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IOT BASED COAL MINE SAFETY MONITORING AND ALERTING SYSTEM

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ABSTRACT

Coal mines are very important and generate money for good economic growth for any country. There is lot of manual work in coal mines in daily operations. Lot of accidents happens in coal mines in various ways. Mainly in underground excavation lot of CO gases generate and cause health hazardous. Sometimes high temperature causes heavy fires.

This project includes WIFI (Esp8266/IOT module) which is connected to Arduino through UART interface. Temperature Sensor and CO (Mq2) sensors are connected to NodeMCU through Analog and Digital IO pins. Buzzer connected to digital IO pin.

Temperature sensor reads Coal mine temperature. Heavy heat causes fires. Mq2 (CO) sensor reads CO emission in Coal mines. These sensors data will be displayed on LCD continuously. In abnormal condition gives buzzer sound to alert coal mine workers. WIFI sends sensor data to server continuously. User can see data in IOT server from anywhere. Before entering into coal mines workers has to observe observe data in IOT server and then leave.

INTRODUCTION

Coal mining is an inherently hazardous occupation, with miners facing numerous risks, including explosions, gas leaks, roof collapses, and flooding. Ensuring the safety and well-being of miners is paramount, and technological advancements have played a crucial role in mitigating these risks. Traditional safety measures, while important, often lack real-time monitoring and rapid response capabilities. The Internet of Things (IoT) presents a transformative opportunity to enhance coal mine safety through continuous monitoring, predictive analytics, and timely alerts.

This project focuses on developing an IoT-based coal mine safety monitoring and alerting system. The system aims to leverage a network of interconnected sensors to collect real-time data on critical environmental parameters such as methane levels, carbon monoxide concentration, temperature, humidity, and ventilation. This data is then transmitted wirelessly to a central monitoring station where it is analyzed to identify potential hazards and trigger alerts. The system also incorporates location tracking of miners using wearable devices, enabling efficient personnel management and rapid response in emergency situations. By providing real-time insights into mine conditions and miner locations, the proposed system aims to significantly improve safety, reduce the risk of accidents, and enhance emergency response effectiveness. This research explores the design, implementation, and

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evaluation of such a system, focusing on its effectiveness in addressing the specific safety challenges of coal mining environments.

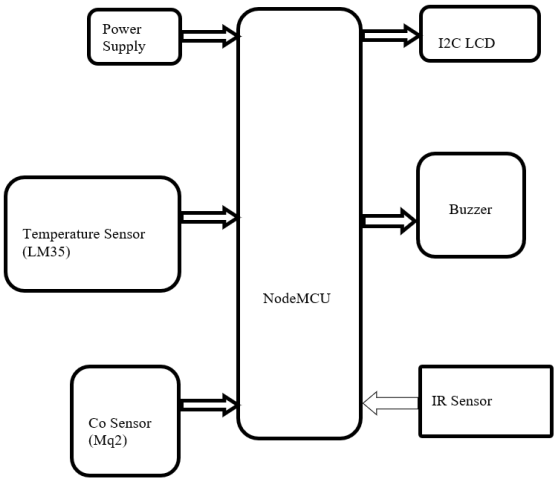

Figure.1 Block Diagram

LITERATURE SURVEY

Coal mining is one of the most hazardous industries, posing risks due to toxic gases, high temperatures, poor ventilation, and structural instability. Traditional safety monitoring systems rely on manual inspections and wired sensor networks, which are often inefficient, slow, and prone to human error. With advancements in Internet of Things (IoT) technology, real-time monitoring, automated alerting, and remote supervision have become possible, significantly improving mine worker safety and operational efficiency. Researchers have proposed IoT-based coal mine safety systems that integrate wireless sensor networks (WSNs), cloud computing, and real-time data transmission to detect and mitigate hazards effectively.

