International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 02 | Feb - 2025 SJIF Rating: 8.448 ISSN: 2582-3930

IOT Based - Smart Helmet for Air Quality and Hazardous Event Detection for the Mining Industry

C Prema, Assistant Professor,
Department of Electronics and Communication Engineering,
Sri Shakthi Institute of Engineering and Technology, L&T Bypass, Coimbatore, premacece@siet.ac.in

Paveen Karthik S, Raja Pandi R, Rajnitheesh A P, Yokesh S M

Department of Electronics and Communication Engineering,

Sri Shakthi Institute of Engineering and Technology, L&T Bypass, Coimbatore

Abstract - *The security of the underground mines must be increase because disasters in underground mines are very serious issues now days. The difficulties faced by miners working underground are gas explosion, temperature, etc. If any disaster occurs in mine and if miner gets injured, all the blame directly goes on supervisor. So there must be communication between miners, supervisor and control station. Therefore the purpose of the proposed system is to modify an existing mining safety. 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 on the internet by using IoT so the control station get to know about the environmental conditions in which miner working and if any abnormal condition occur they are able to provide the rescue as early as possible. The system also includes the LCD and buzzer to let co-workers know if any unwanted event occurs with miner. The proposed system uses different sensors like Gas Sensor, dht11 Sensor, accelerometer, vibration and IR Sensor. Here the IR sensor is used as helmet removing sensor. And also in this system we use machine learning to analysis the employee health, Heart Disease is one among the major diseases affecting the individual around the world. There are several risk factors which leads to heart disease. The combination of logistic regression analysis and neural network provides a novel approach in predicting the heart disease. Initially logistic regression is applied to select the major risk factors for predicting the disease. It produces the significant risk factors that are useful in predicting the heart disease based on statistical p-value. The risk factors which are not having the significant impact are identified and removed. The resultant significant factors are provided as input to the neural network.*

Keywords*: *Underground Mines, Mining Safety, IoT (Internet of Things), Helmet Safety, Gas Explosion, Environmental Monitoring, Real-time Monitoring, Communication System, Machine Learning, Logistic Regression, Neural Network, Heart Disease Prediction, Risk Factor Analysis, Gas Sensor, DHT11 Sensor, Accelerometer, Vibration Sensor, IR Sensor, Helmet Removal Detection, Rescue Operation, Control Station, Buzzer Alert, LCD Display, Safety Equipment.

1. INTRODUCTION

Underground mining is one of the most hazardous occupations, exposing miners to significant risks such as gas explosions, extreme heat, and limited oxygen levels. Ensuring their safety is a top priority, as even a minor lapse can result in catastrophic consequences. The smart helmet is designed as an advanced safety solution to address these challenges. Equipped with IoT-enabled sensors, it continuously monitors environmental conditions, including gas levels, temperature, vibrations, and motion. Real-time data is wirelessly transmitted to the control station, ensuring immediate awareness of the conditions in which miners are operating. Alerts are generated through an LCD display and buzzer to notify nearby workers of potential hazards, such as the presence of toxic gases or the removal of a helmet. This system ensures that any abnormal situation is quickly identified, enabling swift action to mitigate risks and improve rescue operations if needed.

In addition to ensuring environmental safety, the smart helmet incorporates a robust health monitoring system to address the well-being of miners. Leveraging the power of machine learning, it uses a combination of logistic regression and neural networks to predict the risk of heart disease—a prevalent concern among workers exposed to high-stress environments. Key health factors are analyzed to identify significant risks, enabling early detection and intervention. Logistic regression initially filters critical health indicators, while neural networks refine predictions for greater accuracy. By integrating advanced technology for both environmental safety and health monitoring, the smart helmet represents a comprehensive solution to safeguard miners and enhance their quality of life while working in underground conditions.

1.1. Objectives

The system is a robust safety solution designed to enhance the well-being of miners in hazardous underground environments. By continuously monitoring environmental conditions like gas levels, temperature, humidity, and vibrations, it ensures real-time detection of potential hazards. IoT-enabled sensors transmit critical data to the control station, enabling constant situational awareness. In emergencies such as toxic gas leaks or temperature fluctuations, the system provides immediate alerts through alarms, buzzers, and LCD displays, ensuring timely action.

