

Iot Based Smart Helmet for Miners

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Abstract—Mining is one of the most dangerous jobs in the world. In some countries, miners working underground don't have social or safety protections and are left to manage on their own if they get injured. This can result in people being displaced and losing their livelihoods. Mining has the highest rate of work-related deaths, with common causes including rock falls, fires, explosions, methane poisoning, and electrocution.

To address these dangers, we have developed a smart helmet using NODE MCU technology. This helmet monitors hazardous gases, abnormal temperature conditions, and humidity levels in the air. The improved safety features of our system help protect coal miners by alerting them to hazards. The helmet is equipped with four sensors that monitor temperature, force, gas, and oxygen levels in the mine. These sensors are integrated with a website that continuously monitors the readings and website has filters to check reading in various ranges. If a hazardous situation arises, the helmet activates alarm to warn the miner and outdoor operators. This allows the miner to leave the mine and have a chance to escape from danger.

Index Terms—Smart helmet, Node Mcu, Mine Safety

I. INTRODUCTION

Mining is globally recognized as one of the most perilous occupations, with miners facing a myriad of hazards on a daily basis. Despite advancements in technology and safety protocols, mining remains fraught with dangers such as rock falls, fires, explosions, methane poisoning, and electrocution. The high incidence of work-related fatalities in the mining industry underscores the urgent need for enhanced safety measures. In some regions, particularly in developing countries, miners lack adequate social and safety protections, leaving them vulnerable to injury and displacement without recourse.

To address these critical safety issues, we have developed a state-of-the-art smart helmet utilizing NodeMCU technology. Our smart helmet is designed to enhance the safety of coal miners by providing real-time monitoring of hazardous environmental conditions. The helmet is equipped with an array of sensors that measure temperature, humidity, gas concentrations, and physical impacts. This comprehensive monitoring system aims to alert miners and external operators to potential dangers, thereby reducing the risk of accidents and fatalities. The NodeMCU ESP8266 microcontroller serves as the cornerstone of our smart helmet. This low-cost, efficient Wi-Fi-enabled microcontroller collects data from the various sensors and transmits it to a cloud-based database on Firebase. This setup facilitates real-time data tracking and ensures that both miners and safety operators are continuously informed about the environmental conditions within the mine.

Key components of our smart helmet include the DHT11 temperature sensor, which measures environmental temperature and humidity, and the MQ135 gas sensor, which detects hazardous gases such as carbon dioxide, ammonia, and benzene. These sensors are critical for identifying dangerous atmospheric conditions that could compromise miner safety. Additionally, a force sensor is integrated to detect impacts or falls, providing crucial data to ensure timely emergency responses. A pulse sensor monitors the miner's heart rate, offering real-time insights into their health status and allowing for the detection of fatigue, stress, or other health issues that require immediate attention. The data collected by these sensors is stored in Firebase, a cloud-based platform that enables seamless real-time data storage and retrieval. The integration with our web application allows for continuous monitoring and analysis of sensor

readings, with built-in filters to categorize readings into various safety ranges. In the event of a hazardous situation, the helmet triggers an alarm to alert the miner and external operators, providing the miner

with an opportunity to evacuate the dangerous environment.

Our smart helmet project represents a significant advancement in mine safety technology. By leveraging the capabilities of modern sensors and wireless communication, we aim to provide miners with a reliable tool to navigate the hazardous conditions of their work environment safely. This innovation not only enhances individual miner safety but also contributes to the broader goal of reducing mining-related accidents and fatalities. Keywords: Smart helmet, NodeMCU, Mine safety.

