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2. Title of the project: CHATURA SURAKSHA KAVACHA – "THE SMART SAFETY HELMET FOR MINE WORKERS"

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5. Keywords: Internet of things, Blynk, ESP-8266, ESP32 CAM module, GPS module, DHT11, MQ6 Sensor

6. Introduction

In the 21st century, the mining industry has become one of the most dominant sectors of the economy because of the increasing need for metals and other geological materials. It can be mined both by surface mining and underground mining. It is evident that the safety in open pit mines is more than in underground mines due to adequate light and fresh air access. Thus, the safety of underground miners becomes paramount for the concerned authorities. Unexpected accidents and existing dangers in underground mines could provide a stressful and dangerous workplace for workers and operational facilities that impose considerable life and financial threats. A miner's helmet is one of the most regularly used safety equipment for mine workers hence it must be loaded with some more advanced features. The smart helmet has been produced to assist miners operating in the mining industry. With the use of different sensors, the smart helmet will be able to identify catastrophic situations such as harmful gases like Carbon-Monoxide (CO), methane (CH4), liquified petroleum gas (LPG), and natural gases. The existence of the helmet on the worker's head is detected by an infrared sensor. Each sensor has a threshold value that, if exceeded, causes the buzzer to activate and the LEDs to illuminate, signalling the miners and supervisors. The ESP32 cam module fitted in the miner's helmet allows the mining officials to monitor the worker continuously. Furthermore, an Emergency

Button has been implemented, which, when pressed, sends an emergency signal to the higher authorities outside the mines. Each sensor has a threshold value that, if exceeded, causes the buzzer to activate and the LEDs to illuminate, signalling the miners and supervisors. The Esp32 cam module fitted in the miner's helmet allows the mining officials to monitor the worker continuously. Furthermore, an Emergency Button has been implemented, which, when pressed, sends an emergency signal to the higher authorities outside the mines.

7. Objectives

- Detecting the presence of Hazardous gases like Carbon-Monoxide, Methane, LPG, and other natural gases.
- To detect the existence of the helmet on the worker's head.
- Emergency button is provided which need to be pressed in any adverse situation.
- To monitor the mine worker's location continuously using ESP32 Cam.

