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MQTT BASED COAL MINE MONITORING SYSTEM USING - IOT

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Abstract: The coal mining industry faces numerous safety and operational challenges, including hazardous environmental conditions, equipment failures, and worker safety. To address these issues, a monitoring system based on the Internet of Things (IoT) and MQTT (Message Queuing Telemetry Transport) is proposed for real-time data collection and analysis in coal mines. The system integrates various sensors for monitoring environmental parameters such as gas levels (e.g., methane), temperature, humidity, dust, and equipment performance. The IoT network collects sensor data and transmits it via MQTT, a lightweight and efficient messaging protocol, to a centralized cloud-based system for real-time analysis. The use of MQTT ensures reliable communication in low-bandwidth environments typical of coal mines. Alerts and notifications are generated if critical thresholds are exceeded, enabling proactive safety measures and equipment maintenance. This system aims to improve the safety of miners, reduce operational downtime, and optimize resource management in coal mining operations. Additionally, the proposed solution facilitates data-driven decision- making by providing mine operators with real-time insights and predictive analytics.

1. INTRODUCTION

Coal mining is a critical industry that plays a significant role in global energy production. However, it also poses substantial risks to workers and the environment due to unpredictable factors like gas leaks, equipment malfunctions, and hazardous working conditions. To mitigate these risks and improve operational efficiency, the integration of advanced technologies such as the Internet of Things (IoT) has emerged as a promising solution. One of the most effective ways to enable real-time monitoring and management of coal mines is through the deployment of IoT-based systems.

In such systems, sensors are deployed throughout the mining environment to continuously collect data on critical parameters like gas concentrations (e.g., methane), air quality, temperature, humidity, and equipment status. The data gathered is transmitted using the MQTT (Message Queuing Telemetry Transport) protocol, which is a lightweight and efficient messaging protocol specifically designed for low-bandwidth, high-latency networks like those found in remote and underground mining environments.MQTT, due to its lightweight nature, ensures that data transmission is both efficient and reliable, even in challenging environments. The collected data is sent to a central server or cloud platform where it is processed and analyzed in real-time. This enables mine operators to monitor the working conditions continuously, detect early signs of potential hazards, and take immediate actions to prevent accidents or equipment failures.

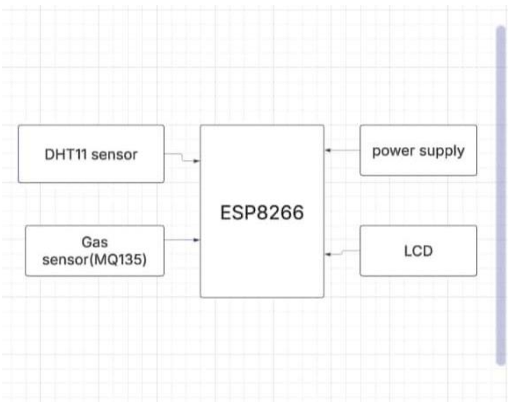

Figure 1: Block Diagram

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2.IOT TECHNOLOGY

The Internet of Things (IoT) is a network of interconnected physical devices that communicate with each other and the cloud via the internet, enabling them to collect exchange, and act upon data without human intervention. These devices are embedded with sensors, software, and other technologies that allow them to gather real-time data from their environment.
At its core, IoT enables seamless communication between devices, allowing them to make decisions based on the data they collect. For example, a **smart home** system can automatically adjust the temperature, lighting, or security settings based on user preferences or environmental conditions. In industries, IoT is used for predictive maintenance, where machines can signal when they need servicing before they break down, minimizing downtime and improving efficiency. The ability to monitor, analyze, and control devices remotely via smartphones or computers enhances convenience, productivity, and safety.
However, the proliferation of connected devices also brings challenges, especially in areas like **data security** and **privacy**. Since IoT devices collect vast amounts of personal and sensitive data, ensuring that this information is protected from unauthorized access is critical. Additionally, interoperability between different IoT devices and platforms is a concern, as the lack of standardized protocols can hinder seamless integration. Despite these challenges, the continued evolution of IoT holds the promise of creating more intelligent and efficient systems across homes, industries, healthcare, cities, and beyond.

