IOT Based Coal Mine Safety Monitoring And Alerting System

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Abstract- *Human Coal mine accidents are becoming more common. Many skilled workers and labourers have died. There is no early warning system in place to detect the alarming cause of coal mine accidents and issue an alert. In the mining industry, workplace injuries and illnesses are common.Firedamp and residue blasts, landslips, mine flames, and transport and motorization related specialized disappointments are the most well-known reasons for mishaps in coal mining.As per an investigation of word related mishaps with regards to social and financial variables uncovers the genuine reasons for these mishaps, which are said to happen unavoidably because of specialized blemishes or disappointments.*

Keywords- IoT, Coal Mine Safety, Monitoring, Sensor Networks,, Real-Time Alerts..

I. INTRODUCTION

The The mines are the world's most dangerous mining operation, with thousands of workers dying each year as a result of massive explosions. According to a recent study, in such mining incidents,an estimated 12,000 people have died on average. Coal is a non-human resource that can be converted; there are a few problems in the mines; and workers risked their lives by working in coal mines; and, unfortunately, some miners end up losing their lives in coal mines. Often, such problems arise as a result of outdated technology and wireless devices, the final result being the mismanagement and spillage of toxic gases in coal mines poses a serious threat to archaeologists, underground operation. If farming is done by hand, more workers are needed, and the required quality work is not achieved. Seeds and fertilizers are also wasted due to inefficiency.

EASEOF USE

The proposed coal mine safety monitoring and alerting system using IoT technology shows promise in improving the safety of underground mining operations. Here's how it can be user-friendly for miners and mine operators:

For miners:

Simple and intuitive interface: The system relies on readily available sensors and displays information on an LCD screen, making it easy for miners with no specialized technical knowledge to understand the environmental conditions.

Real-time alerts: Audible alarms and visual indicators like the LCD screen provide immediate warnings about potential dangers like high gas levels, temperature, or water levels, allowing miners to take quick action.

Panic button: The smart helmet with a panic button offers a direct way for miners to call for help in case of emergencies or medical needs, ensuring timely response from the control room.

Improved communication: Zigbee technology provides reliable wireless communication, potentially enabling miners to stay connected with the control room for updates or instructions.

For mine operators:

Remote monitoring: Real-time data from sensors allows operators to remotely monitor environmental conditions throughout the mine, even in inaccessible areas.

Early warning system: Proactive identification of potential hazards like rising gas levels or temperature changes helps prevent accidents before they occur.

Improved decision-making: Access to accurate and real-time data can inform better decisions regarding safety protocols, resource allocation, and rescue operations in case of emergencies.

Scalability and customization: The system can be easily scaled to accommodate different mine sizes and customized with additional sensors or functionalities as needed.

Overall, the proposed system offers a user-friendly approach to enhancing coal mine safety by providing miners with readily understandable information and tools for self-protection, while empowering mine operators with real-time

data and communication capabilities for better management and emergency response.

Abbreviations and Acronyms :

- LCD: Liquid Crystal Display
- DC: Direct Current
- MHz: Megahertz (unit of frequency)
- LED: Light-Emitting Diode
- IR: Infrared
- API: Application Programming Interface
- GSM: Global System for Mobile Communications
- GPS: Global Positioning System
- HTTP: Hypertext Transfer Protocol
- MQTT: Message Queuing Telemetry Transport

II. METHODS AND MATERIAL

Input: The system gathers data from sensors (temperature, gas, water) and miner signals (panic buttons, voice) to monitor the mining environment.

Output: Based on this data, the system produces alerts (buzzer, displays) for miners and notifies the control room. The data is securely stored in the cloud for analysis and long-term monitoring

Functions: The system described involves several functions to effectively monitor and respond to conditions in a mining environment:

Data Acquisition: Functions to collect real-time data from temperature, gas, and water sensors, as well as miner signals like panic buttons and voice communications.

Data Processing: Algorithms and functions to process incoming data, identify patterns, and detect anomalies or potential hazards.

