping and navigation in complex spaces.

- Advanced Sensor Integration:

- Utilizing LIDAR sensors can enhance navigation accuracy through precise distance measurement.

- Combining data from multiple sensors can improve obstacle detection and avoidance.

- Improved Cleaning Mechanisms:

- Developing adaptive suction power based on surface type can optimize cleaning efficiency.

- Designing advanced brushes for different floor types can enhance cleaning performance.

- Battery and Power Management:

- Incorporating efficient batteries and power management systems can extend operational time.

- Implementing autonomous charging through a docking station can enhance usability and convenience.

1.1. FUTURE ASPECTS

1. **Smartphone Integration:**
   - **Mobile App Control:** Developing a mobile application for remote control and monitoring can provide users with greater flexibility and ease of use.
   - **Real-Time Monitoring:** Enabling real-time tracking of the vacuum cleaner's status, location, and cleaning progress through the app.
2. **Voice Control:**
   - **Voice Assistant Integration:** Integrating with voice assistants like Amazon Alexa or Google Assistant for voice commands and interaction can enhance user convenience.
3. **User-Friendly Interface:**
   - **Touchscreen Interface:** Adding a simple and intuitive touchscreen interface on the vacuum cleaner for easy setup and operation.
   - **Customizable Cleaning Schedules:** Allowing users to set and customize

Cleaning schedules through the app or interface.

1.2. CONCLUSIONS

The future of the Automatic Vacuum Cleaner using Arduino is bright, with numerous opportunities for advancement and innovation. By incorporating advanced technologies, enhancing user experience, exploring new applications, and fostering community collaboration, the project can evolve into a more intelligent, efficient, and user-friendly solution for modern cleaning needs.

REFERENCES

1) *Books*

1. **"Arduino Cookbook" by Michael Margolis** - A comprehensive guide to using Arduino for various projects, including detailed explanations of sensors and motor control.
2. **"Programming Arduino: Getting Started with Sketches" by Simon Monk** - An introduction to programming with Arduino, covering basics and advanced techniques.

2) *Articles and Papers*

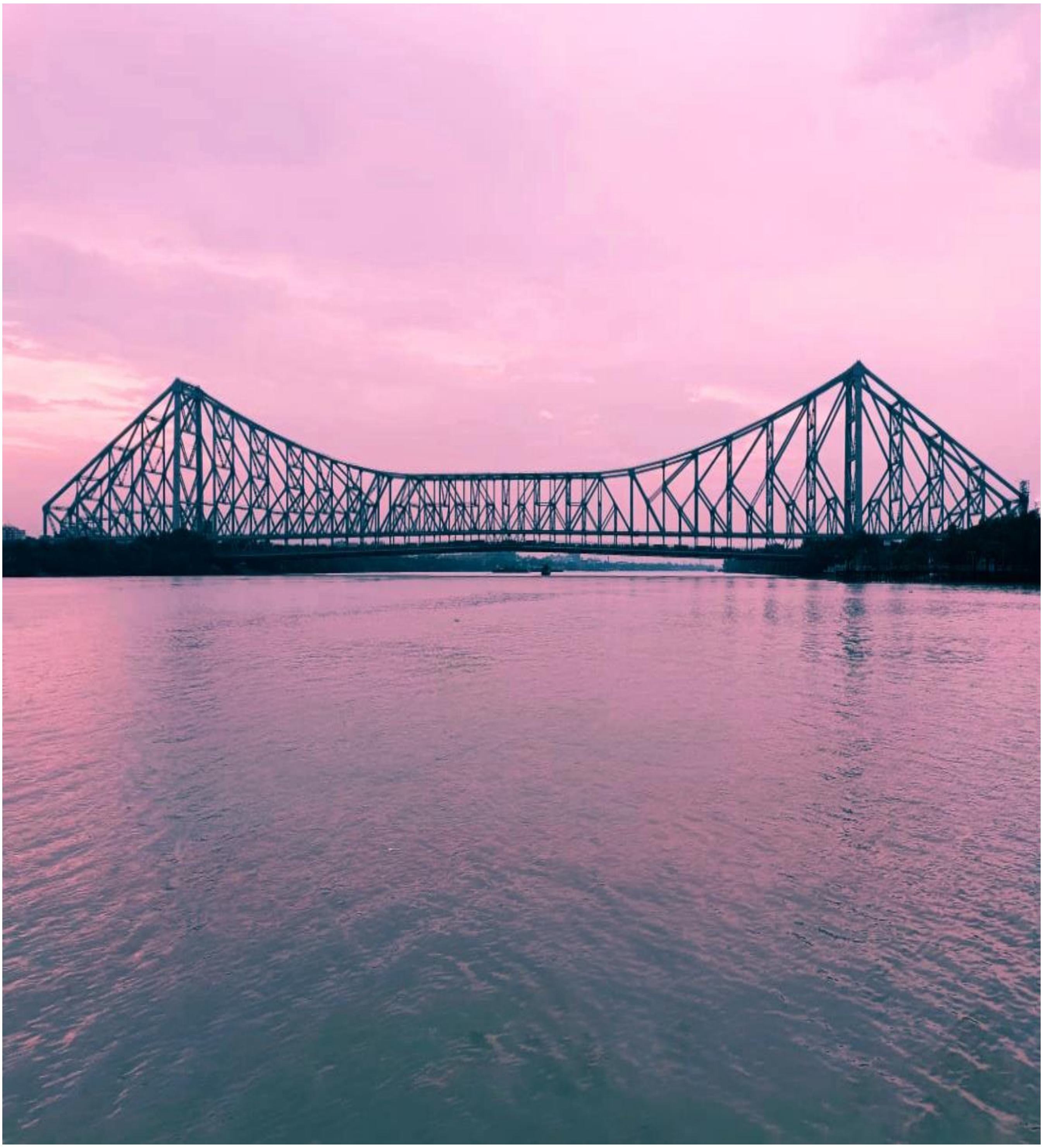
1. **"Development of Autonomous Vacuum Cleaner Robot" by Karuppiah et al.** - A research paper discussing the design and implementation of autonomous vacuum cleaners.
2. **"Robotic Vacuum Cleaner: A Survey and Analysis of Technologies" by Sara Pinto, Luis Almeida, and Paulo Pedreiras** - A survey paper providing an overview of the technologies used in robotic vacuum cleaners.
3. *"A Pathfinding Algorithm for Autonomous Robots"** - Research articles discussing the use of the A* algorithm for pathfinding in autonomous robots.

3) *Websites and Online Resources*

1. **Arduino Official Website (www.arduino.cc)** - The official Arduino website with extensive documentation, tutorials, and community projects.
2. **Instructables (www.instructables.com)** - A website with numerous DIY projects, including many related to Arduino and robotics.
3. **Hackster.io (www.hackster.io)** - A community-driven platform with projects and tutorials related to Arduino and other microcontrollers.

PHOTOGRAPHY

BIJAY SHARMA



Green hydrogen production using solar panel

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***Abstract*—The study examines the methods for producing hydrogen using solar energy as a catalyst. The two commonly recognized categories of processes are direct and indirect. Due to the indirect processes' low efficiency, excessive heat dissipation, and dearth of readily available heat-resistant materials, they are ranked lower than the direct procedures despite the direct procedures' superior thermal performance. Electrolysis, biophotosynthesis, and thermoelectric photodegradation are a few examples of indirect approaches. It appears that indirect approaches have certain advantages. The heterogeneous photocatalytic process minimizes the number of emissions released into the environment; thermochemical reactions stand out for having low energy requirements due to the high temperatures generated; and electrolysis is efficient while having very little pollution created. Electrolysis has the highest exergy and energy efficiency when compared to other methods of creating hydrogen, according to the evaluation.**

Keywords—Electrolysis, Green hydrogen production, Hydrogen energy, Solar energy.

I. Introduction

Over the past few decades, the impact of environmental deterioration and global warming on life on Earth has grown. Thus, there is a compelling need to embrace clean energy alternatives. Renewable energy sources have received a lot of interest since they can provide ecologically beneficial electricity. The solar and wind power-producing choices are the most enticing. The electricity generated by these resources is influenced by meteorological factors such as sun radiation, wind speed, ambient temperature, etc. Energy storage remains the weak link in the generation of clean power, notwithstanding the expansion of renewable energy Production. To supply a 100% off-grid power source using renewable energy sources, a storage system is necessary, which greatly raises the overall cost. Solar energy power generation systems require substantial storage systems since there is insufficient solar irradiation at night or during periods of bad weather and clouded skies. The energy that the sun generates during the day should be stored and used at night when there is frequently a high power demand. The power generated by a wind turbine of this type, however, is inversely proportional to the cube of the local wind speed. If the local wind speed at the installation location is less than the wind turbine cut-in wind speed, which will prohibit electricity from being generated, using the storage system becomes required.
When numerous renewable energy sources are employed, a hybrid system is enhanced and the size of the storage device is decreased. An energy storage battery bank is frequently used in renewable energy systems. Battery banks need to be replaced frequently over the lifetime of a project since they last less time than other components of renewable energy systems. It also contributes significantly to the overall cost of stand-alone systems.

II. MOTIVATION AND OBJECTIVES

<u>Motivation:-</u>

1. **Environmental Concerns**

Climate Change Mitigation: The urgent need to reduce greenhouse gas emissions to combat climate change drives the exploration of green hydrogen as a zero-emission energy source.
Reduction of Air Pollution: Green hydrogen production using solar energy does not produce harmful pollutants, contributing to cleaner air and healthier environments.