Several studies have explored sensor-based mine monitoring using gas sensors (MQ-135, MQ-7), temperature sensors (DHT11), humidity sensors, and accelerometers to measure environmental conditions and structural stability. IoT platforms like Blynk, ThingSpeak, and Firebase are commonly used to transmit and analyze sensor data in real time. GSM/GPRS modules and Wi-Fi-enabled microcontrollers (ESP8266, NodeMCU, or Arduino) enable remote alerts, allowing authorities to take immediate action in case of emergencies. RFID-based personnel tracking is also integrated into some systems to locate miners during critical situations. While IoT-based solutions enhance safety, efficiency, and real-time monitoring, challenges such as network latency, power consumption, and sensor reliability in harsh mining conditions remain key research areas for future advancements.

PROPOSED SYSTEM

The proposed IoT-based coal mine safety monitoring system follows a multi-layered architecture to ensure continuous environmental monitoring, real-time data processing, and immediate hazard alerts. This system

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integrates smart sensors, edge computing, cloud processing, and automated alerts to enhance miner safety and optimize emergency response. The system comprises four key layers:

The Sensing Layer consists of gas sensors (methane, CO, CO_2), temperature and humidity sensors, motion sensors, vibration sensors, and RFID/wearable tags. These sensors continuously monitor the underground environment, detecting hazardous gas levels, structural instability, temperature fluctuations, and personnel movement. Wearable RFID tags enable real-time location tracking of miners, ensuring quick identification in case of emergencies. Edge devices placed strategically in the mine collect and preprocess sensor data to reduce latency and network congestion.

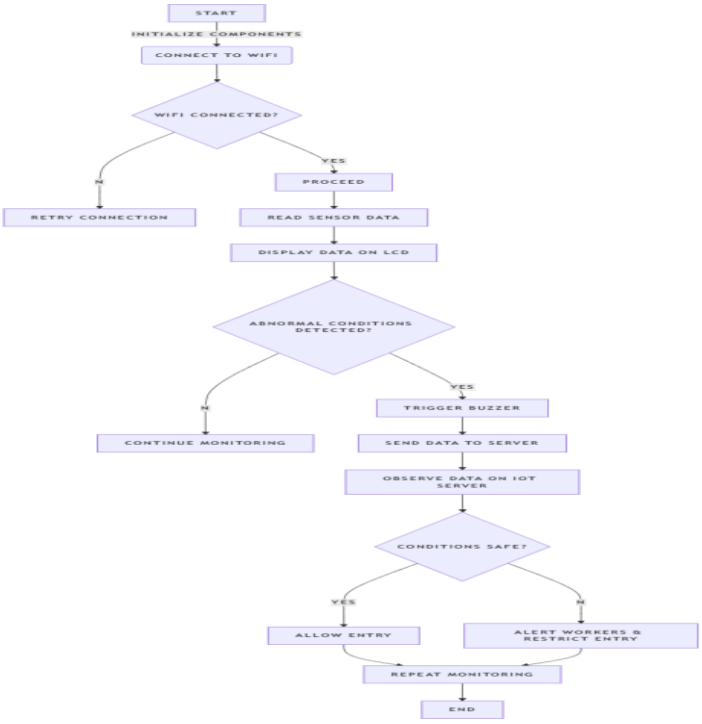

Figure.2 Flow Chart

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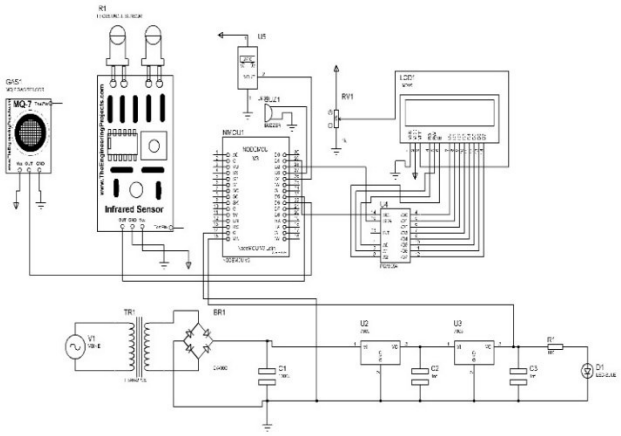