Alert Generation: Functions responsible for triggering alerts, such as activating a buzzer and displaying visual warnings, based on the processed data.

Automation: Automated functions to respond to predefined conditions, allowing the system to take immediate actions without manual intervention**.**

Success Conditions:

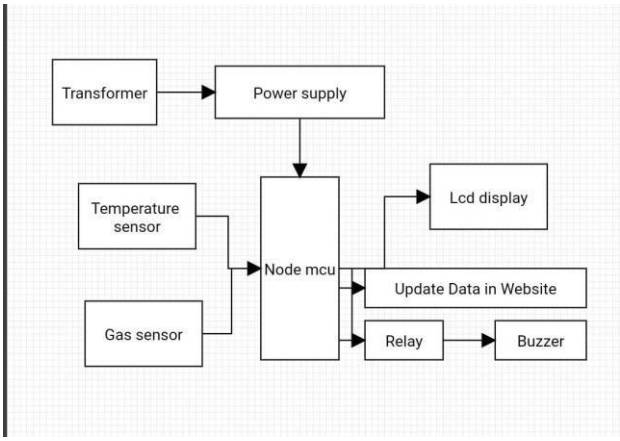
1. Alert accuracy & timely action: Minimizes risks before escalation.
2. Strong communication & response: Ensures efficient rescue and incident control.

Failure Conditions:

1. System reliability & user adoption: Prevents false alarms and encourages proper usage.
2. Cost vs. benefit & adaptation: Maintains viability and effectiveness over time.

Existing System:

In traditional coal mining, various parameters like methane gas, high temperatures, and the risk of fire accidents require constant monitoring. The underground mining industry faces challenges, leading to frequent disasters, causing substantial loss of assets and lives.



The complexities of the mine environment and the diverse range of activities conducted necessitate continuous monitoring. To address these issues, Nevon Projects proposes a wireless sensor network application for coal mining safety. The system employs master and slave controllers, with slaves detecting dangers and alerting the master controller, triggering alarms in tunnels and sending messages via IoT for prompt action.

Disadvantages of Existing System:

1. Manual labor is prevalent in daily coal mine operations.
2. Accidents occur frequently, posing significant risks.
3. CO gases generated during underground excavation pose health hazards.
4. High temperatures can lead to severe fires.

Proposed System:

The proposed system introduces enhanced safety measures in coal mines by integrating gas sensors, temperature

sensors, water level sensors, and relays. These sensors are linked to a controller, and data is transmitted to the ThingSpeak platform for monitoring and control.

S.NO	PARAMETERS	MQ2 GAS SENSOR	LM35 TEMPERATURE SENSOR
1.	Sensing variables/Uses	Gas Concentration	Temperature
2.	Operating Voltage	-	+4V to 30V
3.	Operating Current	800mw	60 micro-A
4.	Output Voltage	0 to 10V	10 mV
5.	Operating Temperature Range	-20 to 70 degreecelsius	-55 to 150 degree Celsius
6.	Output/sensingRange	300 to 10000 ppm	55 to 150 degree Celsius

Gas sensors detect hazardous gas levels, triggering a buzzer to alert mine workers. The system continuously uploads sensor data to the cloud for analysis. Temperature and water level values are also monitored inside the coal mine, with data sent to the control unit via Zigbee.

Advantages of Proposed System:

1. Importance of coal mines for economic growth is maintained.
2. Implementation cost is reduced.
3. Enhanced security through wireless connections.
4. Improved services within coal mines.

Relevant Studies:

Several relevant studies shed light on related aspects of coal mine safety. "Surveillance and Safety System for Underground Coal Mines Based on Low Power WSN" emphasizes the use of ZigBee protocol-based low-power transceivers for efficient communication in coal mine safety. "Radar Hazard Detection in a Coal Structure" introduces a system where a buzzer sounds during emergency conditions, and monitored variables are displayed on a user interface machine. "Statistical Analysis of Coal Mine Accidents of China in 2018" analyzes 2018 mine accident data in China, focusing on occurrence areas, times, and accident types. "Mining's Contribution to National Economies Between 1996 and 2016" investigates mining's impact on GDP, revealing a 43% increase between 1996 and 2016.