8. Methodology

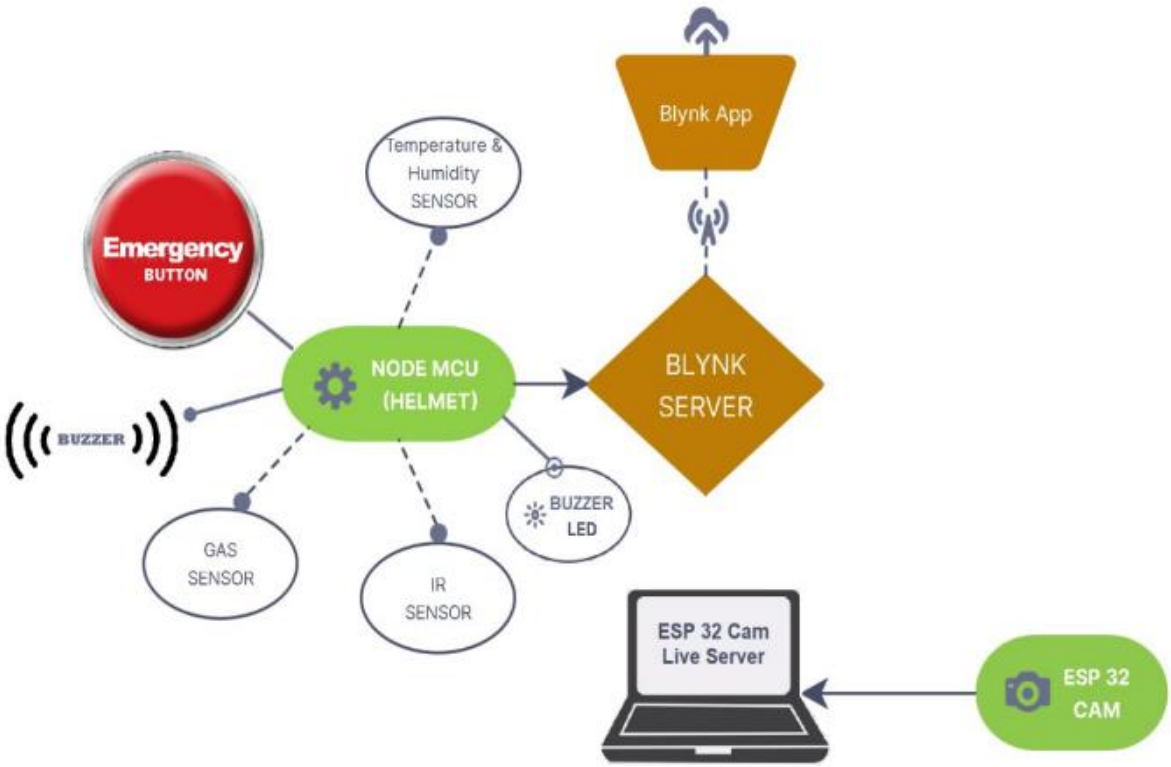

Figure 1: Block Diagram of the Proposed System

In our proposed work, we have used different sensors which perform different tasks. DHT11 is a sensor which measures the temperature and humidity of the working place. MQ6 sensor is a gas sensor which is used to detect the hazardous gases. The temperature, humidity and gas sensor's data are collected by the Node-MCU microprocessor.

Infrared (IR) sensor notifies the existence of the helmet on the worker's head. Using ESP32 CAM the current working condition of the worker can be known. All the data is finally sent to the Blynk server and displayed in the Blynk app. Then the temperature, humidity and gas level will be displayed on the Blynk app. In case of emergency a distress signal can be sent to the mining authorities using the emergency button. As the miner presses the emergency button a mail is sent to the authorities within 5 seconds which helps the authorities to reach the miner as fast as possible thereby saves the miners life. To avoid the possibility of mail ignorance the mail is continuously sent until the authorities give a suitable response.

To continuously monitor the working condition of the worker a live streaming esp32 cam is embedded on top of the helmet. The streaming is done at 160 MHz clock speed with a pixel count of 2MP. This live video stream will help the mining officials to get a constant update of the situation under the mines, it also helps to know whether the worker is properly working in the assigned area or not, through live streaming if any adverse situation in their surrounding area happens then it can be identified and further it can be intimated to the worker in that particular area and can also use this feed for research and future reference.

9. Results

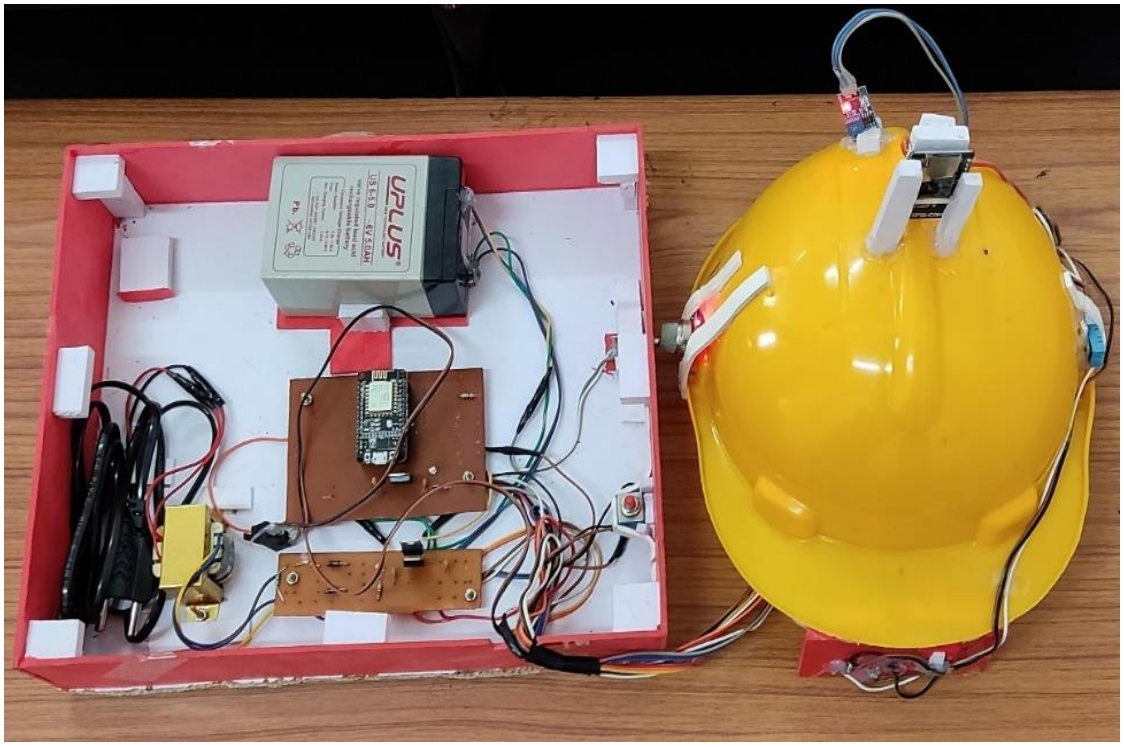

Figure 2: Working Prototype

In this project, the smart safety helmet for mine workers, there are four main objectives. First objective is to detect the presence of Hazardous gases like Carbon-Monoxide, Methane, LPG, and other natural gases, the second objective is about helmet removal by the miners, the third objective is the emergency button pressed in any adverse situation and the last objective

is to monitor the miners continuously using esp32 cam. Therefore, it is crucial to have a monitoring and surveillance system to acquire the evaluated data, transmit it to the control center, and make the most appropriate decision at the earliest possible moment.

