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IOT BASED MINES SAFETY HELMET WITH MULTIPLE SAFETY FEATURE

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Abstract: This Mining is the extraction of minerals and other geological elements from the ground. There are several risks associated with the extraction of these minerals. The majority of accidents in coal mining occur as a result of dangerous gases emitted during mining, such as methane gas.

A mine safety system involving a helmet is constructed, with an IOT platform serving as a data transmission channel. The system is used to monitor and regulate numerous factors in coal mines, such as gas leakage and temperature conditions. These sensors are all considered one unit and are mounted on the helmets of coal mine miners. The sensor values are continually transferred to the things speak for analysis. The gas is regularly monitored here, and if there are any doubts in the level of gas, a bell is utilized to inform the personnel. Temperatures are also continually monitored and shown on both the serial monitor and the things speak platform. The created helmet system is primarily used to improve the working environment in mines and to guarantee worker safety..

Keywords: Safety, Data Monitoring, Temperature Sensor, Gas Sensor, Light Sensor, GPS, Arduino.

I. INTRODUCTION

The Internet of Things, or IOT, is nothing more than the concept of things interacting online. Applications for IOT range widely. There are 493 coalmines in India. The most important resource in the planet is coal. These petroleum products are resources that the earth naturally provides that are used for producing power as well as other things. Coal is an unsuitable source that cannot be easily replaced by humans; there are numerous coalmine mishaps occurring in the mines, and the diggers are putting their lives in danger by working in the coal mines; unfortunately, they occasionally lose their lives in the coal mines. The majority of these catastrophes occur as a direct result of obsolete hardware and electrical systems, resulting in terminate mishaps. Spillage of hazardous gases in coal mines poses enormous threats to the excavators inside the coal mines.

Light is crucial in underground coalmines for communicating their activity. They are unable to leave the mine if there is no valid lighting, which is causing them to compromise mine workers' vision due to working in a low-light environment. So, in order to avoid this problem, we designed the coalmine security framework. In our project work, we resolved the issues by reviewing all of the data collected by the sensors we used, and the monitoring was completed using the Things speak platform. Controlling can be done both automatically and manually.

II. IITERATURE REVIEW

Ninni Singh, Et Al [1] Proposed**" IOT Enabled Helmet To Safeguard The Health Of Mine Workers"**, The suggested method improvises the creation of a real-time surveillance helmet with IoT sensors that can provide early-warning information on the presence of fire, silicosis dust particles, temperature, and hazardous gases.

M. Nivetha Kumari, Et Al [2] Proposed the **"IOT Based Smart Helmet for Construction Workers"**, This system suggests a smart flexible helmet for the construction workers to provide security and rescue measures in case of any emergency conditions. This helmet is designed to provide constant observation of the workers and to prevent them from any health hazards while working. The suggested system describes a sensor-equipped, smart, low-cost helmet for construction workers.

Mangala Nandhini. V, Et Al [3] Proposed the **"IOT Based Smart Helmet for Ensuring Safety in Industries"**, Gas explosion, gas poisoning, and asphyxiation are all potential workplace hazards. Consequently, air quality and the identification of hazardous events are key factors in industry. The suggested system offers a wireless sensor network for real-time monitoring of the working environment from a monitoring station in order to implement those safety measures.

Kodali, R.K., Et Al [4], Proposed **"IOT Based Safety System For Coal Mines"**, proposed mining method made the task of the workers in the mining industries considerably more tough and challenging, without offering any indication of the future risky scenarios that the workers may experience while mining.

Maviya Noorin and Suma KV[5], Proposed, **" IOT Based Wearable Device Using WSN Technology For Miners"**, As different channels are constructed at the IoT platform for each unique user ID, this suggested helmet concept makes it feasible to identify each wearer.

Prof. Deepali Shinkar, Et Al [6], Proposed **"IOT Based Smart Helmet For Coal Mining Tracking"** Volume: 06 Issue: 12 (IRJET), In this work, a helmet was implemented employing temperature, humidity, light, and air quality sensors, as well as a WIFI module and GSM. Prior research on the smart helmet for coal miners employed zigbee technology, which is ineffective at medium to long ranges and is dependent on IOT and WIFI module.

C. J. Behr, Et Al [7], proposed **"A Smart Helmet for Air Quality And Hazardous Event Detection For The Industry"**, There are air quality sensors for A Smart Helmet for Coal Miners hazardous gas detection, helmet removal sensors, collision sensors, and zigbee for communication in this work.

Punam S.Tajane, Et Al [8], proposed **"IOT Mining Tracking & Worker Safety Helmet",** They suggest a method to identify dangerous circumstances in the mining region, such as carbon monoxide gas accumulation, helmet removal, and accident detection. Yongping Wu, Et Al [9], proposed "Coal Mine Monitoring Using The Bluetooth Wireless Transmission System". Bluetooth technology is intended to develop a single low-power, low-cost wireless air interface and controlling software opening system as a standard of unified worldwide short-range wireless communication.

