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Full Length Article

Real-Time Safety Monitoring System In Coal Mines Using IOT

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Abstract

Coal mining is one of the most hazardous industrial activities due to the presence of toxic gases, fire accidents, and poor environmental conditions inside underground mines. This paper presents a real-time safety monitoring system for coal mines using Internet of Things (IoT) technology. The proposed system continuously monitors critical environmental parameters such as methane gas, carbon monoxide (CO), smoke, fire, temperature, and humidity using different sensors including MQ2, MQ7, MQ135, flame sensor, and temperature sensors. The collected data is processed using a Raspberry Pi Pico W microcontroller and transmitted wirelessly through IoT technology for remote monitoring. An OLED display is used for local monitoring, while alert notifications are sent to authorized personnel through Telegram notifications whenever abnormal conditions are detected. The system improves miner safety by enabling early detection of hazardous conditions and providing immediate alerts for preventive actions. Experimental results demonstrate that the proposed system efficiently detects unsafe conditions and provides reliable real-time monitoring suitable for underground coal mine applications.

Keywords: *Internet of Things (IoT), Coal Mine Safety, Raspberry Pi Pico W, Gas Sensors, Real-Time Monitoring, Wireless Communication.*

INTRODUCTION

Coal mining plays a major role in electricity generation and industrial development. However, underground coal mines are highly dangerous environments where workers are exposed to toxic gases, fire hazards, high temperature, and low oxygen levels. Traditional monitoring methods mainly depend on manual inspections and basic alarm systems, which are often slow and inefficient in detecting hazardous conditions.

Recent developments in embedded systems and IoT technologies have enabled the development of intelligent safety monitoring systems capable of real-time environmental monitoring. IoT-based systems provide continuous monitoring, remote accessibility, automated alerts, and improved reliability compared to conventional systems.

The proposed system utilizes multiple environmental sensors connected to a Raspberry Pi Pico W microcontroller. The sensed data is transmitted wirelessly to a web-based monitoring system where officials can observe real-time conditions inside the mine. Alert messages are also generated automatically whenever dangerous situations occur.

EXISTING SYSTEM

In traditional coal mine safety systems, environmental monitoring is performed either manually or using limited standalone gas detection devices. Communication is generally based on radio systems and periodic inspections. These systems suffer from several limitations:

- Lack of continuous real-time monitoring.
- Delayed response to hazardous conditions.
- Limited communication between workers and monitoring stations.
- Poor accuracy and reliability.
- Inability to monitor multiple parameters simultaneously.

Because of these drawbacks, accidents caused by toxic gases and fire hazards continue to occur in mining environments.

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PROPOSED SYSTEM

The proposed system is an IoT-based real-time safety monitoring system designed specifically for underground coal mines. The system continuously monitors environmental conditions using different sensors and transmits the collected data wirelessly.

The major objectives of the proposed system are:

- Continuous monitoring of hazardous gases.
- Detection of fire and abnormal temperature conditions.
- Real-time data transmission using IoT.
- Automatic alert generation through Telegram notifications.
- Display of environmental conditions on OLED display.
- Improvement of worker safety and operational efficiency.

The proposed system consists of:

1. Raspberry Pi Pico W microcontroller.
2. MQ2 gas sensor.
3. MQ7 carbon monoxide sensor.
4. MQ135 air quality sensor.
5. Flame sensor.
6. Temperature and humidity sensor.
7. OLED display.
8. IoT communication module.
9. Alarm and notification system.