Figure 3: Gas Alert in Blynk App

Detecting the presence of Hazardous gases like Carbon-Monoxide, Methane, LPG, and other natural gases is the first objective of our project. Air quality test is done using MQ-6 gas sensor. As shown in Figure 3, as soon the presence of CH4, LPG and natural gases above 55% is detected by the MQ-6 sensor a signal is sent to the higher authorities in the control room. Concurrently, the buzzer and the LED is switched ON to notify the mine worker. The MQ-6 sensor collects data after every 0.2 second interval for better accuracy.

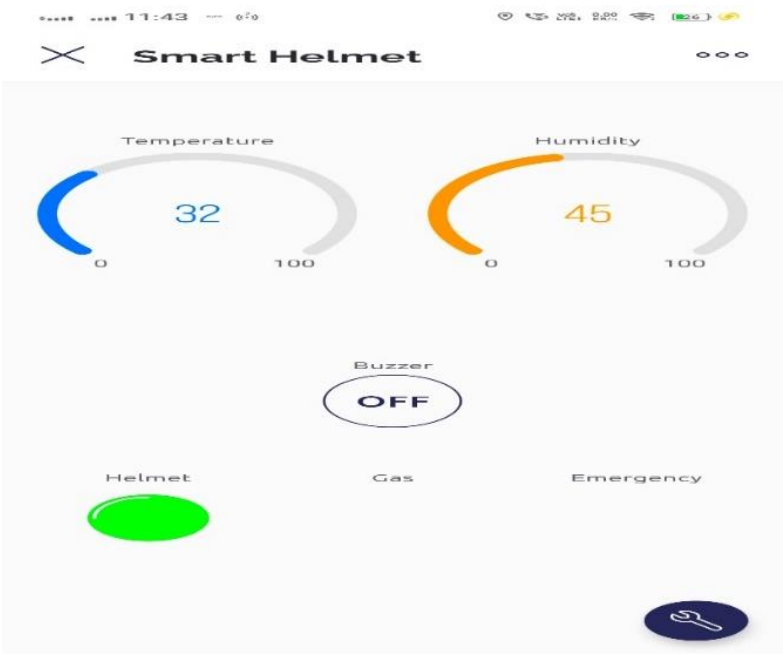

Figure 4: Alert About Helmet Removal

Second objective of our project is to detect the existence of the helmet on the worker's head. An IR sensor is used to perform smart helmet removal test, when a miner removes their helmet, it gets detected by the sensor. As soon as the worker removes the helmet it is detected in the blynk server. Red LED along with a buzzer sound prompting to wear the helmet back is activated. The IR sensor checks the condition after every 0.2 second for more accuracy.

Figure 5: Emergency Signal in Blynk App

Third objective of our project is to press the emergency button in any adverse situation. In case of emergency a signal can be sent to the mining authorities using the emergency button. As the miner presses the emergency button a mail is sent to the higher authorities sitting in the control room within 5 seconds which helps the authorities to reach the miner as fast as possible thereby save the miners life. To avoid the possibility of mail ignorance the mail is continuously sent until the authorities give a suitable response.

