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# IOT BASED COAL MINE SAFETY MONITORING AND CONTROL AUTOMATION USING IOT

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## ABSTRACT
Miners' safety is a pressing concern due to various hazards in the mining environment that endanger both health and lives. Harmful and toxic gases released during mining operations pose significant risks, as they often go undetected by human senses. This study explores the presence of these dangerous gases in critical areas and their effects on miners. We propose a real-time monitoring system utilizing a wireless sensor network equipped with multiple sensors to track temperature, humidity, and hazardous substances. This system provides early warnings to help protect miners from potential dangers before serious incidents occur. It employs ThingSpeak technology to establish an effective wireless sensor network.
Keywords: ThingSpeak, LDR, MQ series.

## I. INTRODUCTION
The safety of coal mining operations has raised significant concerns and resulted in substantial economic losses. Therefore, it is crucial for the global mining industry to improve operational efficiency while enhancing safety measures. This project presents a concept for remote monitoring and automation of physical sensor devices used in mining operations. An Open Service Gateway Initiative (OSGi)-compliant uniform device will be employed in the wireless sensor network (WSN). A prototype has been developed to analyze system efficiency. Underground coal mining presents greater risks compared to surface mining due to ventilation challenges and potential failures. Modern mines implement various safety measures, training programs, and health initiatives, leading to notable improvements in safety standards for both underground and surface mining. In India, coal remains a vital energy resource, significantly contributing to the nation's industrial growth, with about 75% of power generation reliant on it. However, large-scale production generates by-products that can pose environmental hazards to workers. This work aims to assess the severity of these hazards and develop a real-time monitoring system using IoT-based automation.

## II. LITERATURE SURVEY
Boddapati Venkata Sai Phani Gopal discusses the development of an IoT-based coal mine safety system utilizing the Thinger Io platform for data transmission. D. Prabhu et al. proposed a coal mining safety system integrating gas sensor modules, fire sensors, and temperature/humidity sensors with Arduino. Shauohang Yu and Xiang

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Rong examined faults in coal mine ventilators, analyzing causes and summarizing common failure outcomes. P. Koteshwara Rao and colleagues designed a wireless sensor network using Raspberry Pi to control ventilation based on atmospheric conditions. Keerthana E et al. introduced a smart security system for worker safety in mines. Bonala Ashwini et al. suggested an IoT security framework to replace existing underground mining systems. Joshi Gunjan Shailesh focused on a monitoring system for toxic gases and ventilation needs. Borhade Ganesh Lahanu et al. conducted design work for a mine safety system using a wireless sensor network. S. R. Deokar presented a real-time monitoring system for underground mines. N. Balaji et al. developed smart helmets capable of detecting hazardous conditions. Dr. Nagaraj Bhat explored the integration of IoT and AI to optimize human tasks.

## III. SYSTEM REQUIREMENT SPECIFICATION

A. Raspberry Pi: The Raspberry Pi 3 Model B+ is a compact, powerful single-board computer that outperforms earlier models. It offers enhanced processing capabilities and integrated wireless Bluetooth and LAN connectivity, making it ideal for connected designs.

B. LDR Sensor : Light Dependent Resistors (LDRs) are made from semiconductor materials like cadmium sulfide, which change their resistance in response to light. Their conductivity increases and resistance decreases with higher light intensity, though they have a relatively slow response time.

C. Temperature and Humidity Sensor (DHT11): The DHT11 is part of the DHTXX series of humidity sensors, designed to measure both humidity and temperature. It is inexpensive and widely used, making it popular among hobbyists despite its slower response.

D. MQ2 Gas Sensor: The MQ2 is an electronic sensor used to detect various gas concentrations, including LPG, methane, and carbon monoxide. It functions as a chemiresistor, measuring gas levels through changes in resistance and operates on a 5V DC supply.

E. LED (Light Emitting Diode): LEDs are energy-efficient, small light sources with quick switching capabilities and long lifespans, making them suitable for mobile and low-power applications.

F. Buzzer: Buzzers combine a DC power source with electronic transducers to generate sound. There are two types: active and passive buzzers, with the former producing sound only when powered.

