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IOT BASED MINE HAZARD DETECTION AND SAFETY MONITORING APPARATUS

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Abstract **:** Mining is the most hazardous activity, especially in underground mining lot of care must be taken about the safety of workers because the environment may change drastically due to the poor air circulation. Hundreds of miners are dying every year across the world and to overcome this problem, we have developed a prototype model of smart helmet equipped with sensors for the safety of workers. In fact, often the temperature and humidity will change drastically inside the mine and sometimes miners are dying due to the toxic gasses. So we have focussed mainly over these three parameters and are monitored continuously using suitable sensors and information will be transmitted to the concern mobile phone directly through Wi-Fi module interfaced with main processor built with Arduino board. The sensors placed over the helmet can detect any hazardous changes and alert the miners through buzzer. Means if the system detects any toxic gasses, immediately alarm will be energized. Similarly if the temperature is more than the 29 C or humidity is more than the 60%, buzzer will be activated and message will be sent to the concern care taker mobile phone. Here the system is designed to send the parameters values continuously. ESP 8266 IOT device is used to establish a wireless communication link between the phone and processing unit such that the message will be transmitted directly to the phone. LCD is used to display the parameter values continuously and the same data will be transmitted. Since it is a prototype module, the hardware used for the purpose may not accommodate over the helmet and hence it is assembled over a tiny plank and sensors are arranged over a helmet. 12 v rechargeable battery is used to energize entire system and it can be charged when required.

Keywords: Mq3 sensor, DTH11 sensor, Arduino Uno board, ESP8266 Wi-Fi module, LCD, power supply unit, rechargeable battery .

I. INTRODUCTION

Toxic air, extreme temperature and humidity are some of the most unsafe environments observed in underground mining. Miners or mine workers working at such hazardous atmosphere inside the mine is too dangerous and hence it is essential to monitor the above said parameter values continuously. In general miners wear safety helmets and if a device that can measure the above conditions and warn the miner accordingly and if it is attached to the helmet, it will be very useful for miners. Since the helmet designed here is aimed to protect the miner from abnormal atmospheric conditions, it is called as smart helmet. Since it is a prototype model, all devices are exposed for demo purpose, but when it is converted in to engineering model, entire circuit can be

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accommodated over a tiny chip and it can be placed over the helmet at convenient place.The security of the underground mines must be increase because disasters in underground mines are very serious issues these days. The difficulties faced by miners working underground are gas explosion, deficiency of fresh air, etc. If any disaster occurs in mine and if miner gets injured, it is the responsibility of the supervisor and he will be answerable. So there must be a communication between miners and supervisor or any other responsible person. Therefore the purpose of the proposed system is to increase the mining safety by sending the mine worker surroundings data to the concern person mobile phone through Wi-Fi device interfaced with Arduino board. Here the data is transmitted to the mobile directly.

Helmet is one of the safety accessories miner should wear while mining. The aim is to make the helmet even safer by adding network. This added network is used to sense the environmental conditions around the miner working underground and all the real time values are wirelessly updated to the concern mobile phone by using IoT so that the concern person know about the environmental conditions around the miner where he is working. If any abnormal condition occurs, the concern responsible person can able to provide the rescue team as early as possible. The system is also equipped with LCD and buzzer to let co-workers know if any unwanted event occurs within the premises. The proposed system uses Gas Sensor, Humidity and Temperature Sensor.

1.2 Objectives

In order to identify hazards in the mining industry, this research study will examine the design, implementation, and potential advantages of an IoT-based Smart Helmet. These are some of the study's particular goals:

An evaluation of existing hazard detection and monitoring systems and IoT applications in the mining sector.

A Smart Helmet with a variety of sensors and connectivity components to be designed and put into use for monitoring the mining area in real-time

To assess the Smart Helmet's performance in spotting different dangers, such as gas leaks, extreme heat, and noise levels.

To talk about how the IoT-based Smart Helmet may improve miner safety and productivity as well as its advantages, drawbacks, and potential.

To make suggestions for upcoming studies and developments in the area of Internet of Things based danger detection systems for the mining industry.

