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IOT Based Workers Smart Helmet

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Abstract—

The Smart IoT-Based Helmet for Mine Workers is an advanced safety solution designed to significantly enhance protection for miners by offering comprehensive real-time monitoring of environmental and physiological conditions. The system utilizes the ESP32 microcontroller as its core processing unit, which is integrated with a range of sensors to continuously measure critical parameters such as temperature, humidity, gas levels (e.g., methane, carbon monoxide), and atmospheric pressure. Additionally, the helmet is equipped with motion-detection capabilities, using an accelerometer to track worker movements and detect falls or unusual patterns that could indicate distress.

Data from these sensors is seamlessly transmitted wirelessly to the Blynk app, allowing supervisors and safety personnel to access real-time data for analysis, visualization, and instant alerts in case of hazardous conditions. Furthermore, the helmet includes a live video streaming feature powered by the ESP32 CAM module, which enables remote visual inspection of the miner's immediate environment. This added functionality allows safety teams to monitor not only sensor data but also actual working conditions, providing a comprehensive view of potential risks.

The project exemplifies the practical application of IoT technology in occupational safety, delivering a solution that is not only cost-effective but also scalable to other high-risk sectors such as construction, oil and gas, and emergency response. By facilitating continuous monitoring and immediate response, this Smart Helmet system offers a proactive approach to workplace safety, aiming to reduce accidents and enhance overall safety standards in hazardous industries.

Keywords— ESP32 (W-room) Microcontroller, ESP32 CAM module, Buzzer, LCD display.

I. Introduction

The integration of IoT-based technologies in safety equipment, particularly smart helmets, has introduced substantial improvements in risk management across high-hazard industries. Smart helmets not only protect workers from physical harm but also incorporate sensors and communication modules to actively monitor and report environmental hazards and user conditions. These helmets are utilized in sectors like mining, road safety, and construction, where risks of fatal incidents are high due to environmental or operational factors. By alerting users and remotely monitoring unsafe conditions, smart helmets aim to prevent accidents, streamline emergency response, and improve overall workplace safety.

The Smart IoT-Based Helmet for Mine Workers is an advanced safety solution designed to monitor real-time environmental conditions and worker well-being in hazardous settings. By integrating a series of sensors—such as the DHT11 for temperature and humidity, MQ2 for gas detection, BMP180 for atmospheric pressure, and an accelerometer for motion tracking—this helmet continuously collects and transmits data to ensure safety compliance and timely intervention. The system employs an ESP32 microcontroller to process data and send it to the Blynk app, where supervisors can view real-time information, receive alerts, and initiate necessary safety measures.

Equipped with an ESP32 CAM for live-streaming capabilities, this helmet not only provides critical data but also visual context, allowing remote monitoring of workers' environments. Power management through a 12V battery with a buck converter ensures stable operation, while on-site audio alerts via a buzzer warn workers directly in the event of hazardous conditions. The Smart IoT-Based Helmet thus combines IoT and sensor technology to create a proactive safety solution adaptable to high-risk industries like mining, construction, and oil and gas.

II. Literature Survey

[1] P. J. Patil, M. Bhole, D. N. Pawar, S. Nadgaundi, R. Pawar and A. Mhatre, "Smart Helmet for Coal Mine Workers," 2023 International Conference on Integration of Computational Intelligent System (ICICIS), Pune, India, 2023, pp. 1-5, doi: 10.1109/ICICIS56802.2023.10430243. Mining is a notoriously dangerous industry, with numerous hazards including toxic gas emissions, structural collapses, and temperature extremes. To address these risks, researchers have proposed various types of smart helmets specifically tailored for mining environments. In one study, a smart helmet for coal miners is equipped with multiple gas sensors (such as MQ2, MQ7, and MQ135) that detect gases like carbon monoxide, methane, and ammonia, which are common in underground mines. This helmet also integrates temperature and humidity sensors to track the mine environment in real time, alerting miners and supervisors if conditions exceed safety thresholds. The data is transmitted wirelessly via Wi-Fi to the ThingSpeak IoT platform, allowing remote monitoring by the control center, thereby enhancing response times in hazardous situations.