## IV. SYSTEM DESIGN

The proposed system comprises various sensors, a camera module, and a power supply, all connected to the Raspberry Pi 3 Model B+, which features an integrated Wi-Fi module. Key sensors utilized include the DHT11 for temperature and humidity, the MQ2 for detecting toxic gases such as methane and propane, an LDR for light measurement, and an ultrasonic sensor for obstacle detection. The ultrasonic sensor aids miners in navigating safely by identifying obstacles in the mining environment.

The MQ2 sensor monitors hazardous gas concentrations, while the DHT11 sensor provides vital data regarding the temperature and humidity levels in the mine. The LDR sensor continuously assesses light conditions, and all data is regularly updated

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to the cloud. Should any sensor readings exceed predefined threshold levels, an alarm buzzer activates, and the camera module records a short video, which is sent to the relevant authorities via email.

To control the movement of a vehicle within the mining area, a motor driver is utilized, allowing for navigation in multiple directions (forward, backward, left, and right) using Bluetooth communication. For extended ranges, ZigBee or LoRa protocols can be implemented to ensure reliable wireless communication. The motor driver requires a continuous power supply for operation.

## V. METHODOLOGY

The Raspberry Pi serves as the central controller for the system, managing all hardware components. The integration of sensors—including the MQ2, DHT11, LDR, ultrasonic sensor, and a camera module—is achieved through Python programming. Upon powering up, the Raspberry Pi executes the code, checks the connected hardware, and initiates their respective functions. As the automated vehicle navigates the mining area, the gas sensor continuously monitors for hazardous gas concentrations. The LDR identifies low light conditions, while the camera records video whenever the ultrasonic sensor detects an obstacle, sending this footage to the main unit. Data from the sensors are uploaded to the cloud using an IoT platform at ten-second intervals. The vehicle autonomously roams the mining environment, processing and transmitting collected data continuously. The system compares incoming data

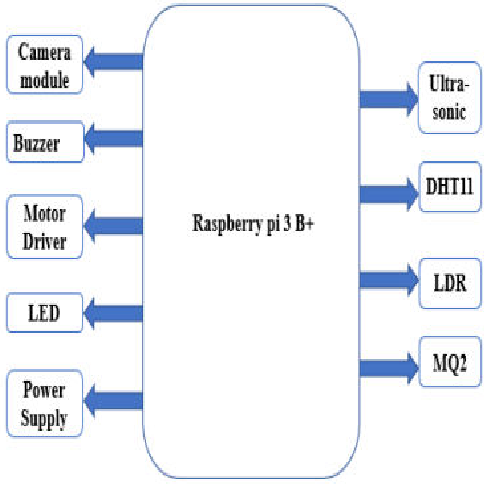


**Fig1: Block Diagram**

against established threshold values. If any values exceed these limits, an emergency alert is sent via the Wi-Fi module to the main authority, while miners are notified to move to a safe zone. The alarm buzzer activates to further alert workers of potential danger, thereby reducing the likelihood of accidents. By uploading all data to the cloud, authorities can analyze incident causes if an accident occurs, allowing them to implement precautionary measures to prevent similar events in the future.

## VI. IMPLEMENTATION

To begin, the Raspberry Pi requires an operating system, which can be installed by downloading the OS file from the Raspberry Pi website. In this project, the Raspbian OS is used, installed via an SD card. The sensors—DHT11, MQ2, ultrasonic, and LDR—are connected to the Raspberry Pi 3 Model B+ to monitor temperature, humidity, gas levels, light, and obstacles. This information is continuously transmitted to the cloud using the built-in Wi-Fi module, specifically via the ThingSpeak platform. The camera module captures short videos of the mining area, particularly in the event of an obstacle or accident, with video files converted from H264 to MP4 format before being sent to the authorities' email. Movement of the vehicle is controlled using a Bluetooth protocol application. Specific keys are assigned for directional movement: 'F' for forward, 'B' for backward, 'R' for right, 'L' for left, and 'S' for stopping the vehicle.

## VII. RESULTS

The outputs of various sensors connected to the system provide critical data for monitoring hazardous conditions in the mining area. These outputs enable timely supervision of potential dangers and enhance the overall safety of miners.

## VIII. CONCLUSION

The proposed system offers real-time monitoring and alerts for hazardous conditions within underground mines. When any sensor value surpasses its threshold, an alarm is triggered, effectively alerting miners and helping to prevent accidents. This system can significantly improve the safety of miners working in hazardous environments.

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