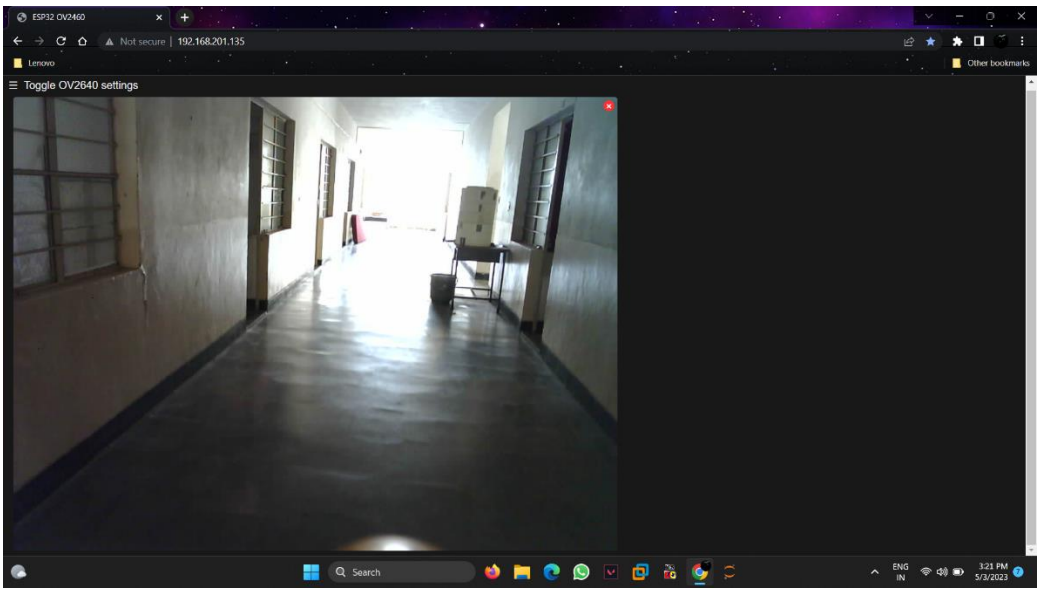

Figure 6: Live Video Streaming of Mine Worker

The last objective of our project is to monitor the mine worker's location continuously using esp32 camera. As shown in above Figure 6, the esp-32 camera module attached to helmet, will stream live video to the authorities for monitoring. The streaming is done at 160 MHz clock speed with a pixel count of 2MP. This live video stream will help the mining officials to get a constant update of the situation under the mines and can also use this feed for research and future reference.

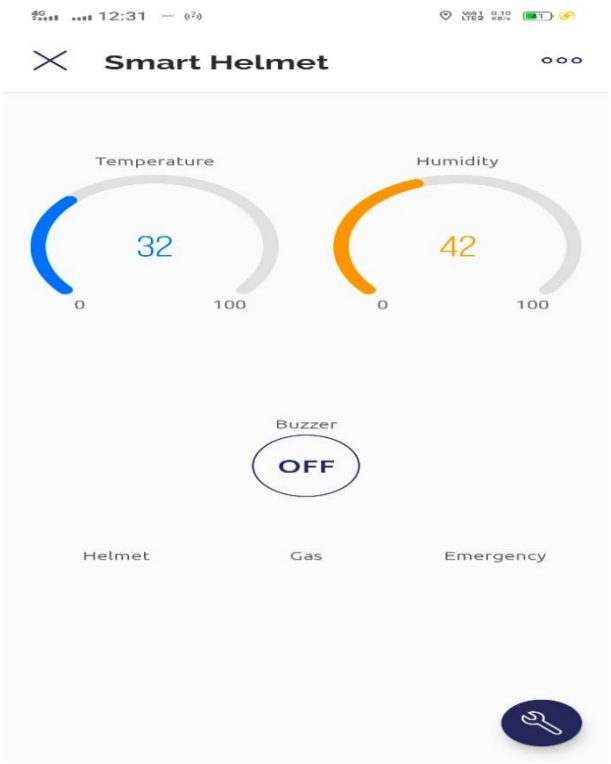

Figure 7: Temperature and Humidity Readings in Blynk app

In our project, we also display the temperature and humidity readings in the Blynk app. In order to increase the efficiency of the measurement, a measurement was conducted every 2 seconds with the DHT11 sensor. It measures temperature from 0 to +50 °C with an accuracy of +/-2 °C and relative humidity from 20 to 95% with an accuracy of +/-5% as shown in above Figure 7. In the proposed model, if the temperature rises above 38°C and if the humidity of the environment exceeds over 86% then the worker is alerted through a red LED and buzzer by the higher authorities in the control room.

Conclusion

The mining industry all over the world is adversely affected by various hazards including gaseous explosions, landslides, fire hazards, etc. Many risky incidents commonly occur in the mining sector, many of which result in life-threatening injuries or death. This leads to the significance of safety for the mine workers. A miner's helmet is one of the most regularly used safety equipment for mine workers hence it must be loaded with some more advanced features. A Wi-Fi based smart helmet has been designed for coal miners which is capable of

detecting threatening events like the increase in the level of harmful gases inside the mine. This smart helmet is also capable of sending real time temperature and humidity levels to the servers thereby keeping the concerned authorities always updated about the mine conditions. -The presence of an emergency button in the smart helmet helps the miners to send signals easily just with a press of a single button that indicates the rescue team that the worker needs to be rescued. The helmet removal notified feature helps the authorities to get informed if any miner tries to remove the helmet. We have provided an esp32 camera to monitor the mine worker's location continuously. This low-cost, reliable and efficient prototype has been designed and tested with software and hardware debugging. Placement of each module and sensors has also been done carefully thus resulting in the best working of the product.

10. Future scope

The proposed model can be upgraded by using a LORA module in addition to the WiFi thereby making the communication process less network dependent. Further an oximeter can also be included to constantly monitor miners' oxygen level and heart rate. Also, a collision sensor can be installed which can detect any collision or accidents. To detect the increasing water level in mines we can integrate a water level sensor in the miners' boots, which will warn the miner of increasing water levels.