1.3 Scope of the study

The purpose of this research study is to examine how IoT technology can be utilised to identify hazards in the mining sector, with a focus on the creation and use of a Smart Helmet. The Smart Helmet's design, sensor choices, data connectivity, and central control unit will all be covered in the study. The article will also examine the possible advantages, difficulties, and ethical issues related to the application of IoT-based danger detection systems in mining operations .

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II. METHODOLOGY AND LITERATURE SURVEY

Block diagram :

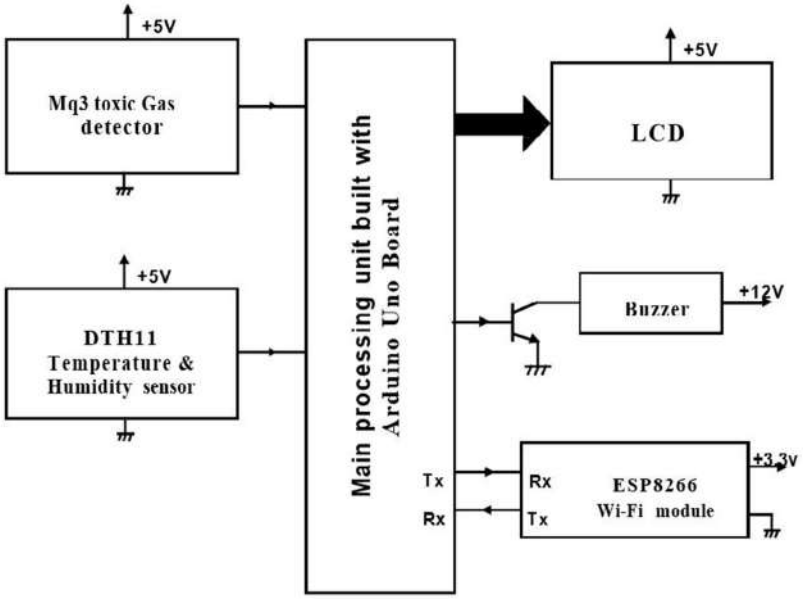

Figure 2.1 : Block diagram of the mine safety monitoring apparatus

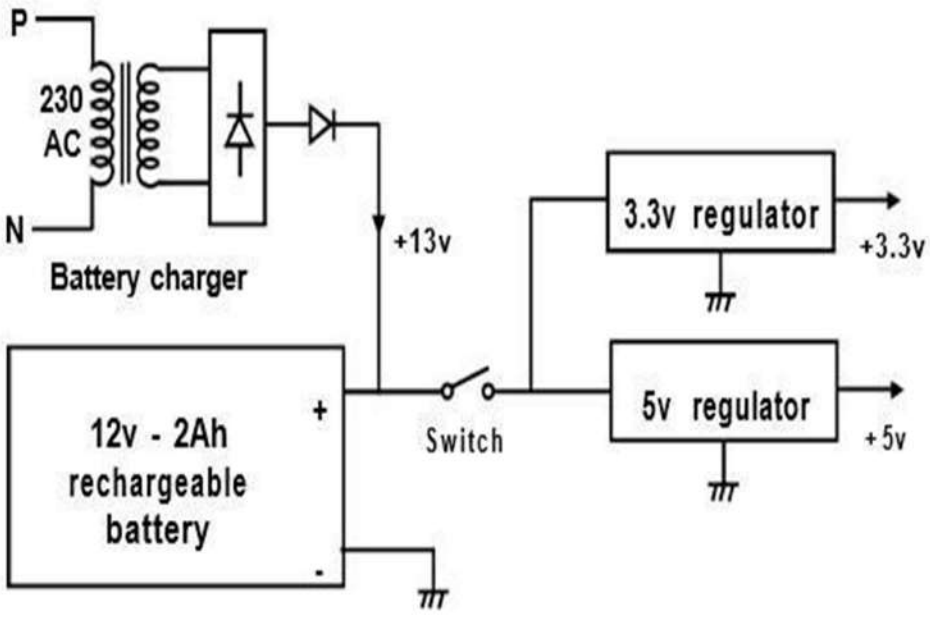

Figure 2.2 : Power supply unit of the mine safety monitoring apparatus

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Circuit diagram :