3.EXISTING SYSTEM

Traditional coal mine monitoring systems have evolved over time but still face several limitations in terms of real-time data collection, efficiency, and safety. Below is an overview of existing systems in coal mine monitoring along with their limitations

Wired Monitoring Systems:
Existing System: Wired monitoring systems have been commonly used in coal mines to monitor parameters like gas levels, temperature, humidity, and equipment health. These systems use a network of sensors connected to a central control room through wired connections. The data is transmitted in real-time to the central system where it is analyzed for potential hazards or maintenance needs.

Wireless Sensor Networks (WSNs) without MQTT:
Existing System: Some modern coal mines employ wireless sensor networks (WSNs) that use various wireless communication protocols (e.g., ZigBee, LoRa, Wi-Fi) to transmit sensor data. These systems offer more flexibility than wired systems by eliminating the need for cables and wires, and the sensors can be placed at various locations in the mine to collect data on gases, temperature, humidity, and machinery health.

4.PROPOSED METHOD

The proposed system utilizes MQTT-based IoT technology to enhance safety and efficiency in coal mining operations. The system will enable real-time monitoring of environmental conditions, such as temperature, humidity, and gas levels. This will allow for prompt response to emergencies and minimize the risk of accidents. The system will consist of a network of sensors deployed throughout the coal mine. These sensors will collect and transmit data to IoT devices. The IoT devices will utilize the MQTT protocol to communicate with the cloud or other networks. The system will also employ data analytics and machine learning algorithms. This will improve the accuracy and reliability of the system. The system will provide early warnings for potential dangers. This will enable prompt response and minimize the risk of accidents.
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5.RESULT & DISCUSSION

The MQTT-based coal mine monitoring system successfully measured temperature, humidity, and gas levels using DHT11 and MQ135 sensors. The ESP8266 transmitted all readings to the Blynk cloud through MQTT, enabling real-time monitoring from a mobile application. The LCD displayed live values, and alert notifications were automatically

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generated whenever gas leakage, high temperature, or abnormal humidity levels were detected.
The results show that MQTT communication is fast, reliable, and suitable for low-bandwidth environments like coal mines. The system provided early hazard detection and operated consistently throughout testing. Overall, the system proved effective, stable, and useful for improving miner safety, although real mines may require more accurate sensors, stronger communication networks, and power-backup support.

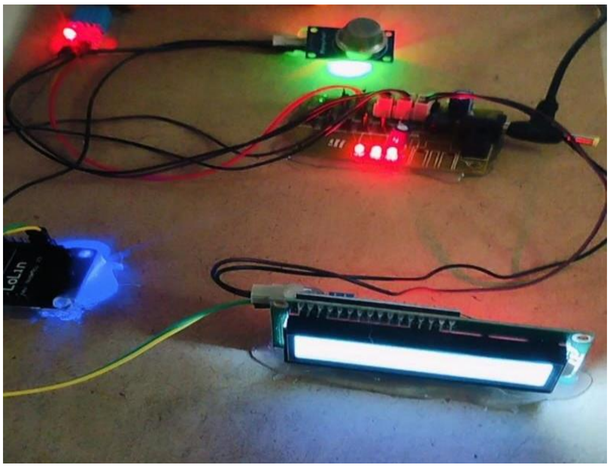

Figure 2: Experimental Setup

6.CONCLUSION

The MQTT-based coal mine monitoring system successfully measured temperature, humidity, and gas levels using DHT11 and MQ135 sensors. The ESP8266 transmitted all readings to the Blynk cloud through MQTT, enabling real-time monitoring from a mobile application. The LCD displayed live values, and alert notifications were automatically generated whenever gas leakage, high temperature, or abnormal humidity levels were detected.The results show that MQTT communication is fast, reliable, and suitable for low-bandwidth environments like coal mines. The system provided early hazard detection and operated consistently throughout testing. Overall, the system proved effective, stable, and useful for improving miner safety, although real mines may require more accurate sensors, stronger communication networks, and power-backup support.

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