Another smart helmet system in mining combines Bluetooth Low Energy (BLE) technology with gas and vibration sensors to offer a proximity alert system for restricted areas. This BLE-based helmet operates with a master-slave relationship, where a beacon device (master) communicates with the helmet (slave) to detect when a worker approaches dangerous zones, such as areas with high structural risk or toxic gas accumulation. This system aims to reduce the risk of structural collapses by alerting the miner in real time and prompting immediate actions or evacuation if necessary. Additionally, the BLE communication protocol minimizes power consumption, extending helmet battery life—a critical feature for use in isolated, underground environments where frequent recharging may not be feasible.

III.Objectives

- To design a helmet equipped with sensors to monitor temperature, humidity, gas levels, and atmospheric pressure.
- To implement an accelerometer for fall detection and emergency alerts for distress situations.
- To enable continuous data transmission to the Blynk app for real-time remote monitoring.
- To integrate live video streaming functionality for visual monitoring of the worker's environment.
- To enhance user safety through immediate audio-visual alerts in hazardous conditions.
- To optimize power consumption to extend operational hours while maintaining high reliability.

IV. Methodology

The Smart IoT-Based Helmet for Mine Workers operates on the principles of IoT and sensor-based monitoring to provide a comprehensive safety system tailored for hazardous environments. The system architecture involves integrating multiple sensors with an ESP32 microcontroller, which acts as the central processing unit. The primary sensors include:

1. DHT11 Sensor: This sensor measures temperature and humidity, providing essential data on environmental conditions that may impact worker safety.
2. MQ2 Gas Sensor: Used for detecting hazardous gases like methane and carbon monoxide, this sensor plays a crucial role in alerting workers to potentially toxic environments. High levels of certain gases can pose significant health risks, and the MQ2 ensures these conditions are quickly identified.
3. BMP180 Sensor: Atmospheric pressure monitoring is crucial in underground environments, as fluctuating pressure levels can indicate structural instability or other potential hazards.
4.Accelerometer: This sensor detects sudden movements or falls, which may indicate a worker is in distress. If a fall or abrupt motion is detected, the system immediately alerts supervisors, enabling timely intervention.
5. ESP32 CAM Module: Provides live video streaming capabilities, allowing supervisors to visually monitor the worker’s surroundings in real-time. This feature is especially valuable in mining operations, where visual context can be critical in assessing risks.

The ESP32 microcontroller processes the data gathered from these sensors and uses Wi-Fi to transmit it to the Blynk app, an IoT platform for monitoring and controlling devices remotely. The Blynk app displays sensor readings, allowing supervisors to view real-time data and receive instant alerts if any parameter exceeds safe limits. The app also supports email notifications, enabling communication with multiple stakeholders in emergencies.

When the sensors detect unsafe conditions, such as elevated gas levels or a fall, the system immediately activates an audible buzzer on the helmet. This alert warns the worker to take precautions or evacuate if necessary. Additionally, the Blynk app sends a notification to supervisors, ensuring prompt response and intervention.

A 12V battery powers the helmet, with a buck converter to regulate and stabilize the voltage supply to all components. This ensures consistent performance and minimizes the risk of power fluctuations. The helmet's components are mounted on a printed circuit board (PCB), optimizing the arrangement for compactness and durability, essential qualities for a wearable device.

Theoretical principles behind this design lie in IoT-based real-time monitoring systems and proactive hazard detection. By leveraging IoT, the helmet’s data can be transmitted instantly to a cloud platform, where it is accessible for remote monitoring. This real-time capability is especially critical in dangerous environments where timely information and swift responses are necessary to prevent accidents. The sensors act as a digital layer of protection, continuously tracking conditions and automatically triggering alerts without requiring manual checks.

