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IOT Empowered Helmets:Pioneering Safety in the Mining Sector

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Abstract— Mining sector is the most prominent to accidents. The accident rate in mining is about 87% .Mining activity involves a lot of tedious and time-consuming tasks as well. Out of the various risks associated with mining there exists many different types of hazardous gases like carbon monoxide, hydrogen sulphide,methane and excess of carbon dioxide. Mining also includes the risk of tremors and landslides as well. Along with that there is the danger of falling of large and bulky objects as well. On top of that removal of helmet is even more dangerous. Moreover ,monitoring each and every miner is also an important factor when it comes to mining. As a result there are lot of risks associated with the same. At times these risks can be life-threatening and result into fatal error .Lifesaving helmet for miners is an IOT based complete protection of miners. As the traditional model of smart helmet doesn't take all the above mentioned safety threats into consideration our aim through this proposed system is to develop a complete safety equipment in the form of helmet to safeguard miners from the various dangers present in the mining industry.

Keywords- *Blynkk;DHT11;ESP 8266;helmet;MO6 sensor*

I. INTRODUCTION

Workers that work in the excavation and building of underground facilities and structures are usually referred to as "underground construction miners". These people are skilled workers who focus on carrying out different duties related to underground building projects. Their main duty is to perform the challenging physical work needed to safely and effectively excavate, support, and construct underground structures [9].Underground construction miners frequently work in tight and cramped spaces, and they frequently encounter hard circumstances such restricted lighting, ventilation, and access. But at the same time safety of miners is major issue due to the rise in mine accidents, such as the Upper Big Branch Mine catastrophe that happened on April 5, 2010, the Safety and Health Administration (MSHA) issued a statement stating that a major accident was caused by a violation of safety protocol. It further stated that several people had lost their lives as a result of hazardous fumes. If they had found the issue early, the damage would have been lessened. The contemporary era's technological breakthroughs allow us to easily solve all of these issues. Taking this issue into account, we developed a smart helmet that may be extremely effective while being lightweight and having inflated security [10].The mining industry poses a high risk of accidents and injuries , making safety helmets a crucial protective gear for miners. These helmets provide protection for the head and skull from falling objects and accidents that occur in hazardous working circumstances. This study paper's main goal is to examine the significance of safety helmets for miners and assess how well they work to avoid head injuries. To accomplish this, the proposed system will investigate the various types of safety helmets, their materials and features, as well as the regulations and standards governing their use in the mining industry or in construction. Moreover, the study will examine case studies of mining accidents that could have been prevented with the use of safety helmets. Ultimately, this research aims to offer insight into the value of safety helmets for miners and emphasize their role in creating a safer and healthier work environment.

II. LITERATURE REVIEW

According to a survey found on the internet, the mining accident rate in India is 87%.Talking about the mining industry, form a period of 2017-2020 a the total number of 100 fatal accidents and 800 serious accidents have been reported in India [6]. Most of these accidents occur due to the tremors and the catastrophic behavior of the mines and the harmful substances present on them. Any type of mining involves a lot of rock-breaking process. Crystalline silica is the most prominent substance found in the earth's crust. During rock-breaking, miners are prone to dust and likewise they get exposed to this substance. The dust in the mines can cause cardiovascular complication and other lung diseases too [1].Similarly, hazardous gases present in the mines can also lead to nervous system complications. Along with that falling of large and bulky objects, constant landslides and prolonged exposure to the noise generated by machines can also lead to hearing problems [7].Along with that monitoring and keeping a touch with each and every miner is also an important factor because the cables

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that are meant for monitoring can be destroyed easily due to tremors [8].As a security measure helmets and PPE kits are used in the mines. But as mentioned we need to tighten the security so that we can eliminate these above mentioned threats. A conventional IOT-based smart helmet variant that can detect falls like the harmful gases present in the mines [9,10].MQ-6 sensor is used for that purpose was released in 2022 [2].Along with this, we can also combine the other sensors to develop communication system, bulky object detection, panic button and GPS tracking system too. In short through this proposed system. We can combine many existing IOT solutions to provide a complete safety protection in the form of helmet for the miners. Temperature and humidity are also an important factor that need to be continuously monitored in underground as well as open pit mines. DHT 11 sensor is a really efficient for monitoring temperature and humidity [11].Communication is an important factor needed to be taken into consideration [12].At such times wired cables are not an efficient solution as they may destroy any time in mines during the rock breaking and landslide, etc. [13].A specific alert is also necessary especially in mines for any emergency situations. In such cases, a panic button must be implemented for the to avoid in fatal situations [14].To be able to integrate all these sensors in a single platform like NODEMCU is a hard task. Node MCU turns out to be really efficient in such applications for integrating different types of sensors [15].Also, providing all this information to Blynk and storing it as well as its analyzing can all together provide an efficient and a complete smart safety helmet for miners.