S. R. Deokar, Et Al [10] Proposed **"Smart Helmet For Coal Mines Safety Monitoring and Alerting"** The monitoring station in this system enables real-time monitoring of industries. The transmitter device is mounted on the worker's helmet, while the reception unit is mounted on the monitoring station. Wi-Fi wireless technology is utilised to transmit data from the workplace to the base station. The Wi-Fi communication network allows the monitoring station to monitor the working environment using the things peak application. The air quality sensor, helmet removal sensor, temperature and humidity sensor are all part of the transmitter unit. The air quality sensors measure the amount of dangerous gases such as LPG, methane, and carbon monoxide.

Rashmi Vashisth, Et Al [11] Proposed **"Implementation And Analysis Of Smart Helmet"**, The implemented system is a smart helmet that reduces the incrimination of motorbike accidents. The system is also divided into two sections: helmet and bike. Each of them operates in tandem, applying a Radio Frequency module to send wireless communication between themselves. SMS messages are sent using a GSM module.

Tarek Eldemerdash, Et Al [12] Proposed, **"IOT Based Smart Helmet for Mining Industry Application"** It was possible to create an automated system that detects hazardous gases, build a monitoring system to update the control room with real-time data, and combine both design systems while analysing the power consumption of the proposed system.

Fatemeh Molaei, Et Al[13] Proposed **" A Comprehensive Review on Internet of Things (IOT) and its Implications in the Mining Industry"** Mining is the most essential industry in the supply chain of resources for manufacturing, technological development, and building, according to this research. Exploration and exploitation of minerals such as metals, nonmetals, aggregates, coal, and crucial elements such as REEs are critical to modern living.

Vinay Kumar Singh, Et Al [14]Proposed **"Safety Helmet For Coal Miners Using IOT For Mining And Tracking"** This document was implemented The deeper the mines, the riskier it may be to be running jobs. There is a confined atomic number 8 leak, and there are square measure problems involved with feat a mine if a crisis occurs. Thus, we prefer to present a mining tracking as well as a safety system for the mining sector that makes use of a microcontroller-based main circuit on the employee helmet.

A.Dhanalakshmi, Et At [15] Proposed **"A Smart Helmet For Improving safety In Mining Industry"** This paper implements a system with several sensors for varied detection and analysis. Gas sensors are used to detect harmful gases.

M.Naveenraj, Et Al [16] Proposed an **"IOT Based Smart Helmet For Unsafe Event Detection For Mining Industry"** Mining activity in the country, on the other hand, remained basic in nature and low in scale until the turn of the century. Because of its numerous advantages, ZigBee technology is emerging as an important wireless sensor networking solution for short and medium-range communication, including unlicensed 2.4 GHz industrial, scientific, and medical (ISM) band, ultra low power (ideal for battery-operated systems), operates for years on inexpensive batteries, a large number of nodes/sensors, reliable and secure links between network nodes, easy deployment and configuration, low-cost system, very fast transition time, digital battery monitor facility and smaller in size.

III. METHODLOGY

There are many existing techniques for communication inside underground mines. The communication schemes include GSM, GPS, RFID, WIFI, Zigbee, Radar sensor network, etc. These techniques are used for communication inside and outside the underground mines. By combining it with other techniques, the efficiency of the selected method can be improved. Each technique has advantages and disadvantages.

DHT-11 temperature and humidity sensor gives an analog value proportional to temperature to Aurdino. reads the temperature from the DHT11 sensor, prints it on the serial monitor, and if the temperature exceeds 31 degrees Celsius, it triggers the LED and buzzer to indicate a high temperature condition.

The MQ2 gas sensor is a commonly used sensor for detecting various types of gases, including LPG, propane, methane, alcohol, hydrogen, and smoke. It operates on the principle of detecting changes in the conductivity of a metal oxide semiconductor (MOS) when it comes into contact with a specific gas. When gas is detected, it triggers the LED and buzzer to provide visual and audible indications.

The IR (Infrared) sensor is a popular electronic component used for detecting the presence or proximity of objects by emitting and receiving infrared radiation. When an object is detected, it turns off an LED, and when no object is detected, it turns on the LED and buzzer to provide visual and audible indications.

The LDR (Light-Dependent Resistor) is a type of photoresistor that changes its resistance based on the intensity of light falling on it. It is commonly used in circuits to detect and measure light levels. When the light intensity falls below the specified threshold, it indicates light detection and turns on the LED. If the light intensity is above the threshold, it indicates no light detection, and the LED remains off.

After the collecting the all data from sensor Aurdino UNO send data to NodeMCU, then NodeMCU send data to OLED display to display the sensor data and ThingSpeak to store and visualize the data on ThingSpeak platform.