This helmet is a scalable solution adaptable for various high-risk sectors. Beyond mining, similar safety measures can enhance worker safety in construction, oil and gas extraction, firefighting, and other industries where environmental hazards are prevalent. By ensuring continuous safety monitoring, this project not only improves operational safety standards but also highlights the growing role of IoT and wearable devices in workplace health and safety solutions.

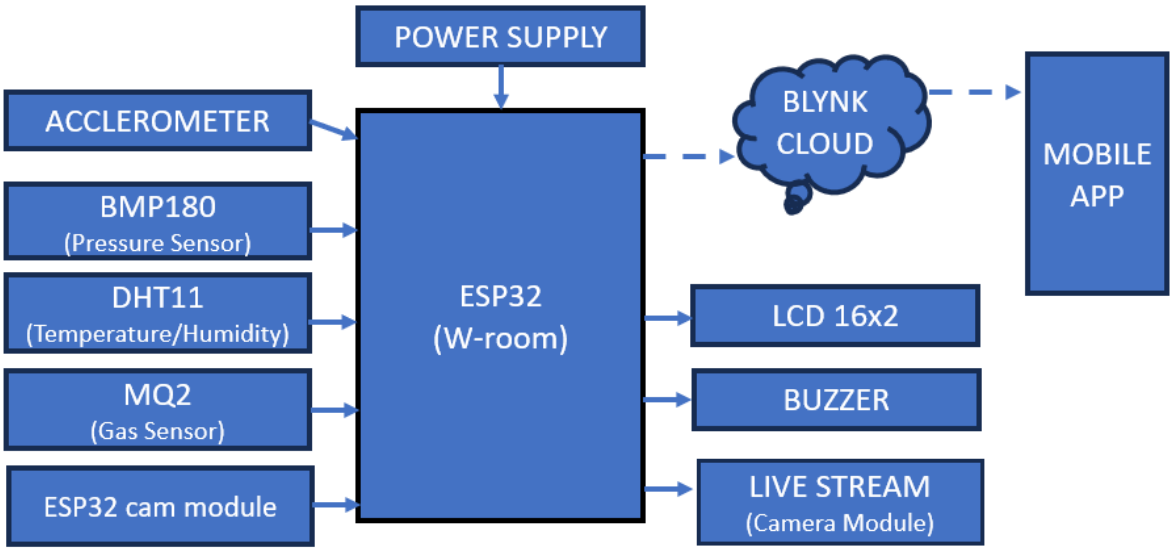

Fig.1 Block Diagram

A. Hardware Specification:

- **ESP32(W-room) Microcontroller :** Microcontroller for data processing and communication.

Fig.2 ESP32 Microcontroller

- **ESP32 CAM Module** - For live video streaming.

Fig.3 ESP32 CAM Module

- **Buzzer:** Generates an audible alarm.
- **Power supply:** 12 V battery provides power to the system.
- **PCB:** For prototyping and connecting components.
- **Jumper wires:** For connecting components on the breadboard.

Fig.4 Jumper Wires

- **Resistors and capacitors:** For configuring the op-amp circuit.

Fig.5 Resistors and Capacitor

- **DHT11 Sensor** - For temperature and humidity measurement.

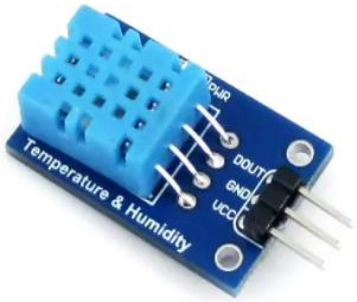

Fig.6 DHT11 Sensor

- **MQ2 Sensor** - For detecting harmful gases.

Fig.7 MQ2 Sensor

- **BMP180 Sensor** - For atmospheric pressure measurement.

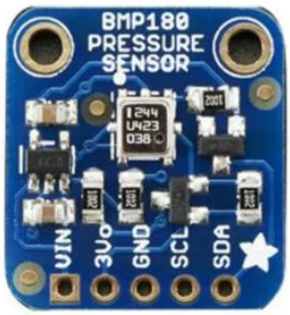

Fig.7 BMP180 Sensor

B. Software Specification:

- Arduino IDE
- Proteus
- **Code:** A series of instructions written in the Arduino programming language that defines the behaviour of the system.