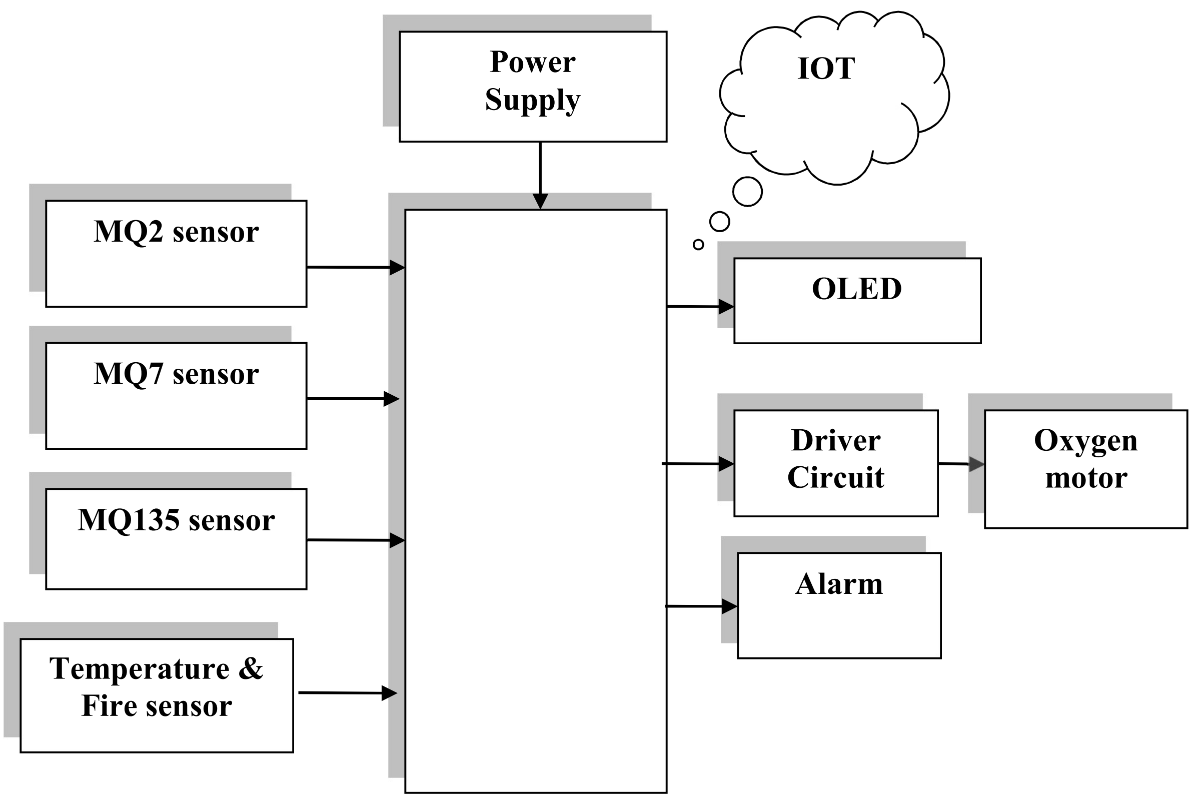
SYSTEM ARCHITECTURE

A. Block Diagram

The overall system architecture consists of multiple environmental sensors connected to the Raspberry Pi Pico W controller. The controller processes the sensor readings and transmits them through wireless communication for remote monitoring.

Functional Flow:

Sensors → Raspberry Pi Pico W → IoT Platform → OLED Display & Telegram Alerts



B. Working Principle

The sensors continuously monitor environmental conditions inside the coal mine. The MQ2 sensor detects combustible gases and smoke, MQ7 measures carbon monoxide concentration, MQ135 monitors air quality, and the flame sensor detects fire hazards. Temperature and humidity sensors measure environmental conditions.

The Raspberry Pi Pico W processes all sensor data and compares the readings with predefined threshold values. If any parameter exceeds the safe limit, the

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system automatically activates an alarm and sends alert notifications to mine officials through Telegram. The IoT platform allows remote monitoring through a web interface, enabling real-time observation of mine conditions from any location.