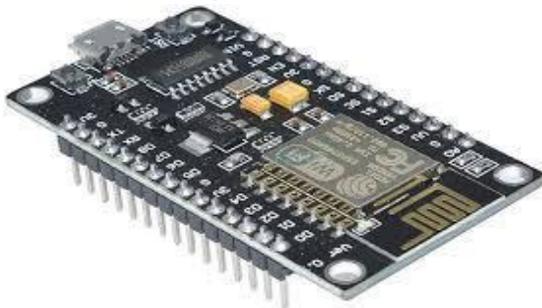
II. METHODOLOGY

A. Design and Implementation of Smart Helmet for Miners

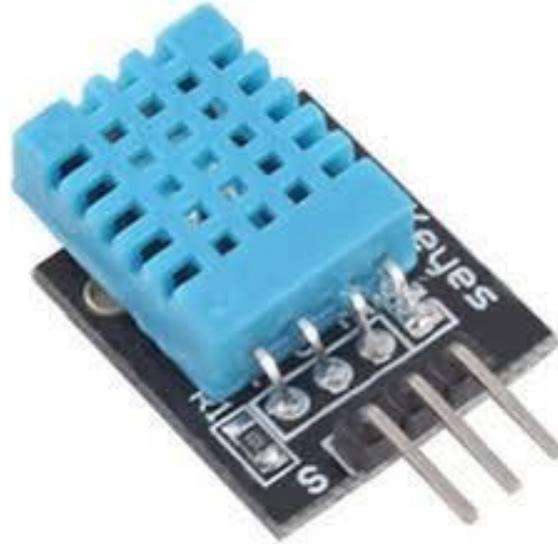
The POC (Proof of Concept) about this project is that we decided to design a smart safety helmet and a complete monitoring system for workers. So first we designed the helmet by mounting all required sensors on it properly. Then we set up every sensor's proper connection with ESP8266 and wrote code for it in Arduino IDE. Further, we created our cloud Database on Firebase where all readings of sensors were stored and fetched. Then Finally we designed our website which was used to monitor all this data

B. Materials and Components:

1. NodeMCU ESP8266: The NodeMCU ESP8266 is a low-cost and efficient Wi-Fi microcontroller, essential for this project as it serves as the main control unit. It collects data from various sensors and transmits it to a cloud database, facilitating real-time monitoring and alerts.



2. DHT11 Temperature Sensor: This sensor measures both temperature and humidity we have used it just for calculating temperature only, crucial for assessing the environmental conditions within the mine. Monitoring temperature helps in detecting potential hazards such as heat stress or dangerous atmospheric conditions.



3. Force Sensor: The force sensor detects pressure or force applied to it. In the context of a miner's helmet, it can help monitor impacts or falls, providing data that can be used to ensure miner safety and prompt emergency responses if necessary.



4. MQ135 Gas Sensor: The MQ135 sensor is used to detect harmful gases such as CO₂, ammonia, benzene, and other toxic fumes. Monitoring air quality is vital for ensuring the miners' safety and

health, alerting them to potentially dangerous atmospheric conditions.

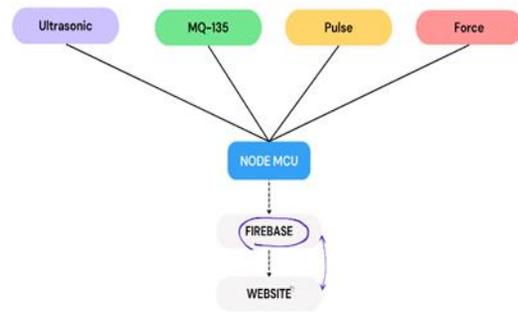
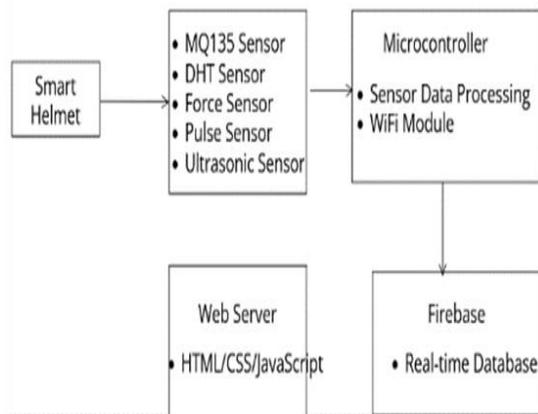


5. Pulse Sensor: This sensor measures the heart rate of the miner, which is critical for monitoring the miner's health status in real time. It helps in detecting signs of fatigue, stress, or other health issues that require immediate attention.

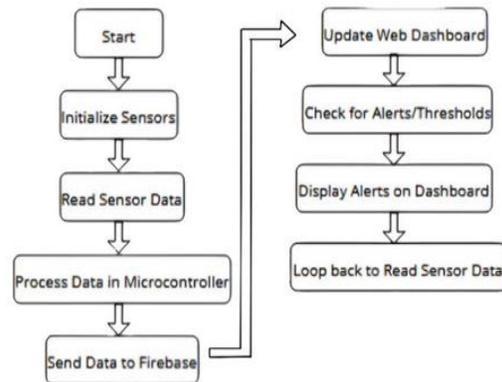


6. Firebase: Firebase is a cloud-based platform that serves as the database for storing sensor data. It enables real-time data storage and retrieval, allowing for seamless integration with web applications to display the data on a website for monitoring and analysis purpose