The EM-18 RFID reader is a popular RFID (Radio Frequency Identification) module that allows for reading RFID tags or cards. With its integrated antenna, the EM-18 reader emits an electromagnetic field that powers up RFID tags within its range and receives their identification information. In our system we used EM-18 for authenticating the worker that are entering into the mine.

After authenticating the worker Node MCU will send the data to display on OLED and to save and visualize on ThingSpeak platform. Also it sed signals to Servo Motor to grant permission to enter into the mine.

IV. BLOCK DIAGRAM

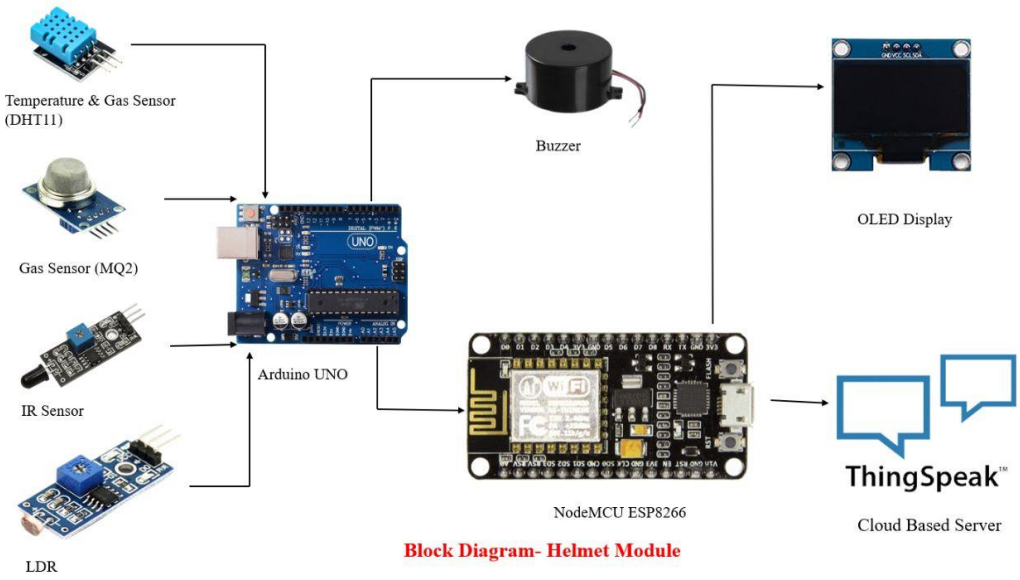

Figure 1: Block Diagram Of Helmet Module

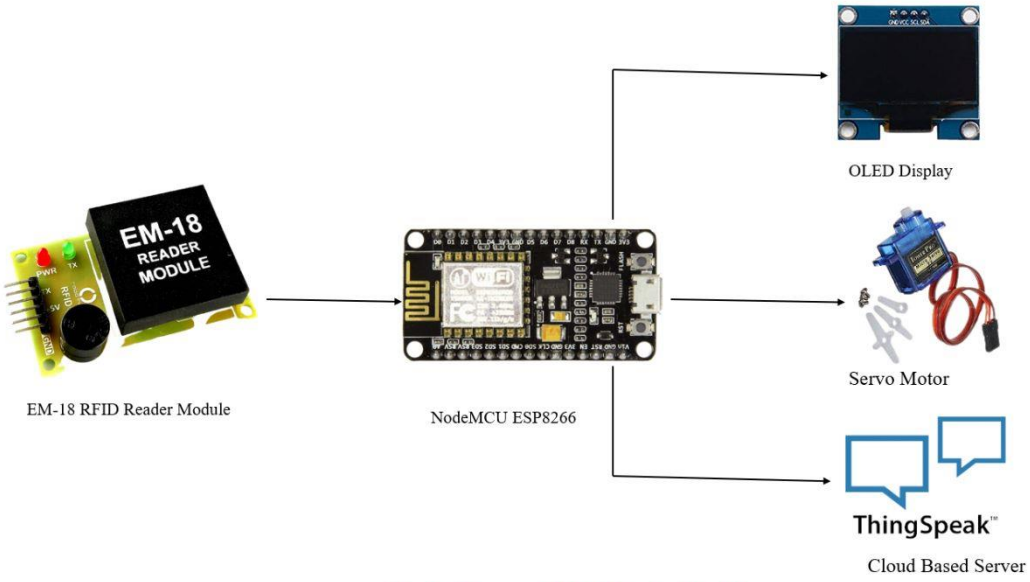

Figure 2: Block Diagram Of RFID Reader Module

V. System Analysis

1] Arduino UNO:

The Arduino UNO is a popular microcontroller board based on the ATmega328P, equipped with 14 digital input/output pins, 6 analog input pins, and a 16 MHz quartz crystal oscillator. It features a USB interface for programming and communication, as well as a power jack for external power supply. The board can be easily programmed using the Arduino software and supports a wide range of libraries and shields to extend its functionality. With onboard EEPROM for data storage, a reset button for program restart, and its versatility, the Arduino UNO is widely utilized for prototyping and building projects in areas such as robotics, home automation, and IoT applications.

