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IMPLEMENTATION OF MINE SAFETY MONITORING SYSTEM USING IOT

[1]Mohammed Sameer Uddin, [2]Muzammil Ahmed, [3]Ismail Shareef, [4]M. A. Majed

[1]BE, Dept. of ECE Deccan College of Engineering and Technology, Hyderabad, Telangana, India, muzammilahmed8637@gmail.com
[2]BE, Dept. of ECE Deccan College of Engineering and Technology, Hyderabad, Telangana, India, sameeruddin4261@gmail.com
[3]BE, Dept. of ECE Deccan College of Engineering and Technology, Hyderabad, Telangana, India, 160320735059@gmail.com
[4](A.P), Dept. of ECE Deccan College of Engineering and Technology, Hyderabad, Telangana, India ,majed@deccancollege.ac.in

ABSTRACT:

Coal is an important energy source and an important resource for many companies. The dangerous and potentially toxic nature of the work must also be taken into account. High temperatures, humidity and emissions of hazardous gases are just some of the challenges coal miners face every day. This creates a risky work environment that puts employees at risk of serious injury or death. In this paper, an IoT-based dynamic sensor information control system (IoT-DSICS) was implemented to combat warm humidity, precipitation and unhealthy carbon emissions of the coal mine. This article uses sensor networks and control systems used in many areas of the Industrial Internet of Things (IOT0). The current information management safety audit was assessed as the national coal mining production remains high and serious accidents are successful. The IoT Wi-Fi microcontroller system monitors and operates the prototypes, activating fans at the Pittsburgh Investigation of Mine and triggering a surface alarm ensuring the low cost of developing alternative coal sources. The results of this feasibility study of the existing communication and tracking infrastructure will be used to investigate the potential of IoT in underground coal mines.

Keywords: Real-time Monitoring, Gas Detection ,Wireless Communication. IoT-DSICS.

Introduction:

The term “mine safety” describes the various procedures, policies and tools used to protect miners from risks to their health, safety and well-being associated with mining activities. In order to detect potential threats early, environmental factors such as temperature, humidity and gas levels are constantly monitored. To avoid accidents, preventive measures such as frequent equipment maintenance, use of protective equipment and strict safety procedures are taken. Additionally, emergency plans that include first aid protocols, evacuation routes and rescue techniques to deal with incidents immediately are part of mine safety. To ensure miners are familiar with safety procedures, emergency protocols and proper use of equipment, education and training are critical parts of mine safety. Compliance with regulatory guidelines from government and industry authorities guarantees the implementation of effective security protocols. Mine safety prioritizes these tactics to reduce hazards, protect the health and welfare of miners, and maintain the safe and effective operation of mining operations.

Methodology:

The methodology for implementing a coal mine safety monitoring system using IoT involves several key steps. First, a thorough safety needs assessment is carried out to identify specific risks such as gas leaks and high temperatures. Based on this assessment, system specifications are defined, including the types of sensors required and the communication protocols to be used. The design phase includes planning the sensor network to ensure comprehensive coverage of critical areas and developing a robust wireless communication infrastructure to maintain reliable data transmission in the demanding underground environment. IoT-enabled sensors will then be installed throughout the mine to continuously monitor environmental conditions. These sensors are integrated into a data acquisition system that collects real-time data and transmits it wirelessly to a central monitoring station. The collected data is then analyzed using cloud computing and big data analytics to provide real-time alerts and predictive maintenance insights to ensure the safety and efficiency of mining operations.