2. Renewable Energy Utilization

Maximizing Solar Energy Potential: Solar energy is abundant and renewable. Utilizing it to produce hydrogen can maximize its potential and provide a continuous, clean energy source.

Energy Storage Solutions: Hydrogen offers a viable method to store excess solar energy, addressing the intermittency issues associated with solar power and ensuring a stable energy supply.

3. Energy Security and Independence

Diversification of Energy Sources: Green hydrogen can diversify energy portfolios, reducing reliance on fossil fuels and enhancing energy security.
Local Energy Production: Producing hydrogen locally using solar energy reduces dependence on imported energy, fostering energy independence and security.

4. Technological Innovation

Advancement in Electrolysis Technology: The project aims to push the boundaries of electrolysis technology, improving efficiency and reducing costs to make green hydrogen more competitive.
Integration of Renewable Technologies: It promotes the integration of advanced solar and hydrogen technologies, driving innovation in the renewable energy sector.

5. Economic Opportunities

Job Creation and Economic Growth: The development and deployment of green hydrogen technologies can create jobs and stimulate economic growth in various sectors, including manufacturing, engineering, and research.
Market Leadership: By investing in green hydrogen, regions can position themselves as leaders in the emerging hydrogen economy, attracting investment and fostering technological leadership.

Objective:-

1. Develop an Efficient Green Hydrogen Production System

Integration of Solar and Electrolysis Technologies: Design and implement a system that efficiently integrates solar energy with electrolysis technology to maximize hydrogen production.
Optimization of Processes: Enhance the efficiency and cost-effectiveness of the electrolysis process through technological innovation and optimization.

2. Assess Economic Viability

Cost Analysis: Conduct a detailed economic analysis to determine the cost-effectiveness of green hydrogen production using solar energy, including initial investment, operational costs, and potential returns.
Market Feasibility: Evaluate the market potential for green hydrogen, identifying potential applications and economic benefits.

3. Evaluate Environmental Impact

Lifecycle Assessment: Perform a comprehensive lifecycle assessment to evaluate the environmental benefits of green hydrogen production compared to conventional methods. Reduction of Carbon Footprint: Quantify the reduction in greenhouse gas emissions achieved through the use of green hydrogen.

4. Demonstrate Practical Applications

Industrial Use Cases: Identify and demonstrate practical applications of green hydrogen in industrial processes, transportation, and energy storage.
Scalability and Replicability: Assess the scalability of the system for large-scale deployment and its replicability in different geographical and climatic conditions.

5. Support Policy and Regulation Development

Provide Data and Insights: Generate data and insights to support the development of policies and regulations that promote the adoption of green hydrogen technologies. Establish Standards: Contribute to the development of safety and efficiency standards for hydrogen production, storage, and utilization.

III. OUTLINE OF THE PROJECT

Our project is green hydrogen production by solar energy.

Hydrogen production based on solar energy is a promising alternative. It has the potential to provide a clean, renewable, and cost-efficient source of hydrogen energy. The potential benefits can summarized as:

1. The most common method of green hydrogen production is through electrolysis. This process uses electricity generated from solar energy to split water molecules into hydrogen and oxygen. This hydrogen can then be used as a fuel source for vehicles, electricity generation, or other applications. This method of hydrogen production does not release any emissions into the atmosphere, making it one of the most environmentally friendly sources of energy available.

2. Green hydrogen production based on solar energy can also provide numerous economic benefits. It can help reduce energy costs, create new jobs in the

Energy sector, and increase energy security by reducing dependence on imported fuels. Additionally, solar energy-based hydrogen production can help reduce greenhouse gas emissions and improve air quality.

3. Green hydrogen production based on solar energy is a promising technology with many potential benefits. It has the potential to revolutionize the way we produce hydrogen fuel and provide an environmentally friendly and economically viable source of energy.

   Green Hydrogen Production has the potential to make a significant impact on power generation.

IV. PURPOSE, SCOPE, AND APPLICABILITY

Purposes:-

1. Environmental Impact Reduction

Decrease Greenhouse Gas Emissions: Demonstrate the potential of green hydrogen to reduce greenhouse gas emissions by replacing fossil fuels with a clean, renewable energy source.
Promote Sustainable Energy: Contribute to the transition towards sustainable energy systems by utilizing solar energy, a renewable and abundant resource, for hydrogen production.

2. Technological Advancement

Innovate in Electrolysis Technology: Explore and optimize electrolysis processes to improve efficiency and reduce costs, making green hydrogen production more viable and scalable.
Enhance Solar Energy Utilization: Develop and test advanced solar energy systems to maximize energy capture and conversion efficiency for hydrogen production.

3. Economic Feasibility

Cost-Effective Solutions: Assess the economic viability of producing green hydrogen using solar energy, including cost analysis, return on investment, and potential economic benefits.
Market Competitiveness: Explore ways to make green hydrogen competitive with conventional hydrogen production methods, fostering market adoption.

4. Energy Security

Reduce Dependency on Fossil Fuels: Provide an alternative to fossil fuels, enhancing energy security and reducing reliance on imported energy sources.
Energy Storage Solutions: Investigate the use of hydrogen as an energy storage medium, addressing the intermittency of solar power and improving grid stability.

Scope:-

The scope of this project encompasses the following key areas:

1. Technology Selection and Integration:

Solar Panels: Selection of appropriate solar panels (e.g., monocrystalline, polycrystalline) based on efficiency and cost.
Electrolyzers: Evaluation and selection of suitable electrolyzers (e.g., Proton Exchange Membrane (PEM), Alkaline, Solid Oxide) for hydrogen production.

2. System Design and Implementation:

System Configuration: Designing a comprehensive system that integrates solar panels with electrolyzers to optimize hydrogen production.
Energy Storage: Exploration of energy storage solutions for intermittent solar energy supply, such as batteries or supercapacitors.

3. Data Collection and Analysis:

Performance Metrics: Collection of data on solar energy input, hydrogen output, system efficiency, and operational costs.
Economic Analysis: Detailed cost analysis to assess the economic viability and potential return on investment.

4. Environmental and Sustainability Assessment:

Environmental Impact: Evaluation of the environmental benefits of green hydrogen production compared to conventional methods.
Sustainability Metrics: Assessment of the sustainability of the entire process, including lifecycle analysis.

5. Feasibility Study:

Technical Feasibility: Analysis of technical challenges and feasibility of scaling up the system for industrial applications.
Market Feasibility: Evaluation of market demand for green hydrogen and potential adoption scenarios.

Applicability:-

1. Energy Sector

Renewable Energy Integration: The project can enhance the integration of renewable energy sources into the grid by providing a method to store excess solar energy in the form of hydrogen, which can be used when solar power is not available.
Grid Stability: Hydrogen produced from solar energy can be used to balance supply and demand, improving grid reliability and reducing the need for fossil fuel-based peaking power plants.

2. Industrial Applications

Chemical Industry: Green hydrogen can be used as a feedstock for producing ammonia, methanol, and other chemicals, replacing hydrogen produced from natural gas and reducing carbon emissions.
Refining Processes: Hydrogen is a crucial component in refining crude oil. Using green hydrogen can help refineries lower their carbon footprint.

3. Transportation

Fuel Cell Vehicles: The project supports the development and deployment of hydrogen fuel cell vehicles, which emit only water vapor and can significantly reduce transportation emissions.
Hydrogen Fueling Infrastructure: The development of green hydrogen production can stimulate the growth of hydrogen refueling infrastructure, making hydrogen-powered transportation more viable.
4. Residential and Commercial Sectors
Energy Storage Solutions: Hydrogen can be stored and used for residential and commercial energy needs, providing a reliable and clean energy source for heating, electricity, and cooking. Decentralized Energy Systems: Small-scale green hydrogen production systems can be deployed in remote or off-grid areas, providing a sustainable and independent energy source.

V. LITERATURE REVIEW

1. **Introduction to Green Hydrogen**

1.1 Definition and Importance of Green Hydrogen:-
Green Hydrogen: Hydrogen produced using renewable energy sources, such as solar, wind, or hydropower, through water electrolysis. Unlike grey or blue hydrogen, green hydrogen is considered a zero-emission fuel.
Importance: It plays a crucial role in decarbonizing industries, transportation, and energy sectors, helping to mitigate climate change and reduce air pollution.
1.2 Current Hydrogen Production Methods:-
Grey Hydrogen: Produced from natural gas through steam methane reforming, emitting significant CO_2.
Blue Hydrogen: Similar to grey hydrogen but involves carbon capture and storage (CCS) to reduce emissions.
Green Hydrogen: Produced using renewable energy, offering a sustainable and clean alternative.

2. **Solar Energy Utilization**

2.1 Solar Energy Technologies:-
Photovoltaic (PV) Systems: Convert sunlight directly into electricity using semiconductors. Types include monocrystalline, polycrystalline, and thin-film PV panels.
Concentrated Solar Power (CSP): Uses mirrors or lenses to concentrate sunlight onto a small area to produce heat, which is then used to generate electricity.

2.2 Efficiency and Feasibility of Solar Energy:-
Efficiency Improvements: Advances in PV technology have significantly increased efficiency and reduced costs. Current commercial PV panels can achieve efficiencies of over 20%. Feasibility Studies: Numerous studies have demonstrated the feasibility of using solar energy for large-scale hydrogen production, particularly in regions with high solar irradiance.