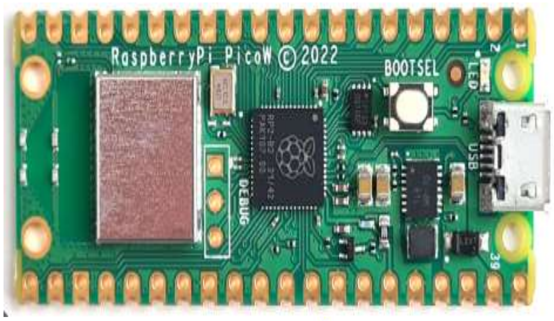
HARDWARE COMPONENTS

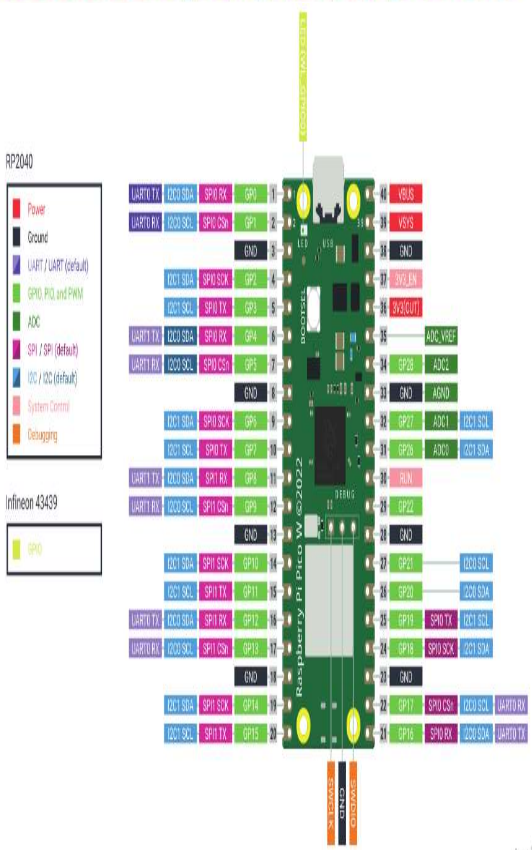
A. Raspberry Pi Pico W

Raspberry Pi Pico W is a wireless microcontroller board based on the RP2040 processor. It supports Wi-Fi communication and provides multiple GPIO pins for interfacing sensors and display modules.

MICROCONTROLLER

RASPBERRY PI PICO W





Features:

- Dual-core ARM Cortex M0+ processor.
- 2.4 GHz Wi-Fi support.
- 264 KB SRAM.
- 2 MB flash memory.
- Multiple GPIO pins.
- Low power consumption.

B. MQ2 Gas Sensor

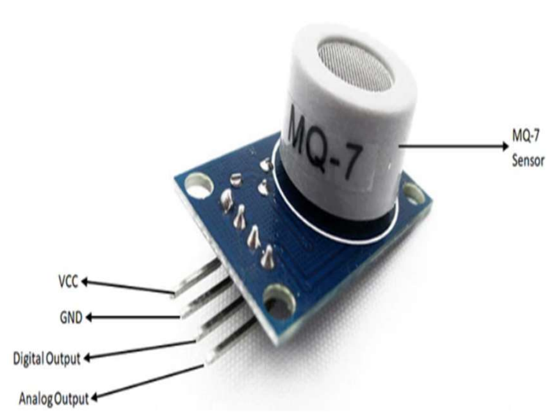
The MQ2 sensor is used to detect combustible gases and smoke in the environment. It is highly sensitive to LPG, methane, hydrogen, and smoke.

Applications:

- Gas leakage detection.
- Smoke detection.
- Industrial safety systems.

C. MQ7 Carbon Monoxide Sensor

The MQ7 sensor detects carbon monoxide gas concentration in the environment. It provides both analog and digital outputs.



Features:

- Fast response time.
- High sensitivity to CO gas.
- Long operational life.
- Adjustable sensitivity.

D. MQ135 Air Quality Sensor

The MQ135 sensor measures harmful gases such as ammonia, benzene, smoke, and carbon dioxide.

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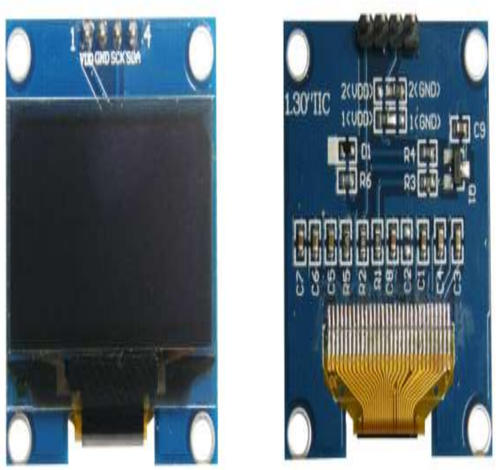
Advantages:

- High sensitivity.
- Low cost.
- Suitable for air quality monitoring.

E. OLED Display

An OLED display is used to display real-time sensor readings locally.



Features:

- Low power consumption.
- High display clarity.
- Compact size.
- I2C communication support.

F: FIRE SENSOR

The Fire sensor, as the name suggests, is used as a simple and compact device for protection against fire. The module makes use of IR sensor and comparator to detect fire up to a range of 1-2 meters.

The device, weighing about 5 grams, can be easily mounted on the device body. It gives a high output on detecting fire. This output can then be used to take the requisite action. An on-board LED is also provided for visual indication.

Feature

- Typical Maximum Range :2 m .
- Indicator LED with 3 pin easy interface connector

G: RELAY

INTRODUCTION

A relay is an electromechanical switch, which perform ON and OFF operations without any human interaction. General representation of double contact relay is shown in fig. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal.