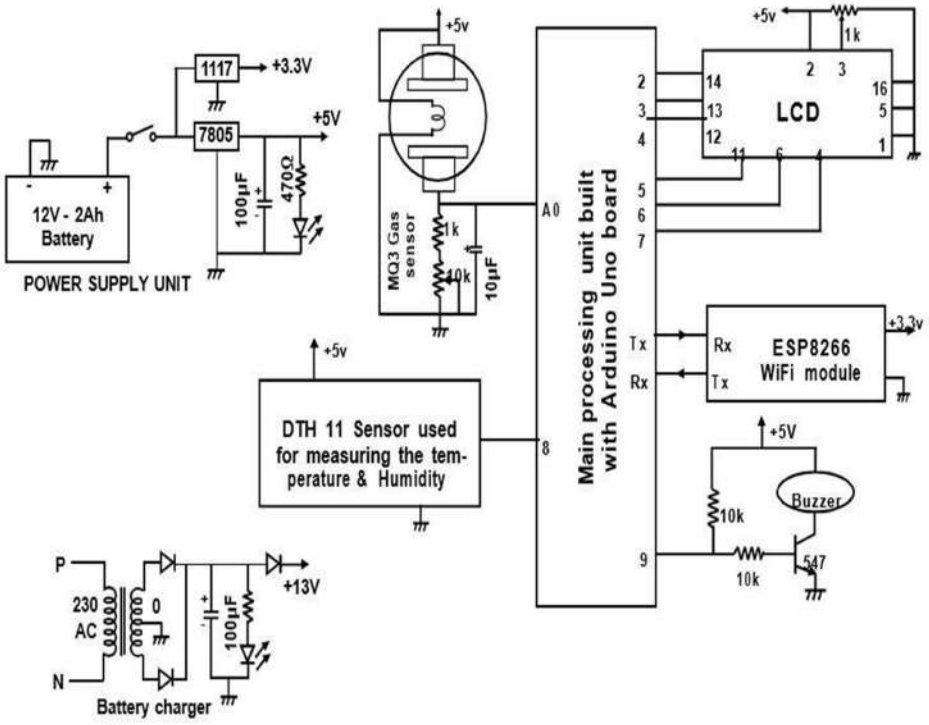

Figure 2.3 : The main circuit diagram of mine safety monitoring apparatus

2.1 Functional description as per the circuit diagram

The system designed with toxic gas detecting sensor is quite useful for the underground mines. This sensor is intended to detect the presence of all sorts of toxic gases including carbon dioxide in a closed mine. Usually air pollution detectors are aimed to detect all sorts of petroleum gases, chemical gases, ammonia, and sulphur dioxide including Co2. Inhaling or breathing polluted air is hazardous to humans and therefore it is essential to detect the any toxic gas or pollution present in the air. The system designed here is known as an instrument that is used to detect the polluted air and if the air quality is poor, means any toxic gas is present in the air, immediately alarm will be energized and information will be transmitted to the concern mobile number through WiFi module.

The sensor used in the project work is very sensitive and it generates proportionate DC output as per the level of air pollution or as per the concentration of toxic gas present in the air. If the air pollution level is increasing slowly, the sensor output also will be increased accordingly. This sensor generates proportionate DC voltage according to the pollution, more pollution more output will be generated. Based on the voltage generated by the sensor, the main processing unit designed with Arduino Uno is programmed to energize the alarm when the output increases more than the set value. Information in the form of “Toxic gas detected” will be displayed through LCD and the same information will be transmitted to the concern mobile number through WiFi module.

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The same processor is also used to measure and display the value of temperature and humidity through DTH11 sensor and these values are also transmitted to the same mobile through same module.

The analog data acquired from the air pollution sensor will be converted in to digital using internal ADC of Arduino Uno processor. With the help of an LCD interfaced with embedded system, parameters values will be displayed.

The sensor used here also can be used to detect combustible, toxic (poisonous) and CO2 gases. The detailed description of this sensor is provided in separate chapter. The MQ series sensors is having good sensitivity characteristics to detect a wide range of air pollution causes like all sorts of toxic gases present in the air. This device is designed to operate at 5V-regulated supply. The most suitable application for the sensor is the detection of smoke, carbon dioxide, methane, propane and butane, which makes it an excellent sensor for air pollution detectors. Whenever the sensor detects any toxic gas its output voltage will be increased and this voltage will be fed to the ADC.