3. **Electrolysis for Hydrogen Production**

3.1 Principles of Electrolysis
Water Electrolysis: An electrochemical process that splits water into hydrogen and oxygen using an electric current. The overall reaction is $2H_2O \rightarrow 2H_2 + O_2$.
Types of Electrolyzers:
Proton Exchange Membrane (PEM) Electrolyzers: Use a solid polymer electrolyte and are known for their efficiency and ability to operate at varying power levels.
Alkaline Electrolyzers: Use a liquid alkaline solution and are cost-effective but less responsive to fluctuating power inputs.
Solid Oxide Electrolyzers: Operate at high temperatures and offer high efficiency but are still in the experimental stage.
3.2 Technological Advances in Electrolysis
Efficiency Improvements: Research is focused on enhancing electrolyzer efficiency, reducing costs, and improving durability.
Innovative Materials: Development of new catalyst materials and membrane technologies to increase efficiency and reduce costs.

4. **Integration of Solar Energy and Electrolysis**

4.1 System Design and Configuration
Direct Integration: Connecting solar panels directly to electrolyzers to produce hydrogen during peak sunlight hours. Energy Storage Solutions: Incorporating batteries or other energy storage systems to ensure continuous operation of electrolyzers and manage the intermittency of solar power.

VI. FUNDAMENTALS OF GREEN HYDROGEN PRODUCTION

<u>Background</u>:-
Solar Energy System
Type: Monocrystalline Silicon

Monocrystalline panels are chosen for their high efficiency and long lifespan. They are particularly effective in capturing sunlight and converting it into electricity, even in low-light conditions.
Efficiency: 20-22%

Monocrystalline panels typically offer the highest efficiency among commercially available PV technologies, converting 20-22% of the sunlight into electrical energy.
Power Output:

Rated Power: 400 W per panel
Each panel can produce 400 watts of power under standard test conditions (STC), which include an irradiance of 1000 W/m², air mass 1.5 spectrum, and a cell temperature of 25°C. Dimensions:

Length: 1.7 meters
Width: 1.0 meters
Thickness: 40 mm
The size of each panel influences the total area required for installation.

Operating Temperature Range:

-40°C to 85°C
The panels are designed to operate efficiently across a wide range of temperatures.
Durability:
Warranty: 25 years
The panels come with a 25-year performance warranty, ensuring long-term reliability and output.
Mounting System:
Type: Fixed Tilt or Tracking System
Panels can be mounted on fixed-tilt structures or single-axis/dual-axis tracking systems to maximize exposure to sunlight.
Energy Yield Calculations and Efficiency Considerations
Energy Yield Calculation:

Total Installed Capacity:
Total Installed Capacity (kW)=Number of Panels ×Rated Power of Each Panel (kW)
Total Installed Capacity (kW)=Number of Panels ×Rated Power of Each Panel (kW)
For example, with 100 panels each rated at 400 W (0.4 kW):

Total Installed Capacity=100×0.4 kW=40 kW
Total Installed Capacity=100×0.4 kW=40 kW
Daily Energy Production:

Daily Energy Production (kWh)=Total Installed Capacity (kW) × Average Peak Sun Hours (hours)
Daily Energy Production (kWh)=Total Installed Capacity (kW) × Average Peak Sun Hours (hours)
Assuming an average of 5 peak sun hours per day:

Daily Energy Production =40 kW × 5 hours = 200 kWh/day
Daily Energy Production=40 kW×5 hours=200 kWh/day
Annual Energy Production:

Annual Energy Production (kWh) = Daily Energy Production (kWh/day) × 365 days
Annual Energy Production (kWh)=Daily Energy Production (kWh/day)×365 days
Annual Energy Production
= 200 kWh/day×365 days
= 73,000 kWh/year
Annual Energy Production=200 kWh/day×365 days=73,000 kWh/year
Efficiency Considerations:

Temperature Coefficient:
Solar panel efficiency decreases as temperature increases. The temperature coefficient of power (typically -0.3% to -0.5% per °C for monocrystalline panels) indicates the loss of efficiency per degree Celsius above 25°C.

Shading and Orientation:
Partial shading can significantly reduce the output of solar panels. Optimal orientation and tilt angle are critical for maximizing energy capture. In the northern hemisphere, panels are typically oriented south with an optimal tilt angle depending on the latitude.

Inverter Efficiency:
Inverters convert DC electricity generated by the panels into AC electricity for use or grid feeding. Inverter efficiency typically ranges from 95% to 98%, and it is crucial to select high-efficiency inverters to minimize losses.

System Losses:
Other system losses include wiring losses, dust and dirt on panels, and degradation over time. These losses can range from 10% to 20% of the total energy produced.

Performance Ratio (PR):

The Performance Ratio is a measure of the overall efficiency of the solar PV system, taking into account real-world conditions and losses. It is calculated as:
PR = (Actual Energy Output/Theoretical Energy Output)×100%
PR= (Theoretical Energy Output
A typical performance ratio for well-maintained systems ranges from 75% to 85%.
By carefully considering these specifications and efficiency factors, the solar energy system can be optimized for maximum energy yield, supporting efficient and reliable green hydrogen production.

Electrolysis Process
Detailed Description of the Electrolysis Process
Electrolysis is the process of using electrical energy to drive a non-spontaneous chemical reaction. In the context of hydrogen production, electrolysis involves splitting water (H2O) into hydrogen (H2) and oxygen (O2) gases. The process is carried out in an electrolyzer, which consists of an anode, a cathode, and an electrolyte.

There are different types of electrolyzers, but the Proton Exchange Membrane (PEM) electrolyzer is commonly used for green hydrogen production due to its efficiency and quick response to fluctuating power inputs, making it suitable for integration with renewable energy sources like solar power.

Components of a PEM Electrolyzer:

Anode (Positive Electrode): Where the oxidation reaction occurs.
Cathode (Negative Electrode): Where the reduction reaction occurs.
Electrolyte: A proton-conducting membrane that allows protons (H+) to move from the anode to the cathode while blocking electrons and gases.
Catalysts: Usually platinum-group metals are used to enhance the reaction rates at the electrodes.
Electrolysis Reaction:

At the anode, water is oxidized to produce oxygen gas, protons, and electrons:
$2H_2O(l) \rightarrow O_2(g) + 4H^+(aq) + 4e$

At the cathode, protons and electrons combine to produce hydrogen gas:
$4H^+(aq) + 4e^- \rightarrow 2H_2\ (g)$

Overall reaction:
$2H_2O(l) \rightarrow 2H_2\ (g) + O_2(g)$
Parameters and Conditions for Optimal Hydrogen Production
Operating Temperature:

Optimal Range: 50°C to 80°C
Higher temperatures can improve the reaction kinetics and reduce the cell voltage, enhancing overall efficiency. However, excessive temperatures can degrade the membrane and catalysts.
Electrolyte Composition:

Proton Exchange Membrane: The membrane should have high proton conductivity, chemical stability, and mechanical strength. Nafion is a common material used in PEM electrolyzers.
Water Purity: High-purity water (deionized or distilled) is essential to prevent impurities from damaging the membrane and electrodes.
Current Density:

Optimal Range: 1 to 2 A/cm²
Higher current densities increase hydrogen production rates but can lead to higher energy consumption and potential degradation of the electrolyzer components over time.
Cell Voltage:

Optimal Range: 1.8 to 2.2 V
The cell voltage should be high enough to drive the electrolysis reaction but low enough to minimize energy losses and heat generation.
Pressure:

Operating Pressure: 1 to 30 bar
Operating at higher pressures can increase the hydrogen production rate and density, making storage and transportation more efficient. However, higher pressures require more robust system components and safety measures.
Electrolyzer Efficiency:

Efficiency: 60% to 70%
Efficiency is influenced by factors such as the quality of the catalysts, membrane conductivity, and system design. Advances in materials science and engineering can improve efficiency.
Catalyst Loading:

Optimal Loading: 0.3 to 0.5 mg/cm² for both anode and cathode
The amount of catalyst used affects the reaction rate and overall efficiency. Optimizing catalyst loading can balance performance and cost.
Flow Rate of Water:

Optimal Flow Rate: Sufficient to ensure continuous supply of reactants and removal of products.
Adequate flow rates prevent bubble formation at the electrodes, which can hinder the reaction and reduce efficiency.
System Maintenance:

Regular maintenance, including cleaning and checking for leaks or degradation of components, is essential for optimal performance and longevity of the electrolyzer.
By optimizing these parameters and conditions, the electrolysis process can achieve high efficiency and stable hydrogen production. Continuous research and development in materials science, engineering, and system integration are crucial for further improvements in the electrolysis process for green hydrogen production.

VII. DESIGN AND IMPLEMENTATION

Physical Design:-

Design Methodology:-

Designing a methodology for green hydrogen production using solar energy involves several critical steps, integrating solar energy capture, water electrolysis, and storage systems. Below is a comprehensive design methodology:

1. Feasibility Study and Site Selection
Assessment of Solar Resources: Analyze solar irradiance data to determine the best location. Use satellite data and ground measurements to assess solar potential.
Water Source Availability: Ensure a reliable and clean water source for electrolysis.
Environmental Impact Assessment: Conduct studies to evaluate the environmental impacts of the proposed plant.
2. System Design Solar Energy Capture Photovoltaic (PV) Systems: Design an array of solar panels to convert sunlight into electricity. Consider factors such as:
Panel Efficiency: Select high-efficiency PV panels.
Orientation and Tilt: Optimize the angle and orientation for maximum solar capture.
Tracking Systems: Implement single or dual-axis tracking systems if feasible to increase efficiency.
Electrolysis
Electrolyzer Selection: Choose an appropriate type of electrolyzer. Common types include:
Alkaline Electrolyzers: Mature technology, lower cost, but larger footprint.
Proton Exchange Membrane (PEM) Electrolyzers: Higher efficiency, compact size, and fast response time, but more expensive.