V. Result:

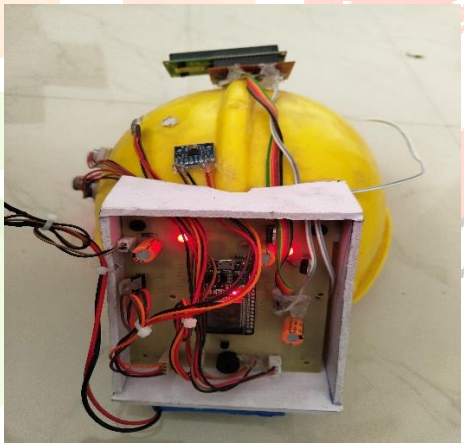

Fig.6 Project Model

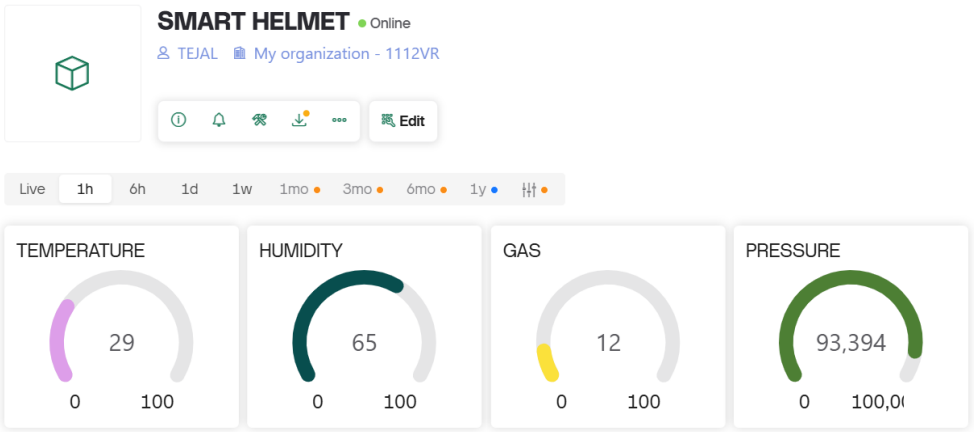

Fig.7 Output of the Model

The Smart IoT-Based Helmet for Mine Workers project successfully demonstrated an IoT-based safety system that continuously monitors environmental conditions and worker safety parameters in real-time. Through the integration of multiple sensors (DHT11 for temperature and humidity, MQ2 for gas detection, BMP180 for atmospheric pressure, and an accelerometer for motion), the helmet provides a comprehensive overview of the worker's environment. The data gathered is sent to the Blynk app via the ESP32 microcontroller, where supervisors can monitor conditions and receive alerts remotely. Additionally, the ESP32 CAM module enabled live video streaming, providing visual access to the worker's surroundings.

Key results from testing include:

1. Real-Time Monitoring: The helmet effectively transmitted sensor data to the Blynk app with minimal delay, allowing supervisors to observe environmental conditions in real-time.
2. Accurate Hazard Detection: The system successfully triggered alerts in cases of gas concentration changes, temperature/humidity variations, and sudden worker movements (such as a fall), activating the buzzer and sending notifications to the app.
3. Reliable Data Transmission: The ESP32 microcontroller consistently sent data to the Blynk app, with alerts delivered via email and app notifications, providing dependable remote access to safety data.
4. Visual Monitoring: The ESP32 CAM module streamed live video to the connected device, allowing for effective visual monitoring in hazardous areas.
5. Power Efficiency: The helmet's 12V battery with buck converter provided stable power for extended periods, though further optimization could enhance battery life.

In conclusion, the Smart IoT-Based Helmet met its objectives of providing a real-time, responsive, and cost-effective safety solution for high-risk environments. The system demonstrated high potential for applications in mining and other industries, contributing significantly to proactive workplace safety.