Figure 3: Arduino UNO

2] NodeMCU ESP8266:

The NodeMCU ESP8266 is a popular development board that combines the ESP8266 Wi-Fi module's capabilities with a programmable microcontroller, making it an ideal platform for Internet of Things (IoT) projects. It includes a powerful 32-bit Tensilica L106 microcontroller with built-in Wi-Fi, which enables developers to connect their projects to the internet and communicate with other devices or web services. The Arduino programming language is supported by the NodeMCU ESP8266, making it simple for both novice and experienced developers to write and upload code using the Arduino IDE or other compatible development environments. We used NodeMCU ESP8266 to create IoT devices that can connect to the internet, collect sensor data, and interact with other devices or web services.

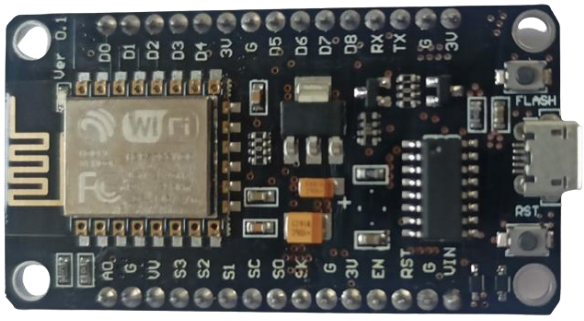

Figure 4: NodeMCU ESP8266

3] MQ2-Gas Sensor:

The MQ2 gas sensor is a commonly used sensor module for detecting various gases in the atmosphere. It is equipped with a small heating element and a gas-sensitive resistor. The sensor is sensitive to flammable gases such as methane, butane, and LPG, as well as smoke and other volatile organic compounds (VOCs). It provides analog output based on the concentration of the detected gas, allowing for easy interfacing with microcontrollers or Arduino boards. The MQ2 gas sensor is widely employed in gas leakage detection systems, fire detection systems, air quality monitoring devices, and other applications where gas detection is essential.

Figure 5: MQ2 Gas Sensor

4] DHT11 - Temperature Sensor:

The DHT11 is a widely used digital temperature and humidity sensor module. It consists of a capacitive humidity sensor and a thermistor to measure temperature. The module provides a digital output signal that can be easily read by microcontrollers or Arduino boards. It has a low cost and is relatively simple to use. The DHT11 sensor is capable of measuring temperature in the range of 0°C to 50°C (32°F to 122°F) with an accuracy of ±2°C and humidity in the range of 20% to 90% with an accuracy of ±5%. It is commonly employed in weather stations, environmental monitoring systems, HVAC applications, and other projects where temperature and humidity sensing is required.

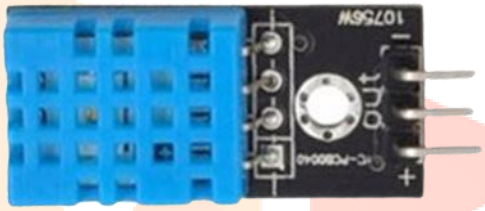

Figure 6: DHT11 Temperature Sensor

5] LDR Sensor:

An LDR (Light Dependent Resistor), also known as a photoresistor, is an electronic component that exhibits a change in resistance based on the intensity of light falling on it. It consists of a semiconductor material whose conductivity varies with light exposure. In bright light conditions, the LDR exhibits a low resistance, allowing current to flow easily. Conversely, in dark or low-light situations, the resistance of the LDR increases, impeding the flow of current. This characteristic makes the LDR suitable for detecting and measuring light levels in various applications. It is commonly used in automatic lighting systems, light intensity meters, photography equipment, and light-sensitive switches, providing a versatile solution for light sensing and control.

Figure 7: LDR Sensor

6] IR Sensor:

An IR (Infrared) sensor is an electronic device that detects and measures infrared radiation emitted or reflected by objects. It comprises an infrared emitter and receiver that work together to sense changes in infrared radiation. When an object is within range, it reflects or emits infrared radiation that is detected by the receiver. This information is then used to generate an electrical signal or trigger a response. IR sensors have a wide range of applications, including proximity sensing, object detection, motion detection, temperature measurement, and remote control systems, making them versatile tools for various industries and applications.

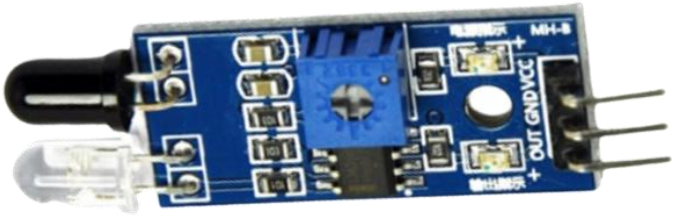

Figure 8: LDR Sensor

7]OLED Display :

An OLED (Organic Light-Emitting Diode) display is a thin and lightweight flat-panel display that emits light independently using organic compounds. It offers advantages like high contrast, wide viewing angles, fast response time, and low power consumption. With no need for a backlight, OLED displays are commonly used in smartphones, tablets, TVs, and wearable devices, providing vibrant visuals with excellent color reproduction.