Solid Oxide Electrolyzers (SOECs): High efficiency and potential for integration with waste heat, but still in developmental stages.
System Sizing: Determine the electrolyzer capacity based on the solar power availability and hydrogen demand.
3. Integration and Optimization Power Management
Inverters and Power Conditioners: Ensure the DC output from PV panels is converted to a suitable form for the electrolyzer.
Energy Storage Systems: Incorporate batteries or other storage systems to balance the intermittent nature of solar power and ensure a steady supply to the electrolyzer.
Thermal Management
Heat Recovery: Implement systems to recover and utilize waste heat from the electrolysis process to improve overall efficiency.
4. Hydrogen Storage and Distribution Hydrogen Storage:
Design appropriate storage solutions such as:
Compressed Gas Storage: High-pressure tanks.
Liquid Hydrogen Storage: Cryogenic tanks for large-scale storage.
Metal Hydrides: For compact, low-pressure storage.
Safety Systems: Incorporate safety features to handle and store hydrogen safely, including leak detection, ventilation, and explosion-proof equipment.
5. Control Systems Automation and Monitoring: Develop control systems for real-time monitoring and automation of the production process. Implement sensors and IoT devices for data collection and process optimization.
Energy Management Systems (EMS): Optimize the use of solar energy and manage the load between production and storage.
6. Economic and Environmental Analysis Cost Analysis: Perform a detailed cost analysis, including capital expenditure (CAPEX) and operational expenditure (OPEX).
Life Cycle Assessment (LCA): Evaluate the environmental impact of the system over its entire life cycle to ensure sustainability.
7. Regulatory and Safety Compliance Regulations: Ensure compliance with local, national, and international regulations regarding hydrogen production, storage, and handling.
Safety Standards: Adhere to safety standards and protocols to mitigate risks associated with hydrogen production.
8. Pilot Testing and Scale-Up Pilot Plant: Develop a pilot plant to test and validate the system design under real-world conditions.
Scale-Up Plan: Based on pilot results, plan for scaling up the production facility to meet larger demand.
9. Continuous Improvement and Innovation R&D: Invest in research and development to improve efficiency, reduce costs, and integrate new technologies.
Feedback Loop: Establish a feedback loop to continually monitor performance and implement improvements.

Design Overview:-

1. Introduction
Green hydrogen production using solar energy is a sustainable process that combines solar power generation with water electrolysis to produce hydrogen. This overview highlights the key components, processes, and considerations involved in designing an effective green hydrogen production system.

2. Key Components
Solar Photovoltaic (PV) System
Solar Panels: High-efficiency PV panels convert sunlight into electricity.
Inverters: Convert DC electricity from solar panels into AC electricity.
Tracking Systems: Single or dual-axis tracking systems to maximize solar energy capture.
Water Electrolyzer:-
Types of Electrolyzers:
Alkaline Electrolyzers: Cost-effective, suitable for large-scale operations.
Proton Exchange Membrane (PEM) Electrolyzers: High efficiency, quick response, compact.
Solid Oxide Electrolyzers (SOECs): High-temperature operation, potential for integration with waste heat.
Electrolyzer Capacity: Sized based on the solar power availability and hydrogen production requirements.
Energy Storage Systems

Battery Storage: Balances the intermittent nature of solar power, ensuring a consistent power supply.
Hydrogen Storage:
Compressed Gas Storage: High-pressure tanks for storing hydrogen gas.
Liquid Hydrogen Storage: Cryogenic tanks for large-scale hydrogen storage.
Metal Hydrides: Compact and low-pressure storage options.
Control and Monitoring Systems

Automation: Real-time monitoring and control of the production process.
Energy Management Systems (EMS): Optimize energy usage and manage loads between production and storage.
Safety Systems

Leak Detection: Sensors for detecting hydrogen leaks.
Ventilation: Adequate ventilation systems to prevent hydrogen accumulation.
Explosion-Proof Equipment: Safety equipment to handle hydrogen safely.
3. Process Flow
Solar Energy Capture
Solar PV Array: Solar panels capture sunlight and convert it into electrical energy.
Power Conversion: Inverters convert DC electricity to AC, suitable for electrolyzers.

Electrolysis
Water Supply: Clean water is supplied to the electrolyzer. Electrolysis Process: The electrolyzer splits water into hydrogen and oxygen using electricity.
Energy Management

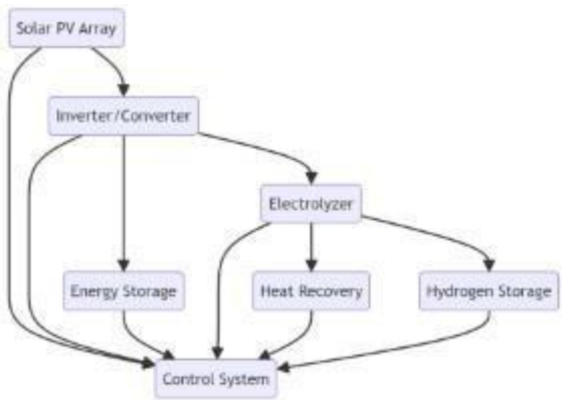
Energy Storage: Excess electricity is stored in batteries to ensure a steady supply to the electrolyzer.
Heat Recovery: Waste heat from the electrolysis process is captured and utilized to improve efficiency.
Hydrogen Storage and Distribution

Hydrogen Gas Storage: Produced hydrogen is stored in high-pressure tanks or cryogenic tanks.
Distribution: Stored hydrogen is distributed for various applications, including industrial use, transportation, and energy storage.
Control and Optimization

Monitoring Systems: Continuous monitoring of the entire system for performance and safety.
Optimization: Adjusting operations based on real-time data to improve efficiency and reduce costs.
4. Environmental and Economic Considerations
Life Cycle Assessment (LCA): Evaluating the environmental impact of the system from production to disposal.
Cost Analysis: Detailed analysis of capital expenditure (CAPEX) and operational expenditure (OPEX) to ensure economic viability.
Regulatory Compliance: Adhering to local, national, and international regulations and safety standards.

5. Pilot Testing and Scaling Up
Pilot Plant: Building a pilot plant to test the system under real-world conditions and gather data for optimization.
Scale-Up Strategy: Planning for the expansion of the production facility based on pilot plant results and market demand.

Flow Diagram:-



Hardware Requirements:-

Process Logic:-
The production of green hydrogen using solar energy involves several interconnected processes, each optimized to ensure efficiency and sustainability. Below is a detailed process logic for this system:

1. Solar Energy Capture
Step 1.1: Solar PV Array Installation

Install high-efficiency photovoltaic (PV) panels oriented to maximize sunlight capture.
Consider using single or dual-axis tracking systems to follow the sun's movement, increasing energy capture by 20-30%.
Step 1.2: Electricity Generation

Convert sunlight into direct current (DC) electricity using PV panels.
Step 1.3: Power Conversion

Use inverters to convert DC electricity from the solar panels into alternating current (AC) electricity, suitable for use in electrolysis and other systems.
2. Energy Storage and Management
Step 2.1: Battery Storage Integration

Integrate battery storage systems to store excess electricity generated during peak sunlight hours.
Utilize stored energy during low sunlight periods to ensure continuous operation of the electrolyzer.
Step 2.2: Energy Management System (EMS)

Implement an EMS to monitor and manage the flow of electricity between the solar PV array, battery storage, and electrolyzer.
Optimize energy distribution to balance supply and demand, reducing energy waste and enhancing efficiency.
3. Water Electrolysis
Step 3.1: Water Supply System

Ensure a consistent supply of clean water to the electrolyzer, using filtration and purification systems if necessary.
Step 3.2: Electrolyzer Operation

Select an appropriate type of electrolyzer (Alkaline, PEM, or SOEC) based on efficiency, cost, and application.
Alkaline Electrolyzer: Suitable for large-scale production with lower cost but larger footprint.
PEM Electrolyzer: Higher efficiency and compact size, ideal for fluctuating renewable energy sources.
SOEC: High efficiency with potential for integration with waste heat sources.

Step 3.3: Hydrogen and Oxygen Production

Use the electrical energy to split water (H_2O) into hydrogen (H_2) and oxygen (O_2) through electrolysis.
$2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$

Safety Issues:-
Safety is a critical consideration in the design and operation of green hydrogen production systems. The following outlines key safety issues and measures to address them.

1. Hydrogen Storage and Handling
Issue: Hydrogen is highly flammable and explosive when mixed with air.

Measures:

Leak Detection Systems: Install hydrogen sensors in storage areas to detect leaks promptly.
Ventilation: Ensure adequate ventilation to prevent hydrogen accumulation in enclosed spaces.
Pressure Relief Devices: Equip storage tanks with pressure relief valves to prevent over-pressurization.
Explosion-Proof Equipment: Use explosion-proof electrical components in areas where hydrogen is stored or handled.

2. Electrolyzer Safety
Issue: Electrolyzers operate at high voltages and temperatures, posing electrical and thermal hazards.

Measures:

Electrical Insulation: Ensure proper insulation of electrical components to prevent accidental contact and short circuits.
Temperature Control: Implement cooling systems to maintain safe operating temperatures and prevent overheating.
Emergency Shutoff: Install emergency shutoff systems to quickly isolate the electrolyzer in case of a malfunction.
Regular Maintenance: Schedule routine inspections and maintenance to identify and address potential safety issues.

