

Wireless Coal Mine Safety Monitoring and Alerting System

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Abstract - Coal mining is one of the most hazardous industries due to risks such as methane gas leakage, fire hazards, and structural collapse. This paper presents a wireless coal mine safety monitoring and alerting system using IoT-based technologies. The system uses multiple sensors such as gas, temperature, humidity, vibration, and flame sensors to continuously monitor environmental conditions inside mines. The ESP32 microcontroller collects sensor data and transmits it wirelessly using the HC-12 module to a receiver unit. If any parameter exceeds predefined safety limits, an alert is generated through a buzzer and displayed on an LCD. This system helps in early detection of dangerous conditions, reducing accidents and improving miner safety. The proposed solution is cost-effective, scalable, and suitable for real-time monitoring in underground mining environments.

Key Words: Coal Mine Safety, IoT, ESP32, Wireless Monitoring, Gas Detection, Alert System

1. INTRODUCTION

Coal mining is inherently dangerous due to the presence of hazardous gases, high temperature, humidity, and chances of fire or collapse. Accidents in mines can lead to serious injuries and loss of life. Therefore, continuous monitoring of environmental conditions is essential.

Traditional monitoring systems are often limited and may not provide real-time alerts. With the advancement of Internet of Things (IoT) technology, it is possible to develop smart monitoring systems that ensure safety and efficiency.

This paper proposes a wireless coal mine safety monitoring system that detects hazardous conditions and alerts workers in real time, thereby preventing disasters and improving operational safety.

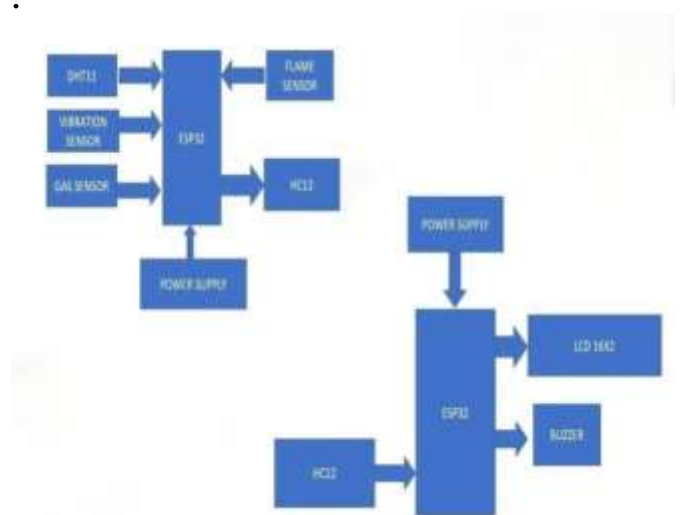
2. Body of Paper

The body of the paper consists of numbered sections that present the main findings. These sections should be organized to best present the material.

It is often important to refer back (or forward) to specific sections. Such references are made by indicating the section number, for example, "In Sec. 2 we showed..." or "Section 2.1 contained a description..." If the word Section, Reference, Equation, or Figure starts a sentence, it is spelled out. When occurring in the middle of a sentence, these words are abbreviated Sec., Ref., Eq., and Fig.

At the first occurrence of an acronym, spell it out followed by the acronym in parentheses, e.g., charge-coupled diode (CCD).

Fig -1: Figure



3. WORKING PRINCIPLE

The system operates in three main steps:

3.1 Continuous Monitoring

Sensors continuously measure environmental parameters such as gas concentration, temperature, humidity, vibration, and fire presence.

3.2 Data Transmission

The ESP32 processes the sensor data and transmits it wirelessly using the HC-12 module.

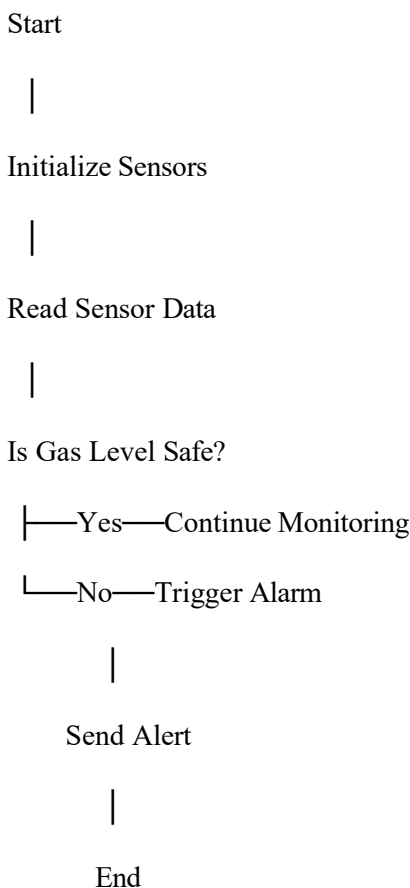
3.3 Alert Generation

At the receiver end:

- Data is displayed on the LCD screen
- If any value exceeds safety limits, a buzzer alarm is triggered

This ensures immediate warning and quick response to hazardous conditions.

4. SYSTEM FLOWCHARTS



5. ADVANTAGES OF THE SYSTEM

- **Real-time Monitoring:** Provides instant updates from underground mines
- **Wireless Communication:** Eliminates complex wiring
- **Multi-Sensor Integration:** Detects multiple hazards simultaneously
- **Cost-Effective:** Uses low-cost components like ESP32
- **Scalable:** Can be expanded for large mining areas
- **Quick Response:** Immediate alerts help prevent accidents

6. LIMITATIONS

- Wireless signal interference in underground environments
- Regular sensor calibration required
- Power supply challenges in mines
- Harsh environmental conditions affecting device durability

7. CONCLUSIONS

The proposed wireless coal mine safety monitoring system is an effective solution for detecting hazardous conditions in real time. By using IoT technology and wireless communication, the system enhances safety, reduces risks, and improves efficiency in mining operations. Although there are some challenges, continuous advancements in technology will make such systems more reliable and widely adopted in the future.

8. ACKNOWLEDGEMENT

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9. REFERENCES

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