Figure.3 Schematic Diagram

RESULTS

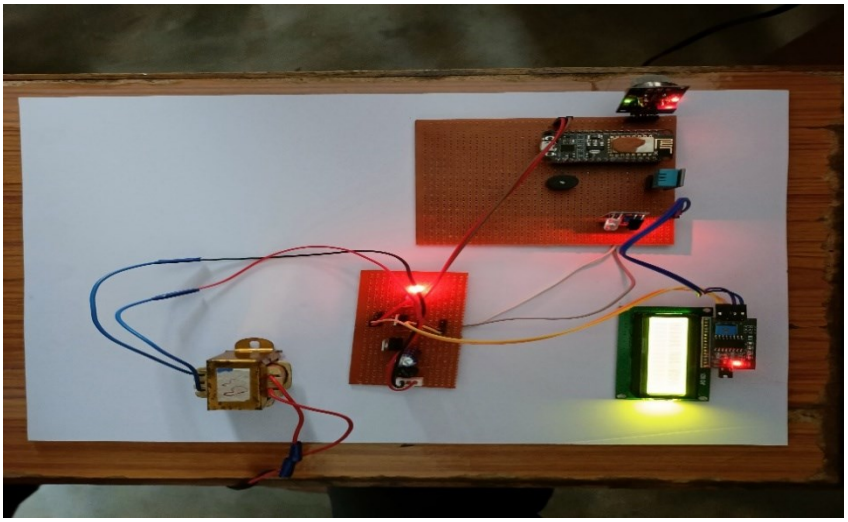

Figure.4 Working Kit

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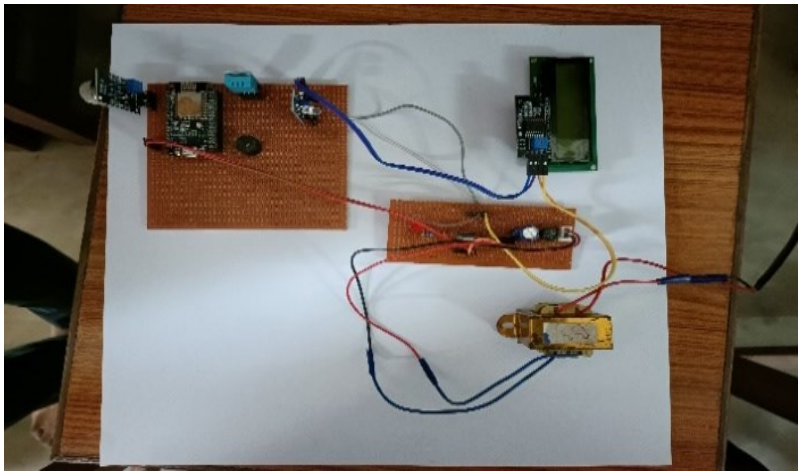