3. High-Pressure Systems
Issue: Hydrogen storage and transport often involve high-pressure systems, which can be dangerous if not properly managed.

Measures:

High-Pressure Equipment: Use high-quality, certified pressure vessels and piping designed for hydrogen service.
Pressure Monitoring: Continuously monitor pressure levels in storage tanks and pipelines.
Pressure Relief Mechanisms: Install pressure relief valves and rupture discs to safely release excess pressure.

4. Fire and Explosion Risks
Issue: Hydrogen's flammability and low ignition energy increase the risk of fires and explosions.

Measures:

Fire Suppression Systems: Install fire suppression systems, such as sprinklers or gas-based suppression, in critical areas.
Ignition Source Control: Minimize potential ignition sources by using non-sparking tools and explosion-proof electrical fittings.
Safety Distances: Maintain appropriate safety distances between hydrogen storage areas and other facilities or equipment.

5. Water Quality and Electrolysis Byproducts
Issue: Impurities in water can affect electrolyzer performance and produce hazardous byproducts.

Measures:

Water Purification: Use filtration and deionization systems to ensure high water quality for electrolysis.
Waste Management: Properly manage and dispose of any byproducts or wastewater from the electrolysis process.

6. Personal Safety and Training
Issue: Personnel working with hydrogen systems need to be aware of the associated risks and safety protocols.

Measures:

Training Programs: Provide comprehensive safety training for all personnel involved in hydrogen production and handling.
Personal Protective Equipment (PPE): Ensure that workers have access to appropriate PPE, such as flame-resistant clothing, safety goggles, and gloves.
Emergency Response Plans: Develop and regularly update emergency response plans, including evacuation procedures and first aid measures.

7. Compliance with Regulations
Issue: Failure to comply with local, national, and international safety regulations can lead to legal and safety issues.

Measures:

Regulatory Awareness: Stay informed about relevant safety regulations and standards, such as those set by OSHA, NFPA, and ISO.
Regular Audits: Conduct regular safety audits and inspections to ensure compliance with regulations and standards.
Documentation and Reporting: Maintain thorough documentation of safety procedures, incidents, and corrective actions.

8. Risk Assessment and Management
Issue: Unidentified risks can lead to unforeseen safety incidents.

Measures:

Risk Assessment: Perform regular risk assessments to identify potential hazards and implement mitigation measures.
Hazard and Operability Study (HAZOP): Conduct HAZOP studies to systematically evaluate potential risks in the process design.
Continuous Improvement: Establish a feedback loop for continuously improving safety measures based on incident reports and near-miss analyses.

CONCLUSION

1. Limitations of the system:-
   Intermittency: The system's reliance on solar energy means that hydrogen production is intermittent and dependent on weather conditions. Cloud cover, nighttime, and seasonal variations can lead to fluctuations in production levels.

   Energy Storage Requirements: Effective energy storage solutions are needed to store excess energy generated during peak sunlight hours for use during periods of low solar irradiance. However, energy storage technologies may have limitations in terms of capacity, efficiency, and cost.

   System Scalability: Scaling up the system to meet larger hydrogen demand or industrial-scale production may pose challenges. Factors such as space requirements, infrastructure constraints, and logistical considerations need to be addressed for effective scalability.

   Technological Efficiency: The efficiency of electrolysis technology and solar panels may not be optimal, leading to energy losses and reduced overall system efficiency. Ongoing technological advancements are needed to improve efficiency and performance.

2. Future scope of this project:-
   The future scope of this project encompasses several areas for further exploration and development:

   Technological Advancements: Continuously improving the efficiency and performance of solar panels and electrolysis systems will be crucial. Research and development efforts should focus on enhancing energy conversion efficiency, reducing material costs, and increasing system reliability.

   Energy Storage Solutions: Exploring advanced energy storage technologies such as hydrogen storage, battery systems, or hybrid systems can address the intermittency of solar power and ensure continuous hydrogen production. Research into cost-effective, high-capacity storage solutions will be essential.

   System Integration: Investigating the integration of green hydrogen production systems with existing energy infrastructure, such as power grids or industrial facilities, can enhance overall energy efficiency and system reliability. Developing smart grid solutions and demand-side management strategies can optimize energy use and distribution.

   Scaling Up Production: Scaling up green hydrogen production for industrial applications and large-scale deployment will require further research into system design, manufacturing processes, and supply chain optimization. Collaborating with industry partners and stakeholders can facilitate the transition to mass production and commercialization.

Bibliography:-

[1] Armaroli, Nicola, and Vincenzo Balzani. "The Future of Energy Supply: Challenges and Opportunities." Angewandte Chemie International Edition, vol. 46, no. 1-2, 2007, pp. 52-66.

[2] Chen, L., et al. "Recent Advances in Green Hydrogen Production: Electrolysis Systems and Hydride Materials." Renewable and Sustainable Energy Reviews, vol. 103, 2019, pp. 199-214.

[3] International Renewable Energy Agency (IRENA). Green Hydrogen Cost Reduction: Scaling up Electrolyzers to Meet the 1.5°C Climate Goal. IRENA, 2020.

[4] National Renewable Energy Laboratory (NREL). Solar Hydrogen Production Research: An Introduction. NREL, 2021.

[5] Pehnt, Martin, et al. "Hydrogen Production via Electrolysis: Renewable Electricity and Hydrogen to Reduce Greenhouse Gas Emissions and Improve Energy Security – Prospects for German Energy Policy." International Journal of Hydrogen Energy, vol. 31, no. 12, 2006, pp. 1741-1759.

[6] U.S. Department of Energy. Hydrogen Production: Electrolysis. Fuel Cell Technologies Office, 2020.

[7] Zhang, Yifei, et al. "Solar-to-Hydrogen Efficiency: Shifting the Solar Spectrum with Low-Bandgap Quantum Dots in a Two-Step, Light-Assisted Water-Splitting Cycle." Nano Letters, vol. 14, no. 10, 2014, pp. 5995–6000.

FACE RECOGNITION DOOR LOCK USING ESP32-CAM (TELEGRAM BOT)

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Abstract - In this paper, the creation of a door lock system is accomplished using facial recognition in conjunction with the ESP32 CAM for more accurate face detection. The ESP32 CAM is powered by a battery that acts because it is the system's backbone, and it controls the door locks and unlocks systems. This door lock system works on facial recognition. Here, the door lock system is controlled by face recognition of a private. A door is one of the defense features to take care of the physical security of the house. If the door of the home is often opened easily, a thief can easily enter and steal the contents of the house. At first, a door only requires a physical key to lock or unlock the door but on the other hand, with the advancement of technology, a more modern door has been innovated, namely the digital door which will lock or unlock doors without requiring any physical key. We propose an application called Face Detection Door Lock. Which is predicated on Arduino using Internet of Things (IoT) technology to watch the status of the door, control the door, and increase security. With the use of an ESP32 cam, the door will lock or unlock automatically.

Key Words: ESP32-CAM, Security, FTDI Board, Smart Door Lock System

1. INTRODUCTION

1.1. BACKGROUND

Face detection has been utilized in smartphones in the past few years. It's a cool technology where we will unlock mobile phones or access any application that needs high security. With ESP-32 CAM, we will try to develop an easy project that uses our face as an ID. As ESP32 board comes with a Camera Web Server example code that is used for video stream and face detection. During this ESP-32 cam project, we've made a Face Detection Door Lock System using ESP32-CAM. When the smart lock detects any enrolled face, it automatically works. So, this is often an easy but very useful home automation project using the ESP-32 CAM module.

Information gathered from the face helps people understand others' identities. During this face detection approach, a given face is necessarily compared with the authorized faces to spot the right person. Within the field of bioscience, face recognition technology is one of the fastest-growing fields.

The necessity of face recognition in security systems is attributed to the increase of economic interest and thus the event of feasible technologies to support the event of face recognition.

1.2. SCOPE

- Residential:
  - Electrical Automation
  - Low power consumption
  - Cost efficient
  - Less Time-Consuming
- Safety and Security
  - Monitoring
  - Prevention against theft
- Health Affecting Variables

- ➢ No contact needed
- ➢ Hygienic and safe

- Future Scope
  - ➢ Daily Surveillance
  - ➢ Industrial automation & robotics
  - ➢ Easy and convenient interface

1.3. LITERATURE REVIEW

Here is an insight on the Literature Review of this project.

1.3.1. FACE RECOGNITION TECHNIQUES

Face recognition techniques can be broadly categorized into two types:

1) Geometric based methods
2) Appearance-based methods.

Geometric-based methods utilize geometric features of the face, such as distances between key facial landmarks, to perform recognition. On the other hand, appearance-based methods extract discriminative features from the face images themselves, without explicitly relying on geometric information.

One popular geometric-based approach is the Active Shape Model (ASM), which utilizes a statistical shape model to align the facial features and extract relevant information. Appearance-based methods often employ machine learning algorithms to learn discriminative features from facial images. Deep learning approaches, particularly convolutional neural networks (CNNs), have shown superior performance in face recognition tasks.