VI. Conclusion

The Smart IoT-Based Helmet for Mine Workers effectively addresses the need for enhanced safety in hazardous environments by providing continuous real-time monitoring of critical environmental and safety parameters. The system's integration of temperature, humidity, gas detection, pressure, and motion sensors allows for comprehensive hazard detection, while the ESP32 CAM module offers live visual monitoring for supervisors. Reliable data transmission to the Blynk app ensures that supervisors can oversee conditions remotely and receive immediate alerts, enabling proactive responses to potential dangers.

The project's successful demonstration of real-time alerts, dependable data transmission, and visual surveillance confirms its feasibility as a low-cost, scalable safety solution. This technology significantly reduces risks by enhancing situational awareness for both workers and supervisors. In conclusion, the Smart IoT-Based Helmet represents a valuable advancement in occupational safety for high-risk industries like

mining, construction, and oil and gas, and showcases the potential of IoT and wearable technology in creating safer work environments.

VII. REFERENCES

[1] P. J. Patil, M. Bhole, D. N. Pawar, S. Nadgaundi, R. Pawar and A. Mhatre, "Smart Helmet for Coal Mine Workers," 2023 International Conference on Integration of Computational Intelligent System (ICICIS), Pune, India, 2023, pp. 1-5, doi: 10.1109/ICICIS56802.2023.10430243.

[2] B. R. Navana, R. Eldho, A. Bhat, M. Solomon Selva, M. Vishnu Raju and N. Manohar, "Design and Development of an IOT based Smart Helmet for Two Wheelers," 2022 3rd International Conference on Communication, Computing and Industry 4.0 (C2I4), Bangalore, India, 2022, pp. 1-5, doi: 10.1109/C2I456876.2022.10051232.

[3] C. Priya, R. Arjun, K. Manimaran, M. Vadivel, R. Sandeep and K. Balachander, "Smart Helmet Proximity Alerts for Enhanced Safety in Underground Mines," 2024 International Conference on Science Technology Engineering and Management (ICSTEM), Coimbatore, India, 2024, pp. 1-4, doi: 10.1109/ICSTEM61137.2024.10561097..

[4] "IoT-Based Smart Helmet for Underground Mines"* - Authors: Borkar, D., and Baru, P. - Year: 2020 - Focuses on using IoT to monitor gas, temperature, and humidity in mines and sends real-time data to control centers.

[5] "IoT Mining Tracking and Worker Safety Helmet"* - Authors: Tajane, P., and colleagues - Year: 2020 - Discusses an IoT-based helmet that tracks worker health parameters such as heart rate and environmental conditions in real-time.

[6] "IoT-Based Mining Worker Safety Helmet Using ESP32 and Blynk App"* - Authors: Umapathi, K., and colleagues - Year: 2021 - Uses ESP32 and the Blynk app to create an IoT solution for tracking environmental and health conditions of miners.

[7] "Smart Helmet Using RF and WSN Technology for Underground Mines Safety"* - Authors: Shabina, M. - Year: 2020 - Investigates the use of radio frequency (RF) and wireless sensor networks (WSN) for safety monitoring in mines.

[8] "Wireless Surveillance and Safety System for Mine Workers Based on Zigbee"* - Authors: Ranjith, P., and Prasad, K. Balanaga Guru - Year: 2023 - A Zigbee-based safety system that uses wireless cameras and sensors to monitor hazardous conditions.

[9] "Smart Helmet for Safe and Efficient Mining"* - Authors: Biswas, S., and others - Year: 2023 - A comprehensive study on smart helmets with sensors for gas and temperature detection to improve emergency responses in mines.

[10] "Design of a Smart Helmet for Miners Using Multi-Parameter Monitoring System"* - Authors: Biswas, S., and Roy, S. - Year: 2023 - A design incorporating multiple sensors to monitor environmental conditions and relay real-time data using GSM technology.