Figure.5 Hardware Circuit

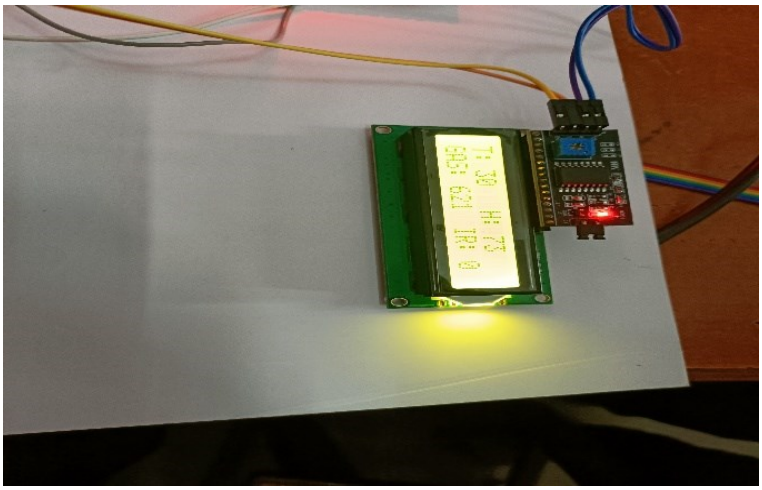

Figure.6 Sensors data Displaying on LCD

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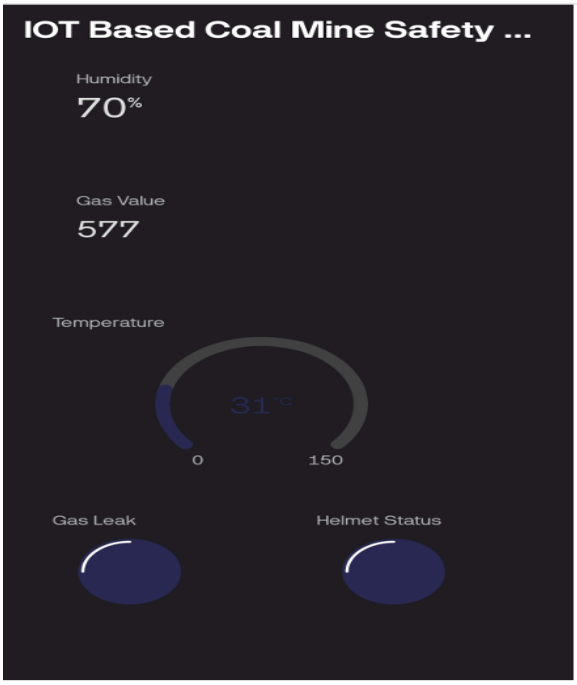

Figure.7 Updating Sensor data On Blynk

ADVANTAGES

- **Real-Time Monitoring:** Continuously tracks environmental conditions and miner safety, reducing the risk of accidents.
- **Automated Hazard Detection:** Instantly detects toxic gas leaks, temperature rise, structural instability, and miner location, improving response time.
- **Immediate Alerts & Response:** Sends alerts to miners, control rooms, and emergency teams via SMS, mobile apps, and dashboards.
- **Worker Safety Enhancement:** Wearable RFID tags and motion sensors help track miners, ensuring quick rescue in emergencies.
- **Remote Monitoring & Control:** Authorities can monitor mine conditions remotely via IoT dashboards and cloud platforms.

APPLICATIONS

- **Underground Mining Safety:** Ensures the safety of workers by monitoring toxic gases, structural stability, and environmental conditions.
- **Disaster Management:** Provides real-time alerts and automated safety actions during gas leaks, cave-ins, or explosions.
- **Personnel Tracking:** Uses RFID and motion sensors to monitor miner movements and enhance worker safety.

- **Remote Mine Monitoring:** Allows mining authorities to oversee operations remotely using IoT dashboards and cloud connectivity.
- **Equipment Health Monitoring:** Predicts equipment failures and overheating using vibration and temperature sensors.
- **Ventilation Control:** Optimizes air circulation by automating ventilation fans based on gas concentration levels.

CONCLUSION

The proposed IoT-based coal mine safety monitoring and alerting system offers a significant advancement over traditional safety practices. By leveraging the power of interconnected sensors, wireless communication, and data analytics, the system provides real-time insights into mine conditions, enables proactive hazard detection, and facilitates rapid emergency response. This technology has the potential to transform coal mine safety, minimizing risks, improving operational efficiency, and ultimately saving lives. The system addresses the critical need for continuous monitoring, proactive intervention, and efficient communication in the challenging environment of a coal mine. The data-driven approach allows for continuous improvement of safety protocols and a more comprehensive understanding of potential hazards.

FUTURE SCOPE

- **Integration of AI and Machine Learning:** Implementing AI and machine learning algorithms can enhance predictive capabilities, enabling more accurate hazard prediction and proactive intervention.
- **Development of More Robust and Reliable Sensors:** Research into more robust and reliable sensors that can withstand the harsh conditions of underground mines is crucial for ensuring system longevity and accuracy.
- **Improved Wireless Communication Technologies:** Exploring and implementing more reliable wireless communication technologies, such as 5G and mesh networks, can improve data transmission and system responsiveness.

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