The initial stabilization time of the sensor is very short and the relative and elapsed characteristics are very good over a long period of Operation. MQ3 is most practically employed in a circuit design, which maintains circuit voltages at fixed value of 5V. This voltage rating is very practical when determining design specifications because of the wide range of available components. This makes the use of the MQ3 an especially economical way to design a low-cost, highly reliable air pollution detection circuits .

III. PERFORMANCE ANALYSIS OF TOXIC GAS DETECTOR USING MQ-3 GAS SENSOR

In general in any underground mine, miners encounter with different situation when compared with open cast mining. In underground mining where we see different gasses being emitted in atmosphere. Monitoring of these gasses is very important with safety point of view. Gas Sensors are very helpful in accomplishing this task. Small nose like sensor spontaneously respond to the alteration of gas concentration and keep our systems updated for special tasks.

3.1 MQ-3 gas sensor

What is MQ- 3 gas sensor and how does it work?

The gas sensor module consists of a steel exoskeleton under which a sensing element is housed. This sensing element is subjected to current through connecting leads. This current is known as heating current through it and the gases coming close to the sensing element get ionized and are absorbed by the sensing element. This changes the resistance of the sensing element which alters the value of the current going out of it.

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PERFORMANCE ANALYSIS OF WI-FI MODULE

The Internet of things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

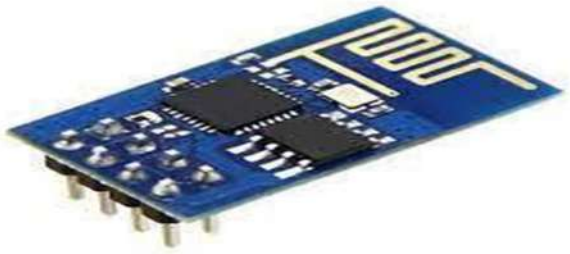

Figure 3.1 : wi-fi module

The definition of the Internet of things has evolved due to the convergence of multiple technologies, real-time analytics, machine learning, sensors and embedded systems. Traditional fields of embedded systems, wireless sensor networks, control systems, automation (including home and building automation), and others all contribute to enabling the Internet of things.In the consumer market, IoT technology is most synonymous with products pertaining to the concept of the "smart home", covering devices and appliances (such as lighting fixtures, thermostats, home security systems and cameras, and other home appliances) that support one or more common ecosystems, and can be controlled via devices associated with that ecosystem, such as smart phones and smart speakers. There are a number of serious concerns about dangers in the growth of IoT, especially in the areas of privacy and security, and consequently industry and governmental moves to begin to address these.

LCD INTERFACING WITH ARDUINO

In Arduino based embedded system design, the Liquid Crystal Display modules play a very important role. Hence it is very important to learn about how to interface LCD with an Arduino of 16×2 in embedded system design. The display units are very important in communication between the human world and the machine world. The display unit work on the same principle, it does not depend on the size of the display it may be big or the small. We are working with the simple displays like 16×1 and 16×2 units. The 16×1 display unit has the 16 characters which present in one line and 16×2 display units have 32 characters which are present in the 2 line. We should know that to display the each character there are 5×10 pixels. Thus to display one character all the 50 pixels should be together. In the display, there is a controller Built in with panel which is HD44780 it is used to control the pixels of characters to display.

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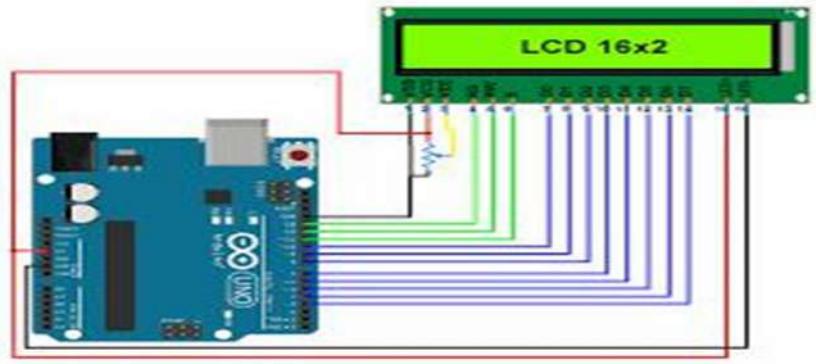

Figure 3.2 : LCD interfacing with Arduino

What is a Liquid Crystal Display?