Figure 9: OLED Display

8] EM18 RFID Reader:

EM18 is an RFID reader which is used to read RFID tags of frequency 125 kHz. After reading tags, it transmits unique ID serially to the PC or microcontroller using UART communication or Wiegand format on respective pins.EM18 RFID reader reads the data from RFID tags which contains a stored ID which is of 12 bytes. EM18 RFID reader doesn't require line-of-sight. Also, it has an identification range which is short i.e. in a few centimeters.

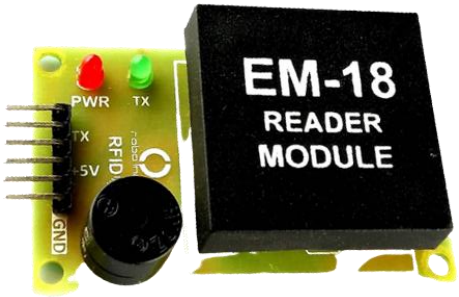

Figure 10: EM18 RFID Reader

9] RFID Tag:

The EM-18 RFID reader is a compact and versatile device that allows for the reading of RFID (Radio Frequency Identification) tags. It operates at a frequency of 125 kHz and is capable of detecting and decoding RFID tags within its range. The EM-18 reader module communicates with a microcontroller or Arduino board through a serial interface, providing a simple and straightforward integration into various projects. It can read RFID tags from a distance of a few centimeters to a few meters, depending on the antenna and tag used. The EM-18 RFID reader finds applications in access control systems, inventory management, attendance tracking, and other scenarios where contactless identification and tracking of objects or individuals is required.

Figure 11: RFID Tag

10]Servo Motor:

A servo motor is a small electric motor that incorporates a feedback mechanism, allowing for precise control of angular position. It consists of a motor, a position sensor, and a control circuit. The control circuit receives signals from a microcontroller or other control devices to determine the desired position, and the position sensor provides feedback on the current position. The servo motor then adjusts its position to match the desired angle. Servo motors are widely used in robotics, automation systems, remote control vehicles, and other applications that require precise and controlled movement. They offer high torque, quick response times, and can be easily controlled for various angular positions, making them a popular choice in many projects.

Figure 12: Servo Motor

11]Buzzer:

A buzzer is a small sound-producing device commonly used in electronic circuits and devices. In an IoT-based safety helmet, a buzzer can be integrated as an audio alert system to provide audible warnings or notifications. When triggered by specific events or conditions, such as detecting a hazardous situation or abnormal behavior, the buzzer emits a sound to alert the wearer or nearby individuals. This can be helpful in enhancing safety measures by providing real-time audio feedback in critical situations. The buzzer can be controlled and activated wirelessly through IoT technologies, allowing for seamless integration with the safety helmet and overall IoT ecosystem.

Figure 13: Buzzer

VI. IMPLEMENTED SYSTEM AND RESULTS

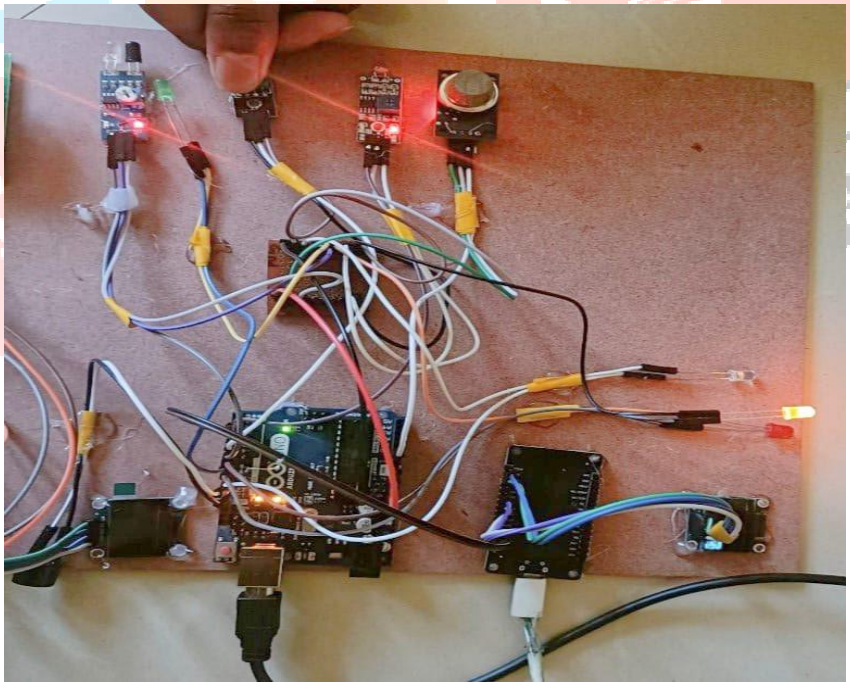

Figure 16: Temperature is more than given condition then Yellow LED is on .