This proactive approach minimizes risks, enables swift rescue responses, and prevents severe incidents, protecting lives and improving safety. By fostering a secure work environment and boosting miner confidence, the system reduces accident rates and sets a new standard for safety in mining operations.

1.2. Internet Of Things (IOT)

The Internet of Things (IoT) is a revolutionary technology that connects physical devices, sensors, and systems to the internet, enabling seamless data collection, sharing, and action. It enhances efficiency by automating routine tasks and minimizing human errors, such as using smart thermostats to optimize energy usage. IoT provides real-time monitoring, allowing quicker decision-making, like detecting equipment issues before failure. It improves resource management, optimizing water, energy, and material usage through precise tracking and control. By offering personalized experiences, IoT devices like voice assistants enhance user convenience and satisfaction. Applicable across industries like healthcare, agriculture, and logistics, IoT creates scalable and versatile solutions. It drives cost savings through predictive maintenance and operational efficiency while

fostering innovation for new products and services. IoT also promotes sustainability by reducing waste and enabling smart city technologies. Ultimately, IoT is transforming industries, improving lives, and unlocking vast potential for a more connected future. The Internet of Things (IoT) is a revolutionary technology that connects physical devices, sensors, and systems to the internet, enabling seamless data collection, sharing, and action. It enhances efficiency by automating routine tasks and minimizing human errors, such as using smart thermostats to optimize energy usage. IoT provides real-time monitoring, allowing quicker decision-making, like detecting equipment issues before failure. It improves resource management, optimizing water, energy, and material usage through precise tracking and control.

1.3. SMART HELMET?

The smart helmet is an advanced safety device designed for miners, equipped with integrated networking capabilities and various sensors to enhance safety and health monitoring. Key features of the smart helmet include:

1. **Environmental Monitoring**: The helmet is fitted with sensors to continuously monitor conditions such as gas levels, temperature, and humidity. This data is transmitted wirelessly to a central control station via the Internet of Things (IoT).
2. **Real-Time Updates**: It provides real-time updates about the miner's surroundings, allowing the control station to quickly assess any hazardous conditions and respond promptly to emergencies.
3. **Alerts and Notifications**: The helmet includes an LCD display and a buzzer to notify co-workers of any unwanted events or emergencies, such as helmet removal or dangerous environmental changes.
4. **Health Monitoring**: The smart helmet utilizes machine learning to analyze the health of miners, particularly focusing on heart disease risk factors. It processes data to predict potential health issues, enabling proactive health management.
5. **Safety Enhancements**: By integrating these technologies, the smart helmet aims to improve overall safety for miners, ensuring better communication and quicker response times in emergencies, ultimately fostering a safer working environment underground.

