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Study on Coal Mine Safety Monitoring and Alerting System Using IOT

Dr. G. Srivalli[1], V. Ujwala Sony[2], G. Sahithi[3], D. Harshini[4], B. Spoorthi[5]
[1]*Associate Professor, G Narayanamma Institute of Technology and Science, Hyderabad, INDIA*
[2, 3, 4, 5]*Student, G Narayanamma Institute of Technology and Science, Hyderabad, INDIA*

Abstract: A coal mine safety monitoring and alerting system using IoT can help improve safety in coal mines by providing real-time monitoring and alerting of hazardous conditions. The system can use various sensors and devices to monitor parameters such as gas concentration, temperature, humidity. The data from these sensors can be collected, processed, and analyzed using an IoT platform to provide insights into the condition of the mine. The system can also incorporate a range of alerting mechanisms to notify mine workers and supervisors of any hazardous conditions For example, the system can use audio and visual alarms, mobile notifications, and even automatic shutdown of machinery in case of danger.

The system utilizes various sensors and devices to monitor parameters such as gas concentration, temperature, humidity, and collects, processes, and analyzes the data using an IoT platform. The system aims to reduce the risk of accidents and injuries to mine workers, increase productivity, and reduce downtime.

Keywords: Coal mine safety, IoT monitoring, Hazardous conditions, Alerting mechanisms.

I. INTRODUCTION

Sensors and actuators for get-together the information and sending over the web are what's undeniably related with this progress. We use cloud not exclusively to store information yet likewise for information assessment, gathering, depiction. Such a rising development can be utilized in different IoT applications like agribusiness, prospering, tricky home, and so forth, to make the previously existing frameworks consistently gainful. The key qualities of the cloud recall for request connection philosophy, in all cases get to, asset pooling and, versatility.

Existing arrangement of Dangerous Gases Location in Coal Mine shafts doesn't meet the necessary green climate boundary and cautioning framework.

This coal mineshaft security framework there isn't anything for information change for refreshing the public individuals just as administration of climate quality and earth tremor alarms encompassing of mines. Because of this no information communicating, no precise boundary observing, we go to the new creative framework or coal mineshaft well being estimation.This study presents a proposed framework designed to screen the boundaries of coal mineshafts and promptly alert personnel in the event of potential threats, ensuring enhanced safety measures in the coal mining operations.

The increasing demand for electricity has led to the utilization of coal for its energy content in power generation, as well as in iron ore extraction and cement production. This has resulted in the extensive development of coal mines worldwide, necessitating a paramount focus on miner safety. Manual supervision of underground mine wirings is time-consuming and labor-intensive. Crucial factors such as temperature, humidity, and CO2 levels pose risks to miners working underground. To address these challenges, a system has been proposed to automate the monitoring of these safety-critical parameters and transmit the data regularly to a central Base Station, eliminating the need for manual labor. This innovative approach streamlines operations, ensures timely data collection, and enhances safety protocols in coal mining operations.

When measured values surpass the predefined threshold, an alarm is triggered, alerting relevant personnel. The transmitted data, facilitated by wireless technology, is received and monitored at the base station [3]. Mishaps and explosions in coal mines often result from inadequate maintenance of electrical wirings, which deteriorate over time. These failures and subsequent mishaps do not transpire abruptly, but rather gradually, as the deteriorating wiring leads to a progressive increase in mine temperature.

To address the challenge of unnoticed gradual temperature increases in mines, a predictive system is implemented, continuously monitoring parameters on a daily basis. This system forecasts potential failures, thus preventing mishaps and safeguarding human lives. The monitoring of these parameters assumes a crucial role in ensuring miner safety.

II. HARDWARE DEVELOPMENT

The development of Coal Mine Safety Monitoring and Alerting System using IOT involves both software and Hardware Components. Here's a general outline of the formulation and Hardware development process for such a system:

A. Hardware Components

ESP32: The ESP32 microcontroller will serve as the main control unit for data acquisition, processing, and communication. It has built-in Wi-Fi and Bluetooth capabilities, making it suitable for IoT applications.

Buzzer: The buzzer will provide audible alarms or warning signals to alert mine workers in case of hazardous conditions.

LED display: The LED display will be used to show relevant information and visual indicators for safety status or warnings.

DSP level sensor: The DSP (Digital Signal Processing) level sensor will monitor the gas levels, such as methane and carbon monoxide, in the coal mine.

B. Sensor Integration

Connect the DSP level sensor to the ESP32 using the appropriate interface (such as I2C, SPI, or UART) according to the sensor's specifications. Implement the necessary code to read the sensor data from the DSP level sensor using the ESP32's GPIO pins or the designated interface.