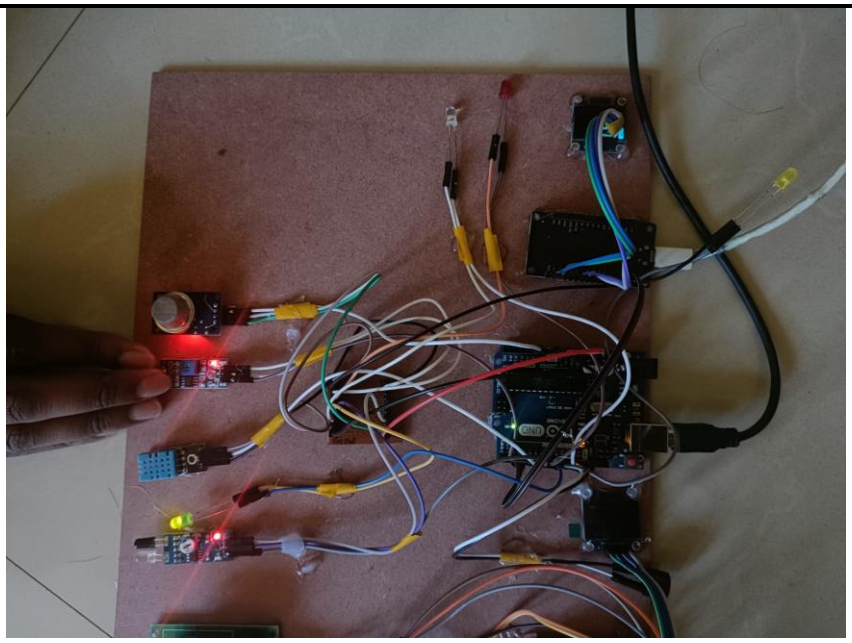

Figure 17: When the presence of light is gone then on the LED

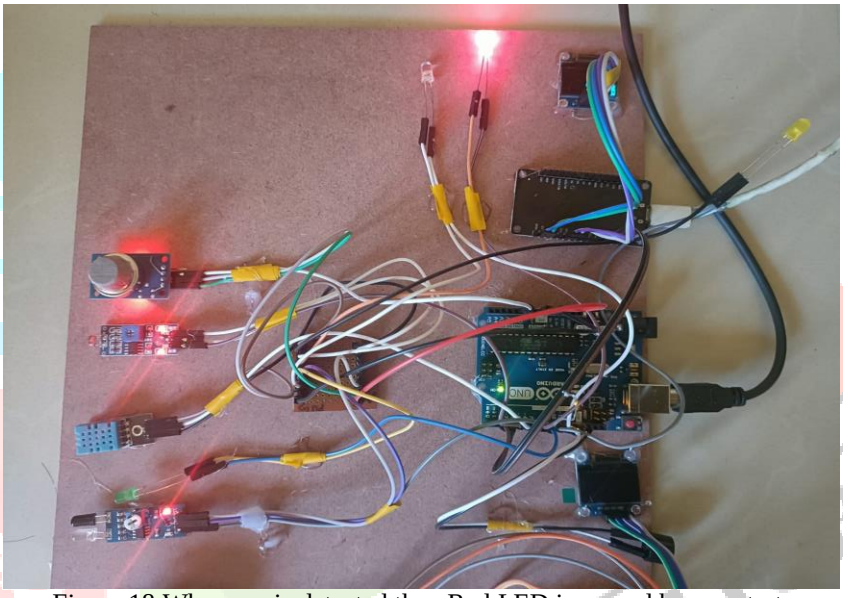

Figure 18:When gas is detected then Red LED is on and buzzer start.