III. METHODOLOGY

A. System Architecture:-

As IOT based smart helmet for miners is a great idea to improve their safety and well-being while working in mines, the proposed system includes the following components:

Helmet: The helmet should be designed to fit comfortably on the miner's head and provide basic sufficient protection from falling objects or head injuries.

Communication system: The helmet could be equipped with a communication system, such as a Blynk, to allow miners to communicate with each other or with the surface. Also ,we can also see these alerts on the OLED display.

Gas sensors: The helmet could also have sensors to detect hazardous gases, such as carbon monoxide or methane, that are commonly found in mines. These sensors could alert the miner if the levels of these gases become too high.

GPS tracking: The helmet could be equipped with a GPS tracking system that would allow the miner's location to be tracked in case of an emergency or if they become lost in the mine.

Camera and display: The helmet could also have a camera and display system that would allow the miner to see their surroundings and any potential hazards. The camera could also be used to transmit a live video feed to the surface, allowing supervisors to monitor the miners.

Emergency alert system: Finally, the helmet could have an emergency alert system that would allow miners to quickly and easily alert the surface in case of an emergency, such as a cave-in or a gas leak.

Figure 1 demonstrates the block diagram of our proposed system.

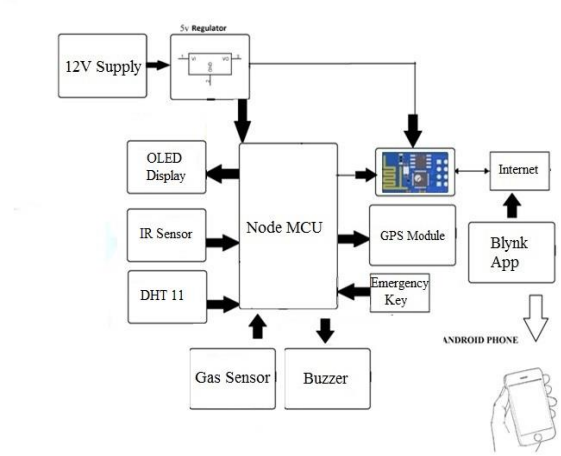

Figure 1. Block diagram of helmet

Figure 2 demonstrates the circuit diagram of our proposed system.

B. Circuit Diagram:

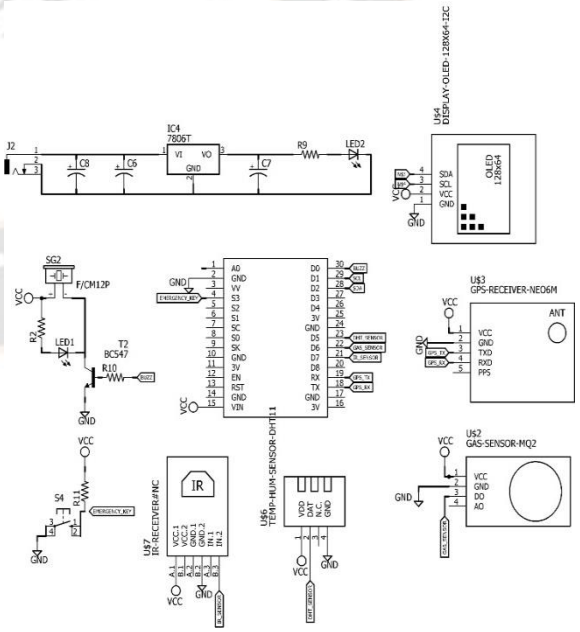

Figure 2. Circuit diagram for helmet

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C. Hardware And Software Components:-

The ESP8266 (Node-MCU) is a low-cost Wi-Fi capable microcontroller that has an integrated Wi-Fi module that enables it to connect to a Wi-Fi network or construct an access point. It may be programmed using the Arduino IDE or other software platforms and is based on the ESP8266 chip. It is frequently utilized in IoT projects and applications that need for Wi-Fi connectivity.

An inexpensive sensor is the MQ-6 gas sensor. that can detect different types of gases, including LPG, butane, propane, and methane. It is a module that operates on the principle of gas detection using a sensitive material called SnO2. The module outputs an analog voltage that can be read by a microcontroller or an ADC for gas detection and monitoring purposes.