1. Block Diagram:



2. Flow Chart:



III. RESULT AND DISCUSSION:

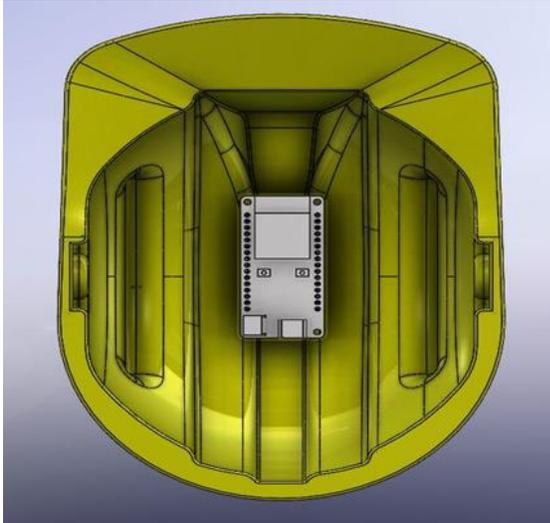
The smart helmet project has demonstrated substantial results in enhancing workplace safety for mine workers. The helmet, equipped with various sensors, effectively monitors environmental conditions and worker health in real-time. Air contamination sensors accurately identified harmful gases, maintaining safety thresholds. Force sensors measured impacts on the helmet, allowing for immediate injury prevention actions. Temperature and humidity sensors ensured safe and comfortable conditions for workers.

Proximity detection sensors effectively alerted workers to nearby obstacles or hazards, preventing accidents and enhancing situational awareness. The pulse rate monitoring system tracked the wearer's health, identifying abnormal readings for timely medical intervention. The real-time database efficiently collected and stored sensor data, facilitating immediate and historical analysis.

Statistical analysis showed a mean pulse rate of 75 bpm and a mean CO2 level of 400 ppm, both within safe limits. Performance metrics indicated high

sensor accuracy, validated against standard instruments, and continuous operation for up to 12 hours on a single charge. The average response time for alerts was less than 1 second, ensuring immediate notification of hazardous conditions.

A. Result & Prototype Pictures:



B. Result Discussion and Future Scope for Improvement:

Future advancements for the smart helmet project include:

Advanced Data Analytics: Integrate AI and machine learning for predictive safety measures based on historical data.

Integration with IoT: Enable remote monitoring and control through IoT networks.

Extended Sensor Capabilities: Add sophisticated sensors for broader environmental parameter detection.

Wearability Enhancements: Improve ergonomics and reduce weight for better user comfort.

Expanded Applications: Customize for other high-risk industries such as construction, firefighting, and chemical plants.

In conclusion, the smart helmet project has shown promising results in improving workplace safety for mine workers. Future developments will focus on enhancing sensor capabilities, ergonomic design, and integrating advanced technologies to broaden its application and effectiveness in various high-risk industries.

IV. ANALYSIS

The smart helmet project indicates significant enhancements in workplace safety through real-time

monitoring systems. The helmet's reliable performance, high accuracy, and positive user acceptance underscore its effectiveness. Immediate alerts for hazardous conditions and real-time health tracking have the potential to prevent accidents and save lives. Consistent data collection and efficient real-time database support comprehensive safety monitoring and historical analysis. Despite these positive outcomes, improvements are needed in sensor calibration and battery life, suggesting areas for future enhancement.

V. CONCLUSION:

In conclusion, our motive for developing a smart helmet for miners has been driven by a deep concern for the well-being of those who work in one of the world's most dangerous professions. Miners face daily threats like rock falls, explosions, fires, methane poisoning, and electrocution. For many miners, especially in regions lacking robust social and safety protections, the risk of injury or even death is a constant companion.

Our smart helmet, utilizing NodeMCU technology, is designed with the miner's safety at heart. By incorporating sensors that continuously monitor temperature, gas levels, and physical impacts, this helmet becomes a vigilant guardian. The NodeMCU ESP8266 microcontroller connects these sensors to a real-time database, ensuring that both miners and their supervisors are always informed about potential dangers. When the helmet detects a hazardous condition, it immediately sounds an alarm, giving miners the precious time, they need to seek safety.

This smart helmet does more than just monitor the environment; it also keeps an eye on the miner's health. The pulse sensor tracks heart rate, alerting to signs of fatigue or stress that could compromise safety, temperature sensor along with the gas sensor helps us get to know how safe the place is. Protecting both from external dangers and internal health issues, aims to provide miners with the security they deserve.

Developing this helmet has been about more than just technology. It's about respecting and valuing the lives of miners. We believe that everyone has the right to work in a safe environment, and our smart

helmet is a step towards making that a reality. By embracing modern technology, we hope to reduce accidents and fatalities, ensuring that miners can return home to their families at the end of the day. Our project is a testament to the power of innovation in making a real difference in people's lives. We are optimistic that this smart helmet will not only save lives but also inspire further advancements in safety for all high-risk professions.

VI. ACKNOWLEDGEMENT

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