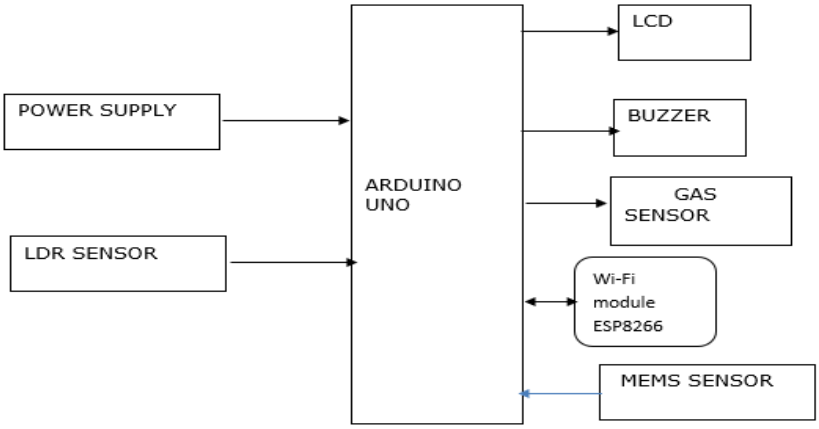

Fig 1 Block Diagram

An IoT coal mine security monitoring based system consists of various interconnected components that work seamlessly together to ensure ongoing security. The system uses sensors to detect hazardous gases, temperature, humidity and pressure changes, as well as proximity sensors to track miners and equipment. These sensors are connected to sensor nodes via microcontrollers that pre-process the data and use wireless communication protocols such as Zigbee or Lo Ra to transmit the data to gateway devices. The gateways aggregate the data and send it to cloud servers over cellular or Wi-Fi connections. In the cloud, data is analyzed in real time using advanced analytics to generate alerts and insights, ensuring proactive safety management and operational efficiency in the mining environment.

A wireless coal mine security monitoring system works by deploying a network of sensors throughout the mining environment. These sensors continuously measure critical parameters such as gas concentrations (methane, carbon monoxide), temperature, humidity and air pressure. Each sensor is connected to a sensor node equipped with a microcontroller for pre-processing the data. These nodes are usually battery-powered and designed to function reliably even in harsh underground conditions. The sensor nodes use wireless communication protocols such as Zigbee, LoRa or Wi-Fi to transmit the collected data. These protocols are chosen for their low power consumption and ability to maintain stable connections in complex underground structures.

The sensor nodes form a mesh network, allowing data to travel between nodes until it reaches a central gateway. This network configuration ensures robust communication even if some nodes fail or obstacles block the direct path.

At the gateway, data from multiple sensor nodes is aggregated and sent to cloud servers via cellular networks, WiFi or Ethernet. In the cloud, data processing and analysis are performed in real time using advanced analytics and machine learning algorithms. This processed data generates alerts and insights that are then communicated to mine operators and security personnel via dashboards, mobile apps or alert systems, enabling timely responses to potential threats and improving overall mine safety

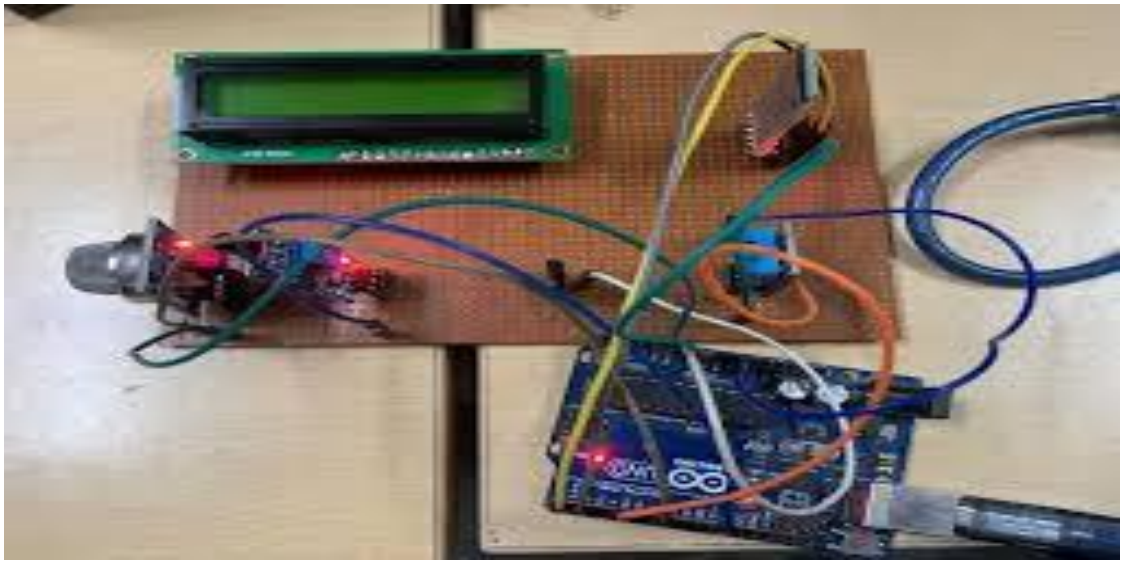

Fig 2. CIRCUIT DIAGRAM

OBJECTIVES:

1. *Enhance Worker Safety*
2. *Real-Time Data Analysis and Response*
3. *Improve Operational Efficiency*

RESULTS

The implementation of the coal mine safety monitoring system using IoT resulted in significantly enhanced safety and operational efficiency. Continuous real-time monitoring allowed for the early detection of hazardous conditions, leading to a dramatic reduction in accidents and incidents. The real-time data analysis and alerts enabled quicker responses to potential dangers, ensuring immediate corrective actions. Additionally, predictive maintenance and automated reporting streamlined operations, minimized equipment downtime, and optimized resource allocation, contributing to a safer and more efficient mining environment.

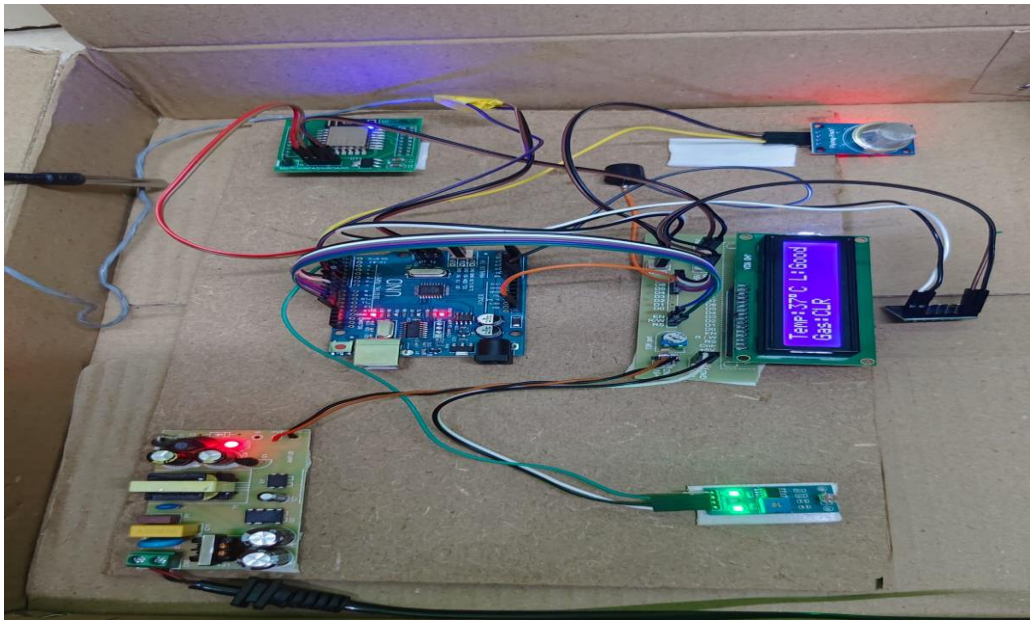

Fig 3 OUTPUT OF THE PROJECT

Moreover, the integration of advanced analytics and machine learning into the system provided deeper insights into environmental patterns and equipment performance. This not only helped in predicting potential hazards before they became critical but also facilitated long-term planning and safety strategy improvements. The use of wireless communication and cloud computing ensured that data was reliably transmitted and accessible from remote locations, allowing for centralized monitoring and control. Overall, the system fostered a culture of proactive safety management and continuous improvement, leading to sustained safety enhancements and operational benefits in the mining industry.

Conclusion

With the installation of a real-time observation device, a clearer and additional objective is given for assessing mine point perspective, which leads to greater accuracy. In this case, this technique will display the parameters on the monitoring screen. Everybody who is currently working in the mine, as well as any worker, will profit from this proposal., who will be able to use it to avoid losing their lives in a work-related accident. When sensing element values have crossed the alarm threshold, the alarm goes off.

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