An IR sensor that can recognize and quantify infrared radiation is known as an infrared sensor, or IR sensor. It is frequently employed for temperature measurement, motion detection, and proximity sensing. When an item emits IR radiation, IR sensors can detect it and turn it into an electrical signal that can be processed by a microcontroller or other electronic equipment.

The Global Positioning System, sometimes known as GPS, is a satellite-based navigation system that can deliver accurate time and location data anywhere on Earth. It is made up of a system of satellites in Earth orbit, ground control centers, and GPS receivers. GPS receivers can be used for navigation, tracking, and other purposes by using signals from the satellites to determine their position, velocity, and direction. The ESP8266 may utilize GPS to determine the miner's position. Wi-Fi can be used to communicate the location data to the surface, enabling managers to keep an eye on the miners and find them in an emergency.

The ESP32-CAM is a small-sized ESP32-based development board that integrates a camera module and Wi-Fi connectivity. It features a OV2640 2MP camera and supports up to 1600x1200 resolution. It can be programmed using the Arduino IDE or other programming environments, and can be used for various IoT applications such as video streaming, surveillance, and home automation.

IV. RESULTS AND DISCUSSIONS

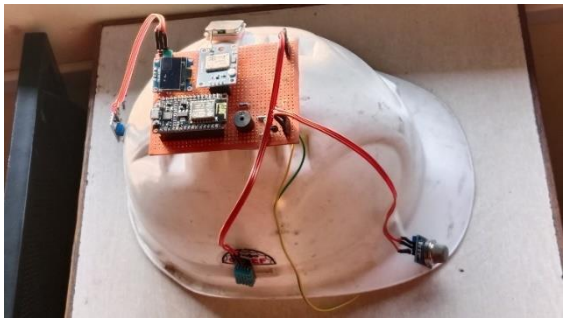

Figure 3. Top view of helmet

Figure 3 is the top view of the helmet. It can be seen that various sensors are integrated together and mounted on the helmet.

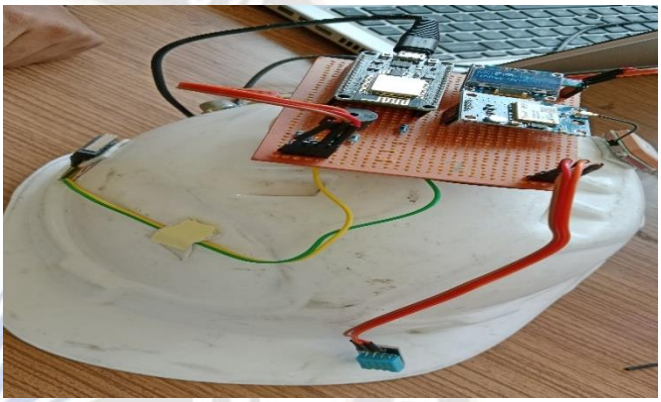

Figure 4. Side view of helmet

Figure 4 is the side view of the helmet. It can be seen that various sensors are integrated together and mounted on the helmet.

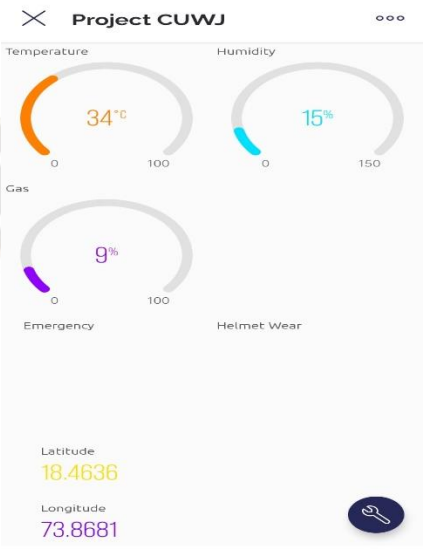

Figure 5. Blynk Dashboard

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Figure 5 is the view of the blynk dashboard. It can be seen that various sensors are monitored together and the latitude and longitude is displayed too.