Hardware Requirements:

In the context of the proposed coal mine safety system, hardware components play a crucial role in sensing, collecting, and transmitting data for monitoring and control. The essential hardware components include:

Gas Sensor Modules:

These modules are designed to detect the presence of hazardous gases, such as methane, within the coal mine environment. The gas sensor provides real-time data on gas levels, contributing to early detection and alert systems.

Temperature Sensors:

Temperature sensors are employed to monitor the temperature conditions within the coal mine. This data is crucial for identifying potential fire hazards and ensuring that the working environment remains within safe limits.

Water Level Sensor:

The water level sensor is utilized to monitor water levels within the mine. This information is essential for assessing the risk of flooding, ensuring a safe working environment for miners.

Relays:

Relays act as switches that control the activation of various devices or alarms based on the data received from sensors. In this system, relays may be used to trigger alarms, cut off power in specific areas, or initiate other safety protocols.

Arduino Microcontroller:

The Arduino microcontroller serves as the central processing unit, integrating data from different sensors. It executes predefined algorithms, processes sensor inputs, and facilitates communication with other components.

Zigbee Module:

Zigbee technology enables wireless communication between different components of the system. Zigbee modules facilitate the transmission of data, especially from temperature and water level sensors to the central control unit.

Buzzer:

The buzzer serves as an audible alert mechanism. It is triggered in response to critical conditions such as high gas levels, enabling miners to receive immediate notifications.

IoT Platform (ThingSpeak):

An IoT platform, such as ThingSpeak, is employed for data storage, monitoring, and analysis. It provides a cloud-based infrastructure for uploading sensor data in real-time, enabling remote monitoring and control.

Software Requirements:

Operating System (OS):

The proposed system requires an operating system, and Windows 10 is specified in the project. The OS manages hardware resources and facilitates the execution of software applications.

Platform:

DOT NET TECHNOLOGY is the chosen platform for developing the software components of the system. This technology framework provides a robust and scalable environment for application development.

Front-End (ASP.Net 4.0):

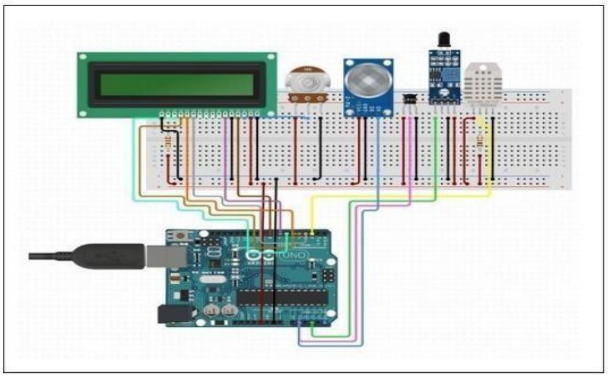
ASP.Net 4.0 serves as the front-end technology for creating the graphical user interface (GUI) and user interactions. It is a web development framework that ensures a responsive and user-friendly interface for monitoring the coal mine safety system.

Back-End (SQL SERVER 2014):

SQL SERVER 2014 is utilized as the back-end database management system. It stores and manages the collected data, allowing for efficient retrieval, analysis, and reporting. The database is crucial for historical data tracking and system optimization.

The seamless integration of hardware and software components in this proposed system enables real-time monitoring of critical parameters in coal mines, enhancing safety and providing a comprehensive solution for potential hazards.

Circuit Diagram :



III. CONCLUSION

The proposed system, utilizing Arduino microcontrollers, aims to enhance mine safety by automating monitoring processes. The integration of various sensors and communication technologies enables real-time monitoring and control, addressing the safety challenges posed by coal mining operations. This study contributes to achieving both safety and development in mining projects through the implementation of a wireless network. The Arduino-based prototype serves as a foundational step toward advancing mine safety technologies.

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