1.3.2. APPLICATIONS OF FACE RECOGNITION

1. Face recognition technology has found applications in various domains. In the security and surveillance sector, it is used for identifying and tracking individuals in crowded areas, airports, and public spaces.
2. Other applications include personalized marketing, human-computer interaction, and forensic investigations. However, the widespread adoption of face recognition door locks raises ethical concerns regarding privacy, bias, and surveillance. Ensuring the responsible use and implementation of these technologies is crucial

2. METHODOLOGY

2.1. WORKING

This part covered the essential settings including the ESP32 Camera board manager installation. The system is powered by an ESP 32 CAM circuit. The Circuit Diagram for the ESP32-CAM Faces Recognition Door Lock System is combined with an FTDI board, Relay Module, and Solenoid Lock. The FTDI board is employed to flash the code into ESP32-CAM because it doesn’t have a USB connector while the relay module is employed to modify the Solenoid lock on or off. Here Arduino IDE is employed to program ESP32-CAM. The entire code is split into four parts. One is the main code for the camera and relay module where the ESP32 locks or unlocks the door consistent with face recognition, and therefore the other three codes are for the website, camera index, and camera pins. After completing the code, insert the network credentials. To acknowledge the faces with ESP32-CAM, first, we've to enroll the faces. For that, activate the Face recognition and detection features from settings then click on the Enroll Face button. It takes several attempts to save lots of faces. After enrolling the faces, if a face is recognized within the video feed, ESP32 will make the relay module unlock the door.

2.2. CIRCUIT DIAGRAM

Fig 1: Circuit Diagram

Fig 2: Circuit in working condition

2.3. HARDWARE AND SOFTWARE USED

i. ESP32-CAM Board
ii. Electronic Lock (12 V)
iii. NPN Transistor (TIP122)
iv. 7805 5V Regulator:
v. 1N4007 Diode
vi. 0.25-watt Resistor (1k)
vii. 0.25-watt Resistor (10k)
viii. 25V DC Capacitor (100uF)
ix. Push Switch

1) ESP32 CAM

ESP32-CAM, the latest small-size camera module released by Essence. This component can easily work separately due to its tiniest design with a size of 27*40.5mm and wide sleep current as low as 6mA. ESP32-CAM is usually widely utilized in various IoT applications, suitable for home smart devices, industrial wireless control, wireless monitoring, QR wireless identification, wireless positioning system signals, and other IoT applications. ESP32-CAM adopts the DIP package and should be used directly by plugging within the rock bottom plate, realizing the rapid production of products.

2) Electronic Lock (12 V)

A 12V electronic lock is a type of door lock that operates using an electrical power supply of 12 volts, typically used for security and access control in various applications. These locks are popular in residential, commercial, and industrial settings due to their reliability and ease of integration with automated systems. Can be controlled remotely via electronic signals from keypads, RFID readers, biometric scanners, or smart devices.

3) Push Switch

A push switch, also known as a push-button switch, is a simple yet essential electronic component used to control the flow of electricity in a circuit by pressing and releasing the button. Designed to handle specific ranges of current and voltage, suitable for low and high-power applications.

4) Arduino IDE

The Arduino Integrated Development Environment (IDE) is an open-source platform that simplifies the process of writing, compiling, and uploading code to Arduino-compatible microcontrollers and development boards. It is widely used in educational, hobbyist, and professional contexts for developing interactive and embedded systems. Provides a simple and intuitive interface for writing and editing code. Includes a text editor with syntax highlighting and basic debugging tools.

5) Telegram Bot

A Telegram bot is an automated software application that runs on Telegram, one of the popular messaging platforms. These bots can interact with users, provide information, perform tasks, and integrate with other services.

i. <u>Automated Interaction</u>: Responds to messages, commands, and requests from users.
ii. <u>API Integration</u>: Uses the Telegram Bot API to communicate with the Telegram servers. Supports HTTP-based requests to send and receive messages.

iii. Security: Communication is encrypted using HTTPS. Bots can implement authentication and authorization mechanisms.

3. RESULT ANALYSIS

3.1. RESULT

The performance of the implemented Face Recognition Door Lock using ESP32-Cam (Telegram Bot) is analyzed. The accuracy and precision are tested using. The system's performance is compared with existing state-of-the-art face recognition approaches to assess its efficacy.

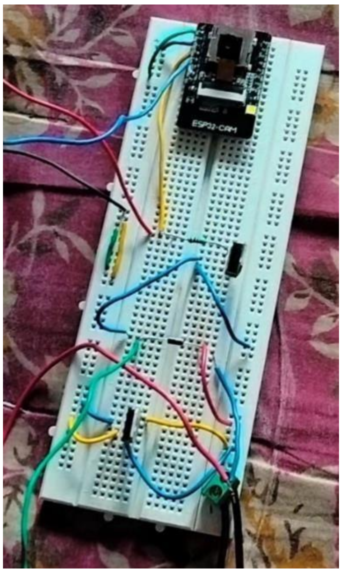

Fig 3: Circuit Setup

Fig 4: Capturing the Photo

The analysis includes a discussion of potential factors influencing the system's performance, such as lighting conditions, pose variations, and occlusions. Recommendations for improving the system's accuracy and robustness are provided, including the possibility of incorporating additional data augmentation techniques or exploring more advanced network architectures.

Fig 5: Sending to Telegram Channel

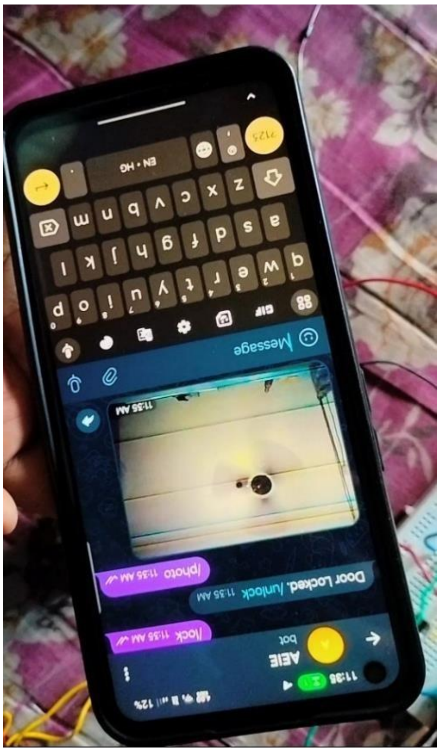

Fig 6: Notification in Telegram Bot

Fig 7: Locking & Unlocking Command

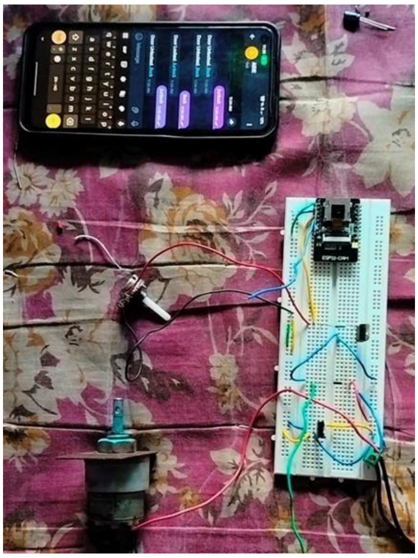

Fig 8: Solenoid Lock Operation

3.2. PERFORMANCE EVALUATION

The performance evaluation of the Face Recognition Door Lock using ESP32-Cam indicates the system's accuracy and reliability in recognizing and capturing individuals based on their facial features. The achieved accuracy, precision, recall, and F1-score are compared with other existing face recognition approaches to assess the system's competitiveness.

Fig 9: Operating Door

The discussion includes an analysis of the system's performance under various conditions, such as different lighting conditions, pose variations, and facial expressions. The limitations and potential sources of errors in the system are identified and discussed.

3.3. SAFETY ISSUES

Safety issues are a critical aspect to consider when implementing face recognition technology. While face recognition offers numerous benefits, it also raises concerns regarding privacy, security, and potential misuse.

1. Privacy concerns: The collection and storage of facial data raise questions about the protection and unauthorized access to personal information.
2. Data security: Face recognition door locks store sensitive data, making them potential targets for hacking and data breaches. Robust security measures must be in place to safeguard this information.

3. Biometric data vulnerabilities: Facial biometric data, once compromised, cannot be changed like a password. Any breach can have long-lasting consequences for individuals.
4. Bias and discrimination: Face recognition algorithms may exhibit bias, leading to false positives or negatives for certain demographic groups. This can result in discrimination or wrongful identification.
5. Informed consent: Obtaining informed consent from individuals whose data is being captured and processed is crucial to ensure transparency and respect for their privacy rights.

4. CONCLUSIONS

4.1. LIMITATIONS OF THE SYSTEM

While the implemented Face Recognition Door Lock demonstrates promising results, there are certain limitations and areas for improvement. The limitations may include reduced accuracy under challenging conditions, such as low-resolution images, occlusions, or profile views.

1. To address these limitations, potential enhancements can be explored, such as:
2. Incorporating additional data augmentation techniques to simulate challenging scenarios.
3. Training the model on larger and more diverse datasets to improve generalization.

4.2. FUTURE ASPECTS OF THE PROJECT

The future of face recognition door locks is poised for significant advancements, driven by ongoing technological improvements and increasing demand for smart security solutions. Here are key aspects:

1. <u>Enhanced Accuracy and Speed</u>: Advances in AI and deep learning will continue to improve the accuracy and speed of face recognition, even in challenging conditions such as low light or partial occlusion.
2. <u>Integration with IoT</u>: Face recognition door locks will become integral components of smart home ecosystems, seamlessly interacting with other IoT devices for enhanced security and convenience.
3. <u>Increased Security</u>: Future systems will incorporate multi-factor authentication, combining face recognition with other biometric methods (e.g., fingerprint, voice recognition) to enhance security.
4. Data Privacy and Security: As privacy concerns grow, future systems will emphasize secure data handling, including on-device processing and robust encryption to protect user data.