The liquid crystal display uses the property of light monitoring of liquid crystal and they do not emit the light directly. The Liquid crystal display is a flat panel display or the electronic visual display. With low information, content the LCD' s are obtained in the fixed image or the arbitrary image which are displayed or hidden like present words, digits, or 7 segment display. The arbitrary images are made up of large no of small pixels and the element has larger elements.

HARDWARE DETAILS

To prove any project work practically for the demonstration purpose, construction of described model is essential. For this purpose suitable hardware in the form of electronic, electrical and mechanical components are essential to perform the given task. When these components are integrated together or working together, better results can be obtained from the project work. Since it is a practical oriented project work, the content presented in the abstract must be proven practically. In this regard required active hardware like IC's and other special components must be gathered and their details must be described in this chapter to fulfil the concept of perfect project report.

Electronic hardware is Hardware, in the context of technology, refers to the physical elements that make up electronic system or electro-mechanical system, and everything else involved that is physically touchable. When an embedded system is considered, that contains a processing unit (Often microcontroller chips are preferred to build a processing unit) Sensors, control circuits that includes the motors, relays, switching devices (like power Mosfets, transistors, etc). Hardware works hand-in-hand with firmware and software to make a system function. Software is a collection of code installed into the microcontroller chip. Often LCD displays are used to monitor the system performance or results.

When computer is considered as example, Hardware is only one part of a computer system, but there is also firmware, which is embedded into the hardware and directly controls it. There is also software, which runs on top of the hardware and makes use of the firmware to interface with the hardware. Hardware is a surrounding term that refers to all the physical parts that make up a computer. The internal hardware devices that make up

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the computer and ensure that it is functional are called components, while external hardware devices that are not essential to a computer's functions are called peripherals.

The following are the active components used in this project work.

1. Arduino processor
2. LCD
3. Voltage regulator
4. Wi-Fi module
5. Buzzer
6. DTH11 sensor

Figure 3.3 : Arduino processor

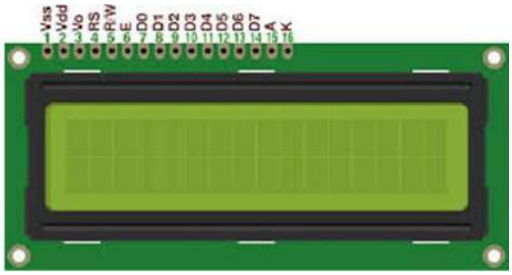

Figure 3.4 : LCD module

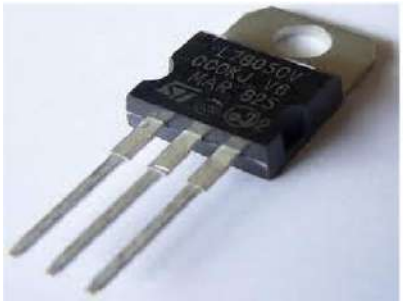

Figure 3.5 Voltage rergulator

Figure 3.6 : Wi-fi module

Figure 3.7 : Buzzer

Figure 3.8 : DTH11 sensor

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IV. RESULT & CONCLUSION

RESULT :