Fig. Relay

History

The first relay was invented by Joseph Henry in 1835. The name relay derives from the French noun relays' that indicates the horse exchange place of the postman. Generally a relay is an electrical hardware device having an input and output gate. The output gate consists in one or more electrical contacts that switch when the input gate is electrically excited

WORKING:

Generally, the relay consists a inductor coil, a spring (not shown in the figure), Swing terminal, and two high power contacts named as normally closed (NC)

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and normally opened (NO). Relay uses an Electromagnet to move swing terminal between two contacts (NO and NC). When there is no power applied to the inductor coil (Relay is OFF), the spring holds the swing terminal is attached to NC contact

H: BUZZER

The Buzzer is the main component in the hardware it buzzes when the sensors detect the leakage of any gas or any other obstacles.

USES

- Annunciator panels
- Electronic metronomes
- Game shows
- Microwave ovens and other household appliances
- Sporting events such as basketball games
- Electrical alarms

SOFTWARE REQUIREMENTS

The proposed system is developed using the following software tools:

Software	Purpose
Arduino IDE	Programming and uploading code
Embedded C / MicroPython	Firmware development
HTML, CSS, JavaScript	Web interface development
Telegram API	Alert notification system

IMPLEMENTATION

The hardware components are interconnected with the Raspberry Pi Pico W controller. Sensor data is continuously collected and processed by the microcontroller.

The implementation process includes:

1. Sensor interfacing.
2. Data acquisition.
3. Threshold comparison.
4. Wireless data transmission.
5. Web-based monitoring.
6. Alert generation.

When abnormal conditions are detected, the controller immediately activates the alarm and sends warning notifications to the concerned authorities.

RESULTS AND DISCUSSION

The developed system successfully monitored environmental conditions in real time. Different hazardous conditions such as increased gas concentration, fire detection, and abnormal temperature levels were tested.

Observed Results:

- Accurate detection of methane and smoke.
- Successful monitoring of carbon monoxide levels.
- Fast response during fire detection.
- Reliable wireless data transmission.
- Instant alert notifications through Telegram.

The system effectively improved safety monitoring and reduced the possibility of accidents in coal mine environments.

APPLICATIONS

- Underground coal mines.
- Industrial safety systems.
- Environmental monitoring.
- Hazardous gas monitoring.
- Smart mining systems.

FUTURE SCOPE

The system can be further enhanced by:

- Integrating AI-based predictive analysis.
- Adding GPS tracking for worker localization.
- Implementing cloud data storage.
- Using advanced wireless communication technologies.
- Developing mobile applications for monitoring.

CONCLUSION

This paper presented a real-time safety monitoring system for coal mines using IoT technology. The proposed system continuously monitors environmental conditions using multiple sensors and provides instant alerts during hazardous situations. The integration of Raspberry Pi Pico W with IoT communication enables efficient remote monitoring and improves the safety of miners working in underground environments.

The developed system is reliable, cost-effective, and capable of reducing accidents caused by toxic gases and fire hazards. Therefore, the proposed solution can serve as an effective safety enhancement system for modern coal mining industries.

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REFERENCES

[1] Molaei fatemeh, "A comprehensive review on the internet of things (IoT) and its implications in the mining industry", American Journal of Engineering and Applied Sciences, 2020.

[2] Arif Hussain, "Application of IoT and artificial neural networks (ANN) for monitoring of underground coal mines", In 2020 international conference on information science and communication technology (ICISCT), 2020.

[3] Sathishkumar N, "IoT based coal mine safety and health monitoring system using LoRaWAN" , 3rd International Conference on Signal Processing and Communication (ICPSC), 2021.

[4] Dheeraj "IoT in mining for sensing, Monitoring and prediction of underground mines Roof support", conference on recent information and advancement technology, 2018.

[5] G.Saranya, "IoT based coal mining safety monitoring system using node MCU", Mukt Shabd Journal, 2020.

[6] M. Shakunthala, C.Raveena, B. Saravanan, "IOT Based Coal Mine Safety Monitoring and Controlling", Annals of R.S.C.B, ISSN:1583-6258, Vol. 25, Issue 4, 2021.

[7] S. R. Deokar, J. S. Wakode, "Coal Mine Safety Monitoring and Alerting System", International Research Journal of Engineering and Technology (IRJET), 2017.

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