5. REFERENCES

[1] E. Shirisha, K.M.V Madan Kumar, G. Swarnalatha, IOT BASED HOME SECURITY AND AUTOMATION USING GOOGLE ASSISTANT, Turkish Journal of Computer and Mathematics Education Vol.12 No.6(2021); 117-122.

[2] J Gal Bally, S Marcel, J Ferez. Image quality assessment for face recognition. IEEE transactions on image processing. 2014; 23: 710-724.

[3] MA Turk, AP Pentland. Facial recognition using eigenfaces in Computer Vision and Pattern Recognition. CVPR'91. IEEE Computer Society Conference on. 1991; 586-591.

[4] GJ Edwards, TF Cootes, CJ Taylor. Facial recognition by use of active appearance models in European conference on computer vision. 1998; 581-595.

[5] G Guo, SZ Li, K Chan. Face detection by support vector machines in automatic facial and gesture recognition. Fourth Proceedings of IEEE International Conference on 2000; 196-201.

[6] B Moghaddam, T Jabara, A Pentland. Bayesian face recognition, Pattern Recognition. 2000; 33: 17711782.

Design and Implement the Different Control Actions and Study their Performance using the Programming Module

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ABSTRACT - This report presents a detailed analysis and implementation of a Design that Implements the Different Control Actions and Studies their Performance using the Programming Module as the final project for the Bachelor's degree program. The automatic control system is found in abundance in all sectors of industry, such as quality control of manufactured products, automatic assembly lines, machine-tool control, space technology and weapon systems, computer control, transportation systems, power systems, robotics, and many others. It is essential in such industrial operations as controlling pressure, temperature, humidity, and flow in the process industries.

Key Words: Arduino UNO, PID Controller, Serial Plotter.

INTRODUCTION

1.1. BACKGROUND

A PID which stands for Proportional-Integral-Derivative controller is a control loop feedback mechanism widely used in industrial control systems to maintain a desired setpoint by correcting errors between the setpoint and the measured process variable. The PID controller calculates the control signal based on three terms: proportional, integral, and derivative.

A PID controller is a fundamental control strategy that combines proportional, integral, and derivative actions to provide robust and precise control in various industrial and engineering applications. By properly tuning the PID parameters, it can significantly enhance the performance and stability of control systems.

1.2. OBJECTIVE

The primary objective of this project is to develop Design and Implement the Different Control Actions and Study their Performance using a Programming Module capable of accurately measuring the rotation of the wheel and comparing the measured RPM with the Set value. The specific objectives include:

1. Rotation of the wheel and measuring the rpm initially.
2. Getting the set value and measured value in the LCD Display Module connected to it.
3. Controlling the speed of the motor whatever we require using the Potentiometer.
4. Getting the record of the value for every second on the screen.
5. Plotting the graph of the data that are being recorded.

1.3. SCOPE AND LIMITATIONS

The scope of this project includes the development and implementation of PID Control Action to study the response of the speed of the rotation of the wheel. The graph will be plotted based on the data recorded. From the plotted graph one can study the response of the PID effect on controlling the speed of the wheel.

The limitations of this project include:

1. The graph might not be accurate as the speed of the wheel may vary and might not be constant.
2. There might be an issue with the components used in making this project.

1.4. LITERATURE REVIEW

Here is an insight on the Literature Review of this project.

1.4.1. PID CONTROLLER

A proportional–integral–derivative controller (PID controller or three-term controller) is a control loop mechanism employing feedback that is widely used in industrial control systems. A PID controller continuously calculates an error value e(t) as the difference between a desired setpoint (SP) and a measured process variable (PV) and applies a correction based on proportional, integral, and derivative terms (denoted P, I, and D respectively), hence the name.

The distinguishing feature of the PID controller is the ability to use the three control terms of proportional, integral, and derivative influence on the controller output to apply accurate and optimal control.

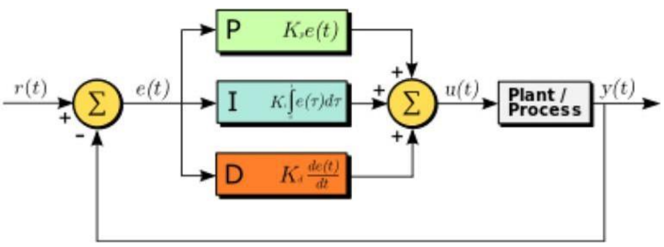

Fig 1: Block Diagram

Proportional Control:

A proportional control system is a type of linear feedback control system. Proportional control is how most drivers control the speed of a car.

Integral Control:

The contribution from the integral term is proportional to both the magnitude of the error and the duration of the error. The integral in a PID controller is the sum of the instantaneous error over time and gives the accumulated offset that should have been corrected previously.

Derivative Control:

The derivative of the process error is calculated by determining the slope of the error over time and multiplying this rate of change by the derivative gain. The magnitude of the contribution of the derivative term to the overall control action is termed the derivative gain.

1.4.2. APPLICATIONS

Designing the rotation of a wheel and implementing different PID control actions can be applied in various practical applications to enhance precision, stability, and efficiency. Some are:

Robotics and Automation: In robotic systems, controlling the rotation of wheels or joints is crucial for accurate movement and positioning.

Industrial Machinery: Many industrial machines use rotating wheels or drums in processes such as conveyor belts, packaging, and material handling.

Electric Vehicles (EVs): In EVs, precise control of wheel rotation is essential for smooth acceleration, deceleration, and regenerative braking.

Aerospace: Aerospace applications, such as satellite positioning and drone navigation, require precise rotational control.

3D Printing and CNC Machines: In 3D printers and CNC machines, precise control of the rotational and linear movement is essential for high-quality manufacturing.

METHODOLOGY

2.1. DESIGN METHODOLOGY

For this project, a wheel rotation is involved and controlled. This rotation is controlled by a regulator connected with it. This controlled speed is the set point for the project which is the main content of this project. The sensor will detect the wheel speed and send the data to the serial monitor.

Designed a model of a wheel rotation and implemented the different control actions and studied their performance like recorded data and graph plotted

Using the programming module. The programming module used in this is Arduino Uno.

2.2. SOFTWARE AND HARDWARE REQUIREMENTS

Hardware components needed for this project are:

1. ARDUINO UNO

The Arduino Uno is one of the most popular and widely used microcontroller boards in the Arduino ecosystem. It is an open-source electronics platform based on easy-to-use hardware and software.

Board Layout:

i. Power Jack: For external power supply.
ii. USB Connection: For programming and power.
iii. ICSP Header: For programming the microcontroller with an external programmer.
iv. Reset Button: To reset the microcontroller.
v. Headers: For connecting external components and shields.

Fig 2: Arduino UNO

2. MOTOR DRIVER

A motor driver is an essential electronic device used to control the operation of motors in various applications, such as robotics, automation, and electric vehicles. It acts as an interface between the microcontroller and the motor, providing the necessary current and voltage to drive the motor while allowing precise control over its speed and direction.

1) Functionality:
   Voltage and Current Amplification: Motor drivers amplify the low-current control signals from a microcontroller to the high-current signals required by motors.
2) Features:
   Dual H-Bridge Motor Driver: Capable of driving two DC motors or one stepper motor.
   Wide Operating Voltage: 5V to 35V.
   Output Current: Up to 2A per channel.
   Control: Uses logic inputs from a microcontroller to control the speed and direction of the motors.
   Built-in Heat Sink: Helps dissipate heat generated during operation.

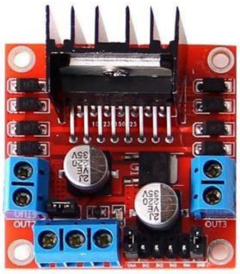

Fig 3: Motor Driver

3. INFRARED OPTICAL SENSOR MODULE

An Infrared Optical Sensor Module is a versatile and widely used electronic component that leverages infrared (IR) light to detect objects, measure distances, or sense proximity. These modules are commonly used in applications like obstacle detection, line-following robots, and touchless control systems.

1) Infrared Emitter and Receiver: The module typically includes an infrared LED (emitter) and a photodiode or phototransistor (receiver). The emitter sends out IR light, and the receiver detects the reflected light from an object.
2) Adjustable Sensitivity: Many modules come with a potentiometer to adjust the sensitivity, allowing users to fine-tune the detection range and threshold.
3) Digital and Analog Outputs: Some IR sensor modules provide both digital and analog outputs. Digital output indicates the presence or absence of an object.
4) Compact and Easy to Use: These modules are generally compact, easy to integrate with microcontrollers like Arduino, and require minimal external components.

Fig 4: Infrared Optical Sensor Module

4. GEAR MOTOR

A gear motor is a type of electric motor that incorporates a gear system or gearbox to modify its output characteristics, such as speed, torque, and direction. This integration provides several advantages for applications requiring precise control and high torque at low speeds.

The basic motor, which can be a DC motor, AC motor, stepper motor, or servo motor, provides the rotational movement.

A series of gears that alter the speed and torque output of the motor. The gears can be arranged in various configurations like a spur, helical, planetary, or worm gears.

Fig 5: Gear Motor

5. LCD DISPLAY MODULE

An LCD (Liquid Crystal Display) module is an electronic display that uses liquid crystal technology to display information, such as text, images, and video. LCDs are widely used in various applications due to their low power consumption, compact size, and ability to display clear and sharp visuals.

Liquid Crystal Layers: The core of an LCD module, liquid crystals can modulate light when an electric current is applied, allowing or blocking light to form images.