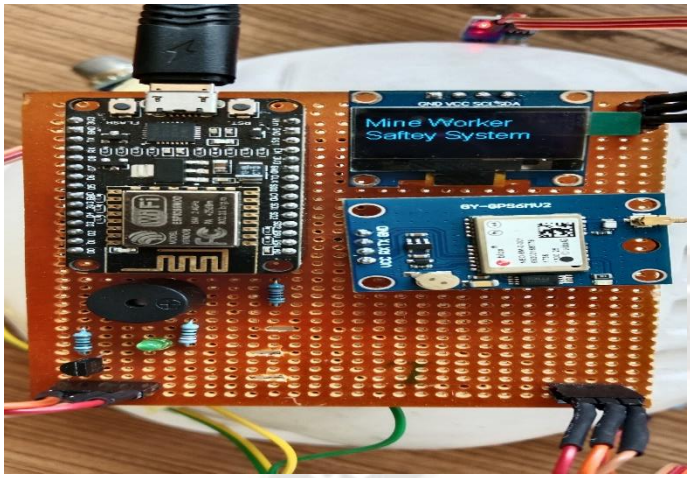

Figure 6. Welcome message

Figure 6 is a simple welcome message for miners. It is displayed when the system is started.

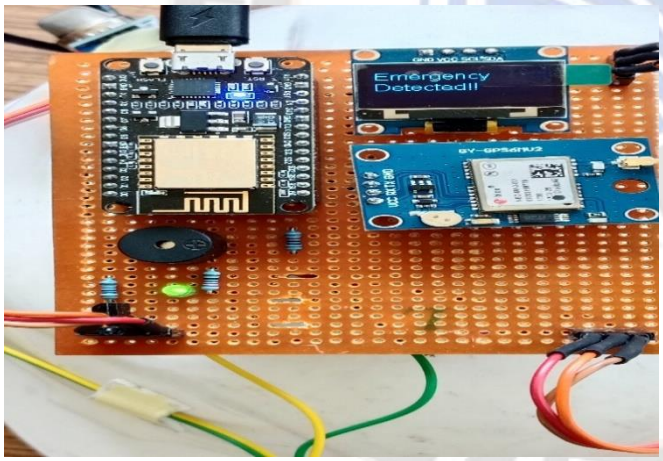

Figure 7. :Emergency Detected message in OLED display

Figure 7 is the emergency detection message through the OLED display. It can be seen that this message appears when the buzzer is activated.

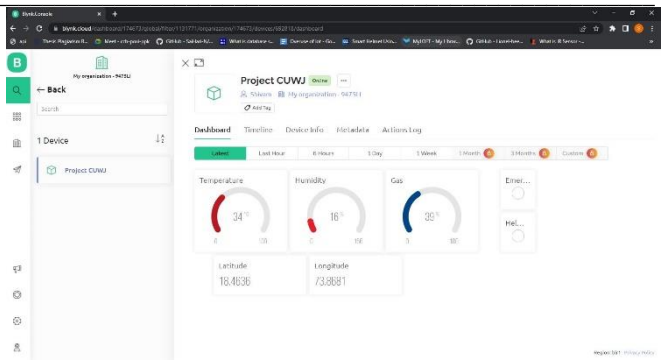

Figure 8. Emergency Detected message in Blynk

Figure 8 is the emergency detection message through the Blynk Server It can be seen that this message appears when the buzzer is activated.

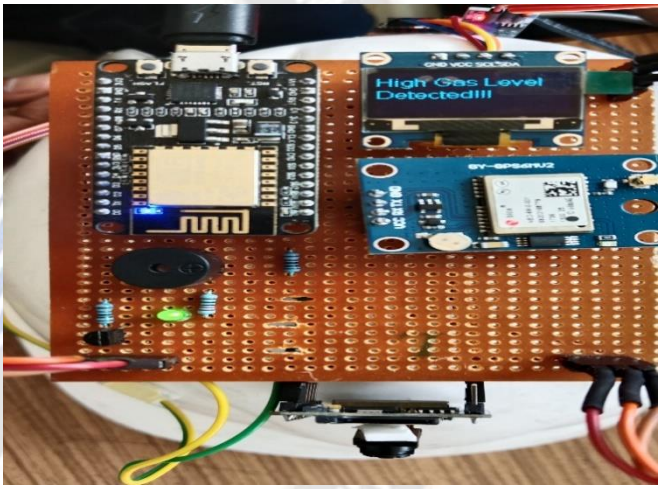

Figure 9. Toxic gas detection

Figure 9 is the toxic gas detection message through the OLED display. It can be seen that this message appears when the harmful gases such as propane, butane , LPG are sensed by the MQ6 sensor.

Figure 10:Top View of helmet through Camera module

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Figure 10 is the top view of the helmet through the camera module. It can be seen that the inside mine condition can be monitored through this camera by the mine administrator or their head.