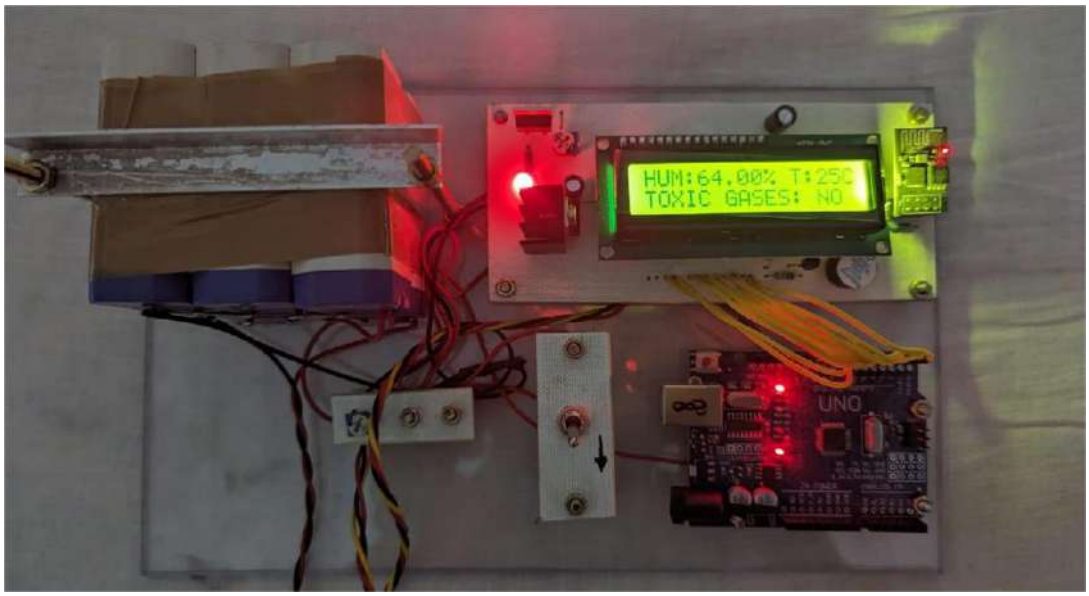

Figure 4.1 : Indication of threshold limit of humidity level by visual and hearing warnings

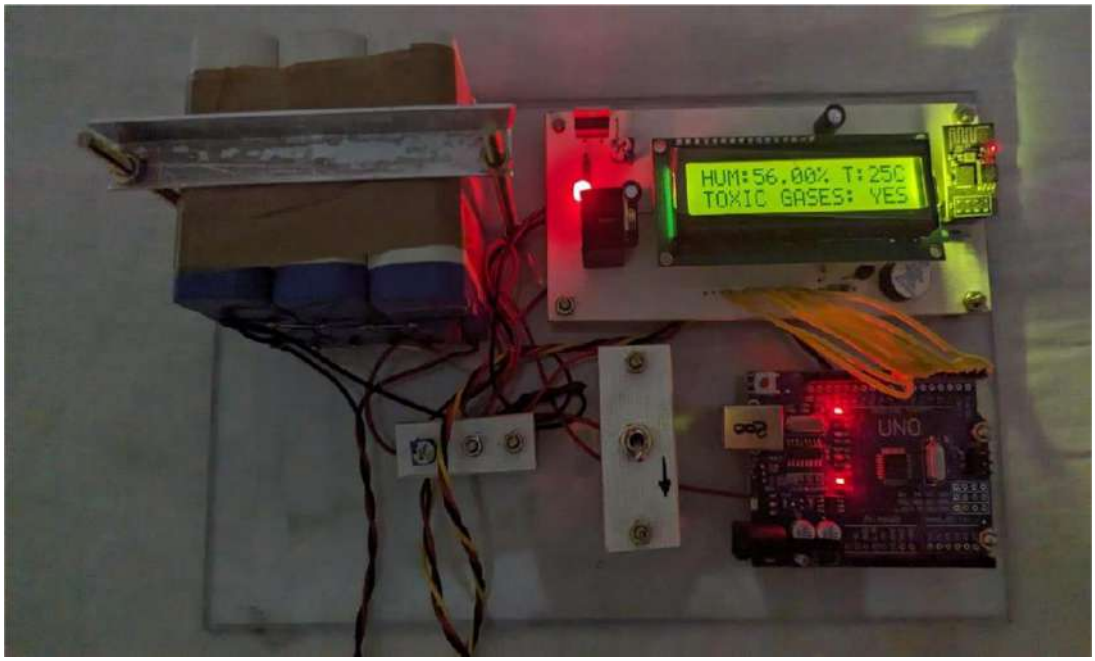

Figure 4.2 : Indication of harmful ppm levels of toxic gases by visual and hearing warnings