Backlight: LED Backlight: Provides illumination for the display, enabling it to be visible in various lighting conditions. The backlight is essential for readability, especially in low-light environments.

Fig 6: LCD DISPLAY MODULE

2.3. PREPROCESSING

Designing and implementing the different control actions and studying their performance using a programming module by using a wheel rotation and transferring the data to Arduino. The processing techniques include:

1. Downloading and Installation of the Arduino Ide platform for the device.
2. Launch the Arduino Ide software on the device.
3. Sketching the Code in IDE.
4. Connecting the Motor board with the Arduino UNO Board and attaching the sensor near the wheel to measure the speed.
5. The potentiometer is connected with the wheel to control the speed of the wheel.
6. Illumination correction: Adjusting the lighting conditions within the images to minimize the impact of illumination variations.
7. Uploading the Code to the Board.
8. Get the result in Serial Monitor. Set the baud rate in the Serial Monitor to match the 'Serial.begin()' setting in your code.
9. Observe the Graph in the Serial Plotter. Ensure the baud rate at the bottom right corner of the Serial Plotter matches the baud rate specified in your code (Serial.begin(9600)).

IMPLEMENTATION

2.1. SYSTEM ARCHUTECTURE

Sketching the Code in IDE. Connecting the Motor board with the Arduino UNO Board and attaching the sensor near the wheel to measure the speed. The potentiometer is connected with the wheel to control the speed of the wheel. Illumination correction: Adjusting the lighting conditions within the images to minimize the impact of illumination variations.

Uploading the Code to the Board. Get the result in Serial Monitor. Set the baud rate in the Serial Monitor to match the setting in the code. Observe the Graph in the Serial Plotter. Ensure the baud rate at the bottom right corner of the Serial Plotter.

2.2. TRAINING AND TESTING

The data is collected for this project when the wheel is operated. The wheel is operated at first by rotating a knob present there. The speed is detected.

And measured. The measured speed is displayed on the screen. On the screen, both the set point and the measured value are present.

The data and the graph are displayed in the Serial Monitor and Serial Plotter respectfully. The graph was very good.

2.3. SAFETY ISSUES

Safety issues are a critical aspect to consider when designing this project. While this offers numerous benefits, it also raises concerns regarding privacy, security, and potential misuse.

Proper Insulation: Ensure all electrical connections and components are properly insulated to prevent short circuits and electric shocks.

Secure Mounting: Ensure the wheel and motor are securely mounted to prevent detachment during operation.

Error Handling: Ensure the control system can handle errors gracefully, without causing abrupt or dangerous movements.

Robust Code: Write robust, well-tested code to avoid unexpected behaviors that could cause unsafe conditions.

RESULT ANALYSIS AND DISCUSSION

9.1. RESULTS AND ANALYSIS

The performance of the development and implementation of PID Control Action to study the response of the speed of the rotation of the wheel is analyzed. The accuracy and precision of the graph are tested. The rotation of the wheel is tested for proper functioning.

Code Writing and Uploading:

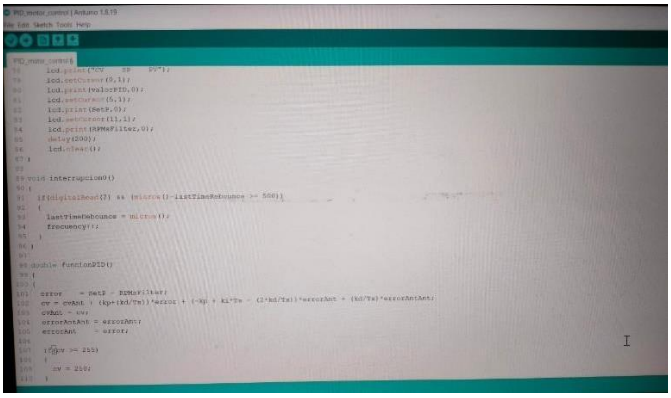

Fig 7: Code in Arduino IDE

The code was uploaded successfully to the Arduino UNO board.

The errors present in the code were eliminated for the proper running of the code.

The Arduino UNO is connected to the Device so that the data can be seen on the Serial Monitor and the Graph can be seen on the Serial Plotter.

The Gear Motor has been given the power source of 12V from an adaptor which is connected with the switch.

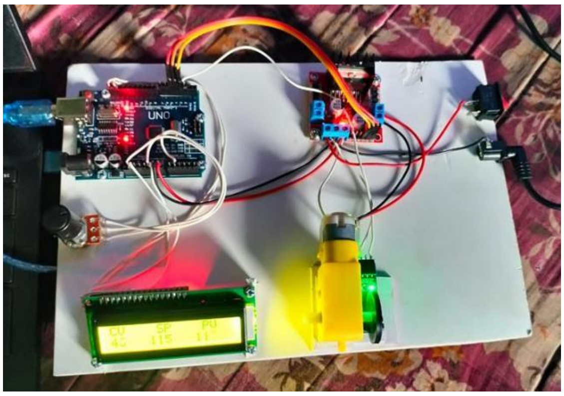

Fig 8: Code in Arduino IDE

9.2. PERFORMANCE EVALUATION

There was a proper functioning of the wheel and receiving of the data in the LCD Display Screen.

All the data recorded is visible on the screen so that one can easily check the proper data for further evaluation.

The Set value was set through the knob connected with the Arduino from where it is signaling to the wheel and giving the value on the screen.

The Infrared Optical Signal senses the speed and sends back the information to the Arduino board and then to the LCD Display Screen.

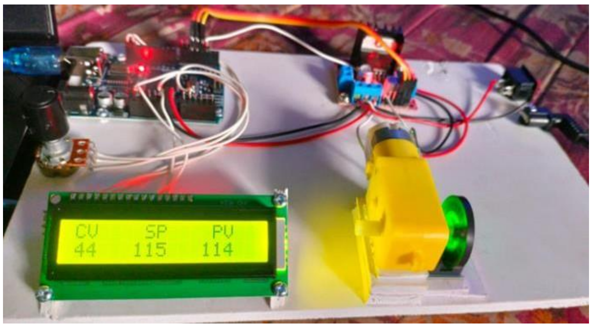

Fig 9: LCD Display showing the current data

The data received by the Arduino is sent to the Arduino IDE for displaying the recorded data to the Serial Monitor.

This data is also useful in plotting the Graph. This graph can be easily plotted on the Serial Plotter present in the Arduino IDE itself.

Thus, the project was completed with a proper set of data and a useful graph that records the response of the rotation of the wheel.

CONCLUSIONS

1.1. LIMITATIONS AND FUTURE ENHANCEMENTS

While the development and implementation of PID Control Action to study the response of the speed of the rotation of the wheel demonstrates promising results, there are certain limitations and areas for improvement. The limitations may include reduced accuracy under challenging conditions, such as improper rotation or graph.

To address these limitations, potential enhancements can be explored, such as:

1. Utilize more sophisticated PID tuning methods like auto-tuning algorithms or adaptive control techniques to dynamically adjust PID parameters based on system behavior.
2. Additional sensors can be used to provide more accurate feedback on wheel speed and improve control performance.
3. Implement the different theories for a proper and stable output of the graph.

1.2. FUTURE ASPECTS

The future aspects of the development and implementation of PID Control Action to study the response of the speed of the rotation of the wheel are:

1. Robotics and Automation: In robotic systems, controlling the rotation of wheels or joints is crucial for accurate movement and positioning.
2. Industrial Machinery: Many industrial machines use rotating wheels or drums in processes such as conveyor belts, packaging, and material handling.
3. Electric Vehicles (EVs): In EVs, precise control of wheel rotation is essential for smooth acceleration, deceleration, and regenerative braking.
4. Aerospace: Aerospace applications, such as satellite positioning and drone navigation, require precise rotational control.3D Printing and CNC Machines: In 3D printers and CNC machines, precise control of the rotational and linear movement is essential for high-quality manufacturing.

1.3. CONCLUSIONS

Designing and implementing the different control actions and studying their performance using a programming module by using a wheel rotation and transferring the data to the Arduino App was successful. The project showcases the successful application of PID controllers and development in various systems.

The project's findings contribute to different fields like Robotics, Aerospace, and other Automation fields present. The limitations and future enhancements identified in this project pave the way for further research and development in the field.

In conclusion, designing and implementing the different control actions and studying their performance using a wheel rotation presents a viable solution for applications requiring accurate and reliable controlling operations. It can find applications in robot making, big machinery, and other uses. One can easily study through this.

REFERENCES

1. https://en.wikipedia.org/wiki/Arduino.
2. https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.indiamart.com%2Fproddetail%2Fshockley-dc-bo-dual-shaft-smart-plastic-car-robot-gear-motor-for-arduino-yellow-2849748268948.html.
3. https://www.google.com/url?sa=i&url=https%3A%2F%2Fm.indiamart.com%2Fproddetail%2Fl298n-dual-motor-driver-module-24236164091.html.
4. https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.ebay.ca%2Fitm%2F314907755298&psig=AOvVaw3_B2e_OWLmWONSi8NHU6zs&ust=1717489951671000&

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PHOTOGRAPHY

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VARIOUS ACTIVITIES OF THE DEPARTMENT

INSPIRE 2024

A magazine of AEIE Department, Haldia Institute of Technology, Haldia

ABSTRACT

The departmental journal of Haldia Institute of Technology's AEIE department, Inspire, publishes information on the department's numerous student-led and group activities. You can let us know about your activity.

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