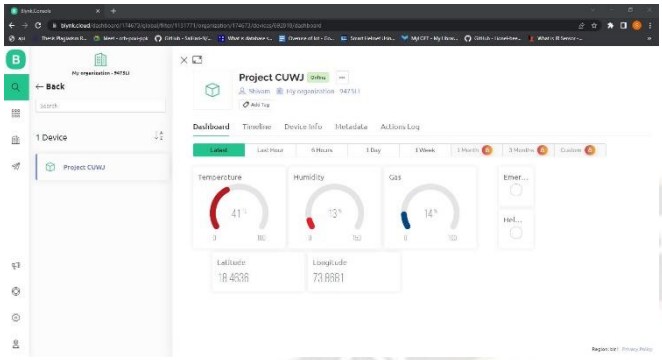

Figure 11. High Temperature and humidity Detection

Figure 11 is the high temperature and humidity detection message through the Blynk Server It can be seen that this message appears when the temperature and humidity levels rise.

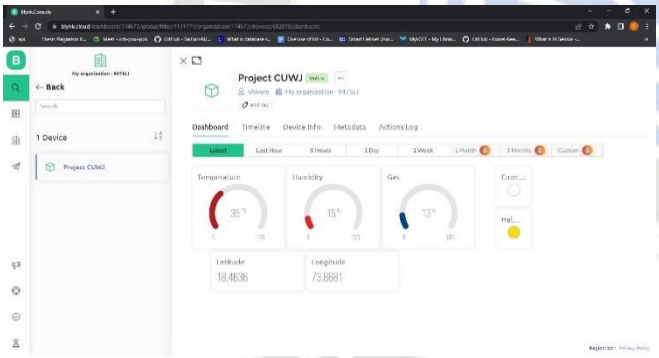

Figure 12. When panic button is pressed, yellow light appears

In Figure 12 it can be seen that when the panic button is pressed, a yellow light appears on the blynk.

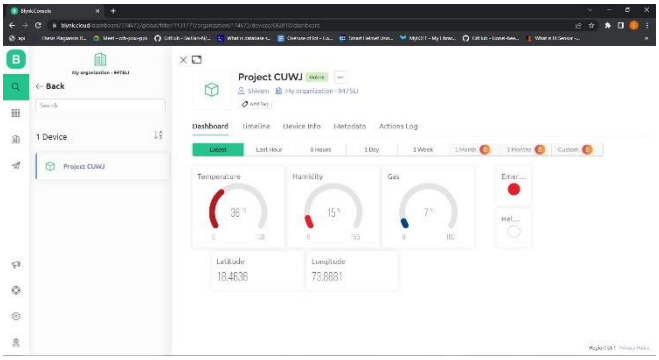

Figure 13. When emergency occurs, red light appears

In Figure 13 it can be seen that when the emergency button is pressed, a red light appears on the blynk.

V. FUTURE SCOPE

Future miners' life-saving safety helmets will use cutting-edge technologies to improve worker protection and rescue efforts. Integrated respiratory protection systems for clean air supply, temperature sensors to prevent heat-related incidents, emergency beacons and locators for quick rescue responses, communication and tracking systems for effective coordination, impact and fall detection sensors for immediate distress signals, visual and audible alert systems, and novel lightweight and energy-efficient technologies are some of the key advancements. These developments are intended to reduce hazards, accidents, and to advance the security and wellbeing of miners in difficult underground conditions.

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Therefore we would like to express our sincere gratitude to Mrs. Puja Chavan ma'am for her timely guidance and mentoring throughout the proposed system. Her knowledge, support, and commitment have been extremely helpful in making this proposed system a success Prof. Puja Chavan has continuously given us smart recommendations, constructive feedback, and priceless materials that have significantly improved my comprehension of the subject. Her persistence and willingness to respond to our questions and worries have been crucial in overcoming obstacles and completing the proposed system's goals.

CONCLUSION

A smart helmet for miners is an innovative solution that can improve safety and productivity in the mining industry and construction. It can incorporate various technologies such as communication systems, gas sensors, GPS tracking, and cameras to provide real-time information and alerts to the miners and supervisors. The ESP8266 (Node-MCU) and MQ-6 gas sensor can detect hazardous gases, while the IR sensor can provide proximity sensing. The ESP32-CAM can provide navigating location and Wi-Fi connectivity. The combination of these technologies can improve situational awareness and prevent accidents in hazardous environments. The implementation of a smart helmet can ultimately lead to a safer and more efficient mining environment, and improve the well-being of the miners.

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