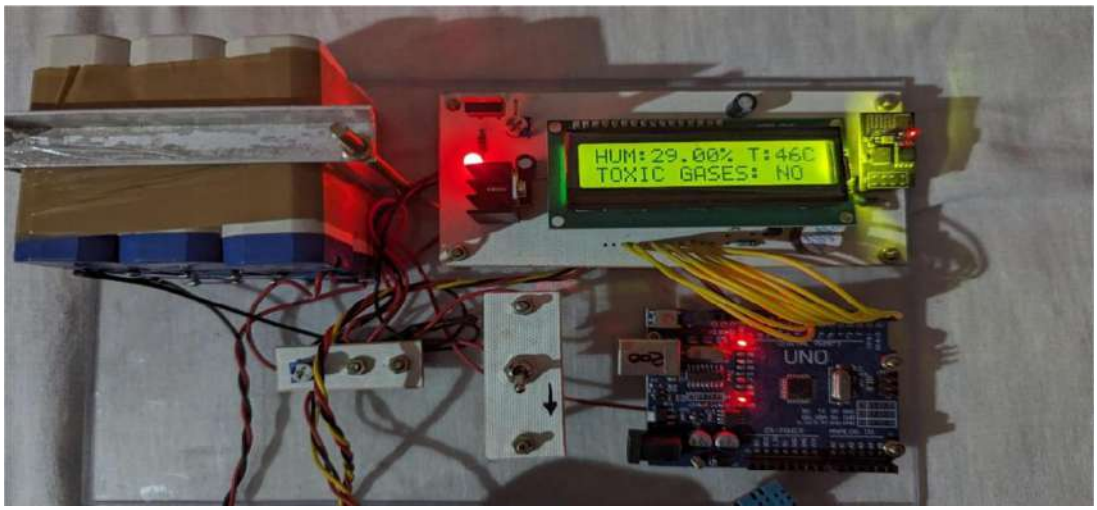

Figure 4.3 : Indication of threshold limit of temperature and flashing

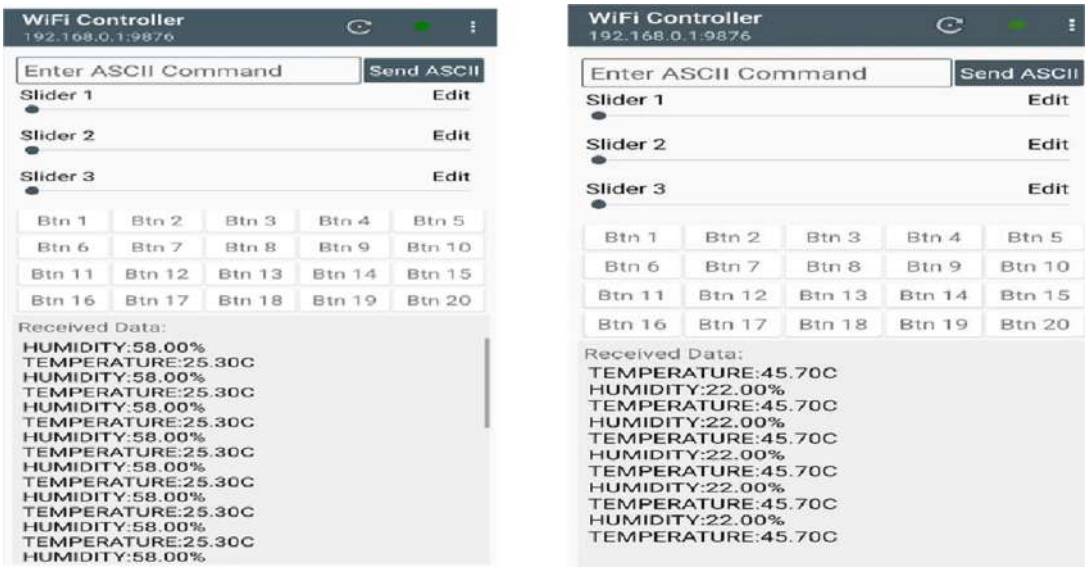

Figure 4.4 : visualization of helmet modules on wi-fi module platform

V. 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

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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.

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 ,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.

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