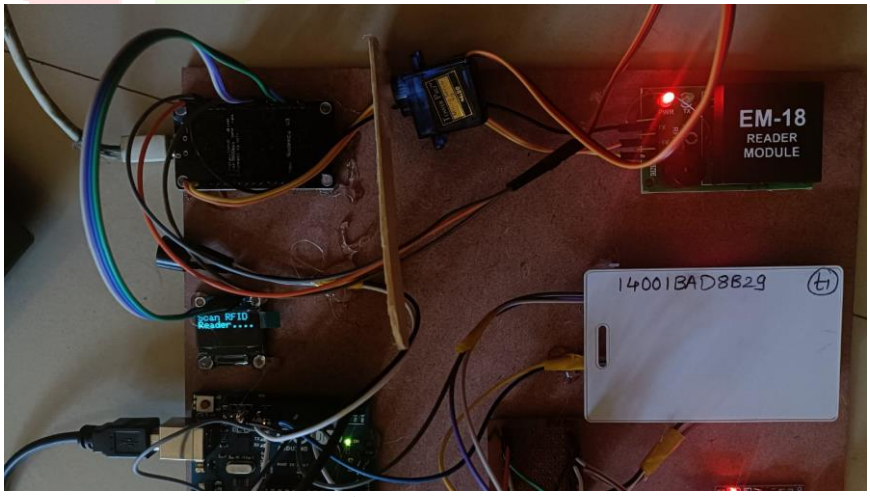

Figure19.1: RFID Tag scanning

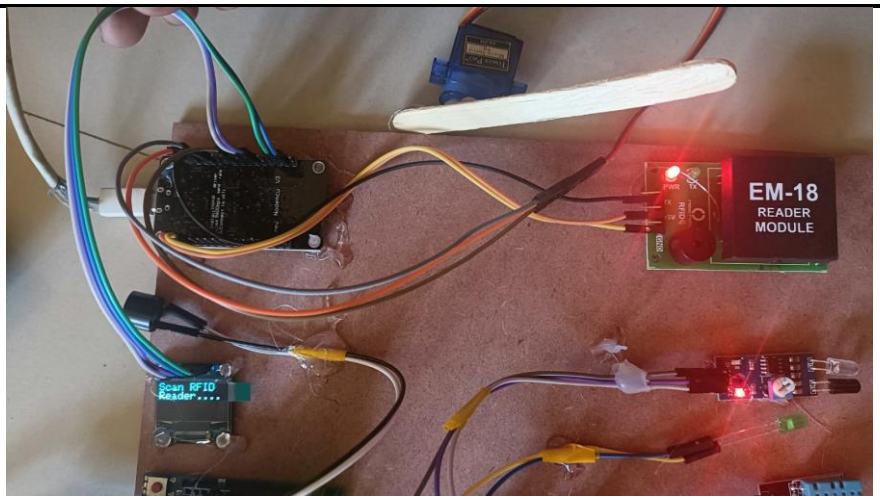

Figure 19.2: Servo motor start to open gate.

Thing Speak Results:

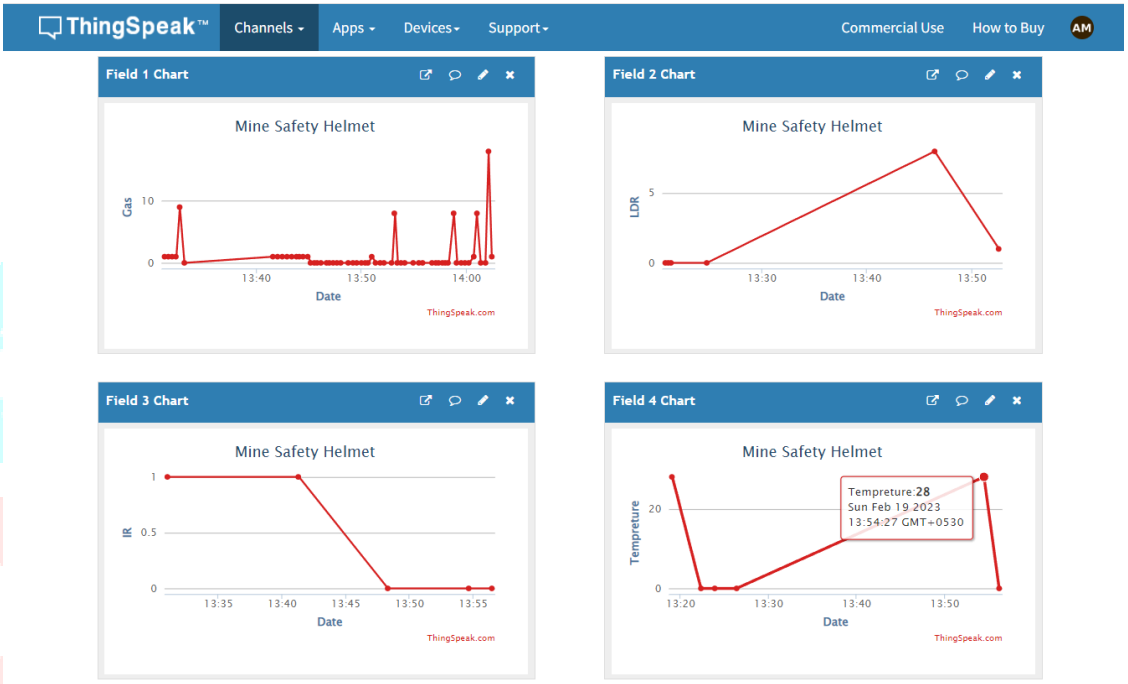

Figure 20.1: Visualization of Helmet Module on ThingSpeak Platform

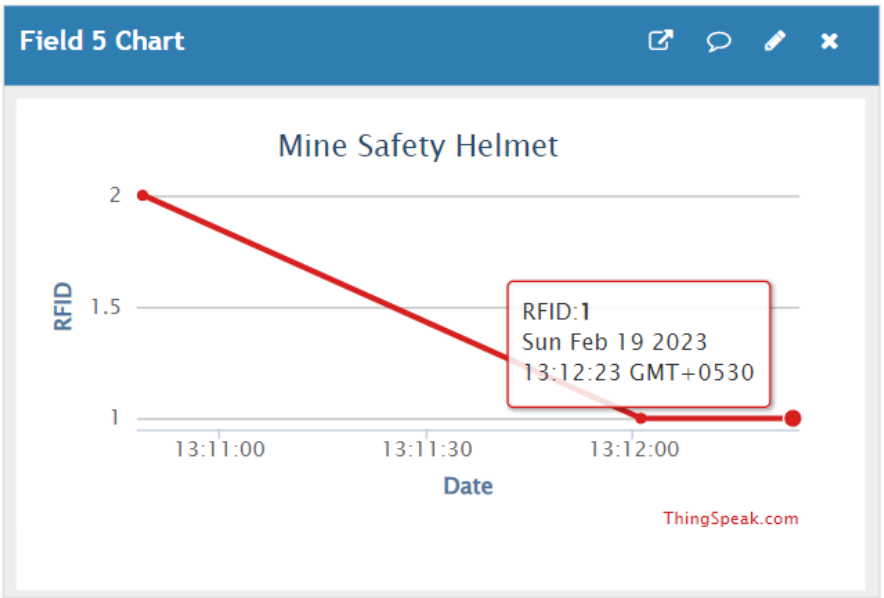

Figure 20.1: Visualization of RFID Module on ThingSpeak Platform

VII. Conclusion

The implementation of a mine safety system is a complex process that requires the utilization of various sensors. The primary objective of the system is to improve the protection of workers in coal mines by preventing potential hazards and ensuring their safety. To accomplish this objective, the system employs IoT technology to constantly monitor the mine. The sensors installed in the system transmit crucial information about the mine's environmental conditions to a centralized monitoring system that deploys advanced algorithms and analytics to analyze the data in real-time.

This sophisticated system ensures that any anomalies or irregularities in the mine's environment are detected immediately, and workers are alerted instantly to take appropriate measures. The system also provides valuable insights into the conditions of the mine, enabling mine operators to take proactive measures to eliminate potential hazards and improve worker safety. With this system in place, the risk of accidents and injuries in the mine can be greatly minimized, and workers can work in a secure and safe environment.

VIII. Future Scope

To ensure the utmost safety and enhanced productivity in mining operations, it is strongly recommended to implement a GSM GPS system capable of accurately tracking the movements and locations of workers within the mines. By utilizing this cutting-edge technology, management can receive real-time updates on each employee's whereabouts, enabling them to closely monitor the activities and movements of their workforce. This allows for the swift and timely response to any potential safety hazards or productivity issues, leading to improved overall operations.

A way to improve the existing system is by incorporating an active RFID model that enables real-time monitoring of workers and assets. This technology eliminates the need for manual scanning of RFID cards and can be utilized for authenticating the identity of personnel entering mines. The active RFID model eliminates the potential errors associated with manual scanning and improves the efficiency of the monitoring process by providing a seamless experience. By implementing this system, mine managers can have up-to-date information on the location.

Piezoelectric materials are capable of converting mechanical vibrations and movements into electrical energy, which makes them extremely useful for harvesting energy generated by mining equipment such as conveyor belts and drilling machines during operation. Essentially, when these mining equipment components move or vibrate, a piezoelectric element is able to convert that mechanical motion into electrical energy that can be utilized in a variety of applications. This electrical energy can be used to power low-energy devices or recharge batteries.

IX. Acknowledgement

We extend our heartfelt gratitude to Dr. Suresh Mali, the Principal of DYPCOEI (Dr. DY Patil College of Engineering and Innovation), for his kind assistance and unwavering motivation throughout our project. His guidance and support were instrumental in our success, and we are truly grateful for his mentorship.

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We would like to convey our sincere appreciation to Dr. Deepali Sale, the project coordinator, for her helpful insights and constructive comments during the planning and development stages. Her inputs significantly enhanced the quality of our work, and we are grateful for her guidance throughout the project.

Lastly, we would like to express our heartfelt thanks to Dr. Latika Desai, our guide, for her exceptional guidance and ongoing oversight. Her expertise and mentorship were vital in steering us in the right direction and ensuring the successful completion of our project. Additionally, we are grateful to her for providing us with important information about job opportunities related to our project and for assisting us in the final stages of its completion.

Overall, we are immensely grateful to Dr. Suresh Mali, Dr. Alpana Adsul, Dr. Deepali Sale, and Dr. Latika Desai for their unwavering support, guidance, and contributions to our project. Their assistance has been invaluable, and we are indebted to them for their immense help and encouragement.

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