2. BLOCK DIAGRAM

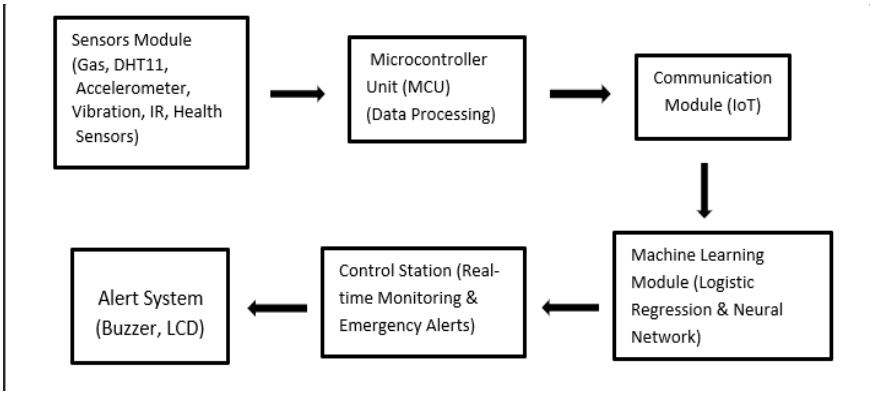

FIG 1: BLOCK DIAGRAM OF THE PROPOSED SYSTE

2.1. BLOCK DIAGRAM

Data detection from sensors involves capturing, processing, and interpreting signals from the environment to derive meaningful information. Sensors interact with physical phenomena such as temperature, light, or motion and convert them into measurable signals, often electrical. These raw signals undergo conditioning processes like amplification, filtering, and analog-to-digital conversion to make them suitable for analysis. The conditioned data is then processed, calibrated, and interpreted, enabling insights or triggering specific actions, such as displaying readings or activating alarms. Advanced systems may combine data from multiple sensors to improve accuracy and adapt to changing conditions. Sensors are essential in applications ranging from environmental monitoring and healthcare to automotive systems and smart devices. Key considerations for effective sensor use include accuracy, sensitivity, range, response time, and robustness.

3. WORKING

The working of a smart helmet integrates sensor-based data detection, IoT data storage, and visualization to enhance safety and functionality. Sensors embedded in the helmet, such as accelerometers, gyroscopes, temperature, and gas sensors, capture environmental and motion data. These sensors convert physical phenomena like movement or harmful gas levels into measurable electrical signals. The raw signals are processed and transmitted to IoT platforms like ThingSpeak via protocols such as HTTP or MQTT.

The platform stores the data in organized channels with fields for specific parameters like impact force or air quality. Real-time visualization tools on the platform display data through charts or dashboards, enabling users to monitor helmet status and environmental conditions. Integration with APIs allows remote access and automation, triggering alerts like alarms or notifications for hazardous situations. This system ensures safety by analyzing trends, sending alerts during accidents, and enhancing decision-making in industrial, construction, or biking applications.

4. RESULT AND DISCUSSION

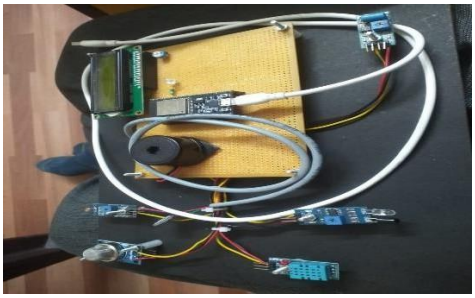

Figure 1. HARDWARE

Figure 2. HARDWARE

5. OUTPUT

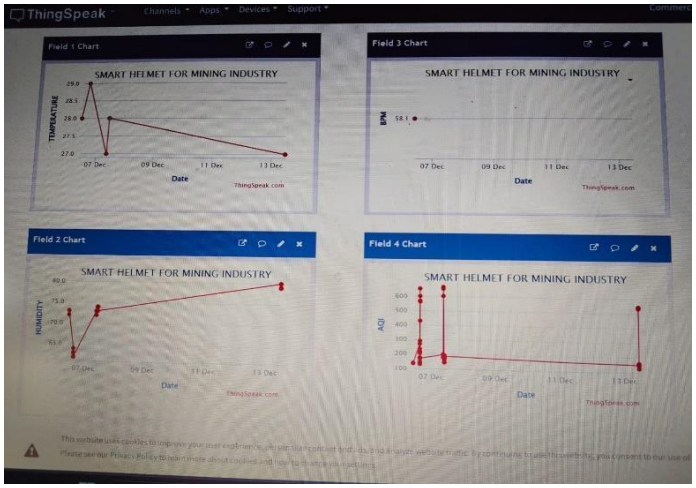

Figure 3. SOFTWARE OUTPUT

Designed to efficiently process and analyze IoT data, the software output includes real-time sensor readings such as temperature, humidity, or motion levels, presented through visualizations like charts, graphs, dashboards, and heatmaps for trend analysis and spatial insights. It generates alerts or notifications for critical thresholds, ensuring timely responses to hazardous conditions. The system also supports data export in formats like CSV for offline analysis and provides API responses in Graph for seamless integration with other applications. Additionally, automation outputs, such as triggering devices or notifications, enhance functionality for efficient monitoring and decision-making.

ACKNOWLEDGEMENT

The authors thank the Management and Principal of Sri Shakthi Institute of Engineering and Technology, Coimbatore for providing excellent computing facilities and encouragement.

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