Configure the ESP32 to communicate with the other components, such as the buzzer and LED display, using their respective GPIO pins.

C. Data Processing and Alert Generation

Develop firmware for the ESP32 to process the sensor data and analyse it for potential safety hazards.

Define safety thresholds for gas levels and other parameters, based on established safety regulations and standards.

Implement algorithms or logic to detect abnormal conditions and trigger appropriate alerts. When hazardous conditions are detected, activate the buzzer to emit an audible alarm and display relevant warning messages on the LED display.

D. Data Processing and Alert Generation

Develop firmware for the ESP32 to process the sensor data and analyse it for potential safety hazards.

Define safety thresholds for gas levels and other parameters, based on established safety regulations and standards.

Implement algorithms or logic to detect abnormal conditions and trigger appropriate alerts. When hazardous conditions are detected, activate the buzzer to emit an audible alarm and display relevant warning messages on the LED display.

E. Testing and Deployment

Conduct thorough testing of the hardware components, firmware, and communication interfaces to ensure their reliability and accuracy. Deploy the system in the coal mine, considering factors such as sensor placement, power supply, and environmental conditions. The below table 1 Represents the Representation of coal mine monitoring system.

Table 1: Representation of Coal mine monitoring system

Temp in C	Humidity	Gas in %
00028	00050	00005
00027	00040	00005
00025	00049	00005
00026	00018	00005
00028	00019	00005
00028	00651	00005
00027	00032	00004

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The ESP32 as shown in Fig 1 is a powerful and versatile microcontroller developed by Espress if Systems, widely used in the Internet of Things (IoT) applications. It features a dual-core Tensilica LX6 processor, built-in Wi-Fi and Bluetooth connectivity, ample I/O pins, and support for variou s communication protocols such as SPI, I2C, UART, and more.

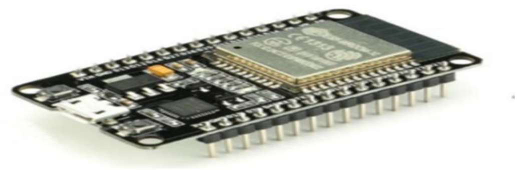

Fig 1:ESP32

The DHT11 as shown in Fig 2 is a popular and affordable temperature and humidity sensor widely used in various Arduino and IoT projects. It provides accurate measurements of temperature (from 0 to 50 degrees Celsius) and relative humidity (from 20% to 90%) with a relatively low power consumption, making it suitable for monitoring environmental conditions.

Fig 2:DHT11

The MQ-2 sensor as shown in Fig 3 is a gas sensor module commonly used for detecting various gases like LPG, propane, methane, alcohol, and smoke in the air. It operates based on the principle of gas conductivity, providing analog output that can be interfaced with microcontrollers or other devices for gas detection and monitoring applications..

Fig 3:MQ2 Sensor

LCD (Liquid Crystal Display)as shown in Fig 4 is a widely used technology for visual output in electronic devices, featuring a flat panel display that utilizes liquid crystals to produce images or textLCD displays offer advantages such as low power consumption, high contrast, wide viewing angles, and compatibility with various display resolutions, making them suitable for applications ranging from calculators and digital watches to smartphones and televisions.

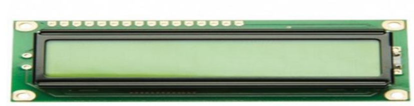

Fig 4:LCD

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A buzzer as shown in Fig 5 is an electronic component that produces sound by vibrating a diaphragm when an electrical current passes through it, commonly used for audible alerts or notifications in electronic devices. Buzzer modules are often employed in various applications, including alarms, timers, doorbells, and interactive systems, providing a simple and effective way to convey auditory feedback.

Fig 5:Buzzer

III. SOFTWARE DEVELOPMENT

A coal mine safety monitoring and alerting system using IoT typically involves the integration of various sensors, data collection devices, and communication technologies to monitor the working environment and personnel safety in coal mines. Here's a general workflow for such a system:

1) *Sensor Deployment:* Install different types of sensors throughout the coal mine to monitor various parameters. These sensors may include gas detectors, temperature sensors, humidity sensors, air quality sensors, vibration sensors, and wearable devices for personnel tracking.
2) *Data Collection:* Sensors collect real-time data on environmental conditions and personnel activities. The data can include gas concentrations, temperature, humidity levels, airflow, and the location of workers.
3) *Data Transmission:* The collected data is transmitted using wireless communication protocols such as Wi-Fi, Bluetooth, or Zigbee to a centralized server or gateway within the mine.
4) *Data Processing:* The server or gateway receives the data and performs real-time analysis and processing. It may use algorithms to detect abnormal patterns or dangerous conditions, such as high gas levels or sudden changes in temperature.
5) *Alert Generation:* If the system detects any hazardous situation or abnormal conditions, it generates alerts and notifications. These alerts can be sent to mine operators, supervisors, and workers through various communication channels like SMS, email, or dedicated mobile applications.
6) *Visualization and Monitoring:* The processed data is presented in a user-friendly interface for real-time monitoring. This interface may include dashboards, charts, and maps to display the current status of different parameters and the location of workers within the mine
7) *Emergency Response:* In case of emergencies, the system can trigger predefined emergency protocols, such as activating warning alarms, initiating evacuation procedures, or sending distress signals to rescue teams.
8) *Historical Data Analysis:* The collected data can be stored for historical analysis and future safety improvement. By analyzing trends and patterns in the data, the system can identify potential risks and suggest preventive measures.
9) *Maintenance and Calibration:* Regular maintenance and calibration of the sensors and devices are crucial to ensure their accuracy and reliability. The system should have provisions for monitoring the health and performance of the sensors and alerting maintenance personnel when any issues arise.
10) *Continuous Improvement:* Based on the analysis of historical data and feedback from operators and workers, the system can be continuously improved to enhance safety measures and optimize mining operations.

It's important to note that the implementation of such a system requires expertise in IoT technologies, sensor integration, data analysis, and safety regulations specific to coal mining. It should also comply with relevant safety standards and guidelines to ensure the well-being of the mine workers and overall operation.

IV. RESULTS

We have successfully implemented and constructed a coal mine system with internet-based monitoring. The integration of input modules and output modules into the ESP32 platform has been accomplished, yielding accurate results with a system accuracy of 80%. This proposed system serves as a cohesive addition to existing safety protocols, offering a low-cost and easily feasible solution.

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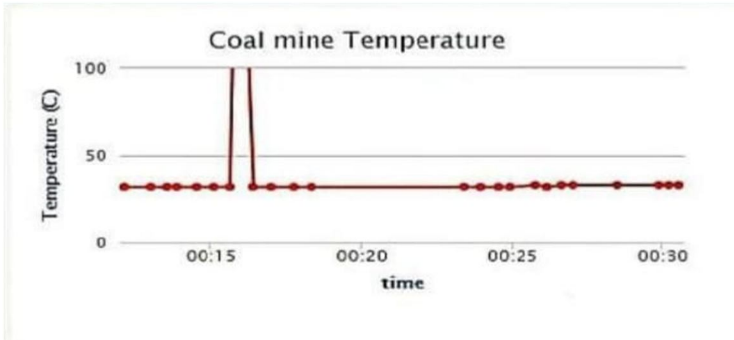
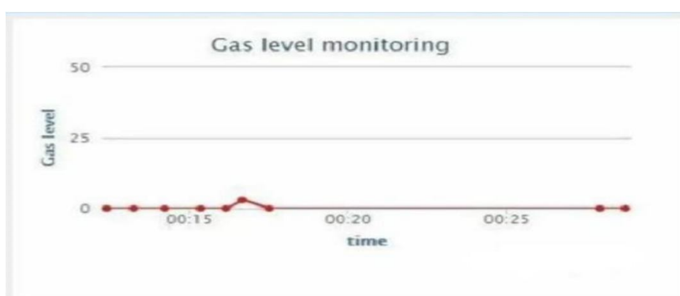
Our approach involves the utilization of Internet of Things (IoT) technology, integrating sensors such as MQ2 and DHT to facilitate comprehensive monitoring. Additionally, the ESP32 module has been employed to create a server and enable alerting through a public government dashboard.

This work showcases the advantages of employing flexible networking in coal mine operations, enabling improved deployment and reduced installation and operating costs. The paper's main outcome emphasizes the real-time analysis of harmful gases in underground mines using the MQ2 sensor, effectively alerting the rescue room to provide assistance to miners in distress. Additionally, the paper presents various graphical representations of the coal mine data, including Graph 1: Temperature vs. Time, Graph 2: Humidity vs. Time, and Graph 3: Gas Level vs. Time. These findings contribute valuable insights to the field of scalable safety mechanisms in coal mining operations.



Graph 1: Temperature v/s Time

Graph 2: Humidity v/s Time



Graph 3: Gas Level v/s Time

V. CONCLUSION

The proposed system aims to monitor coal mine parameters and update them through IoT. The system integrates vibration and smoke sensors with an ESP32 module to create a server for data transfer and alerting to a government dashboard.

Data from each sensor is processed and displayed on an LCD module, as well as on the IoT server for easy access by the government. The system is capable of monitoring temperature, carbon components, and harmful gases in the coal mine, and uses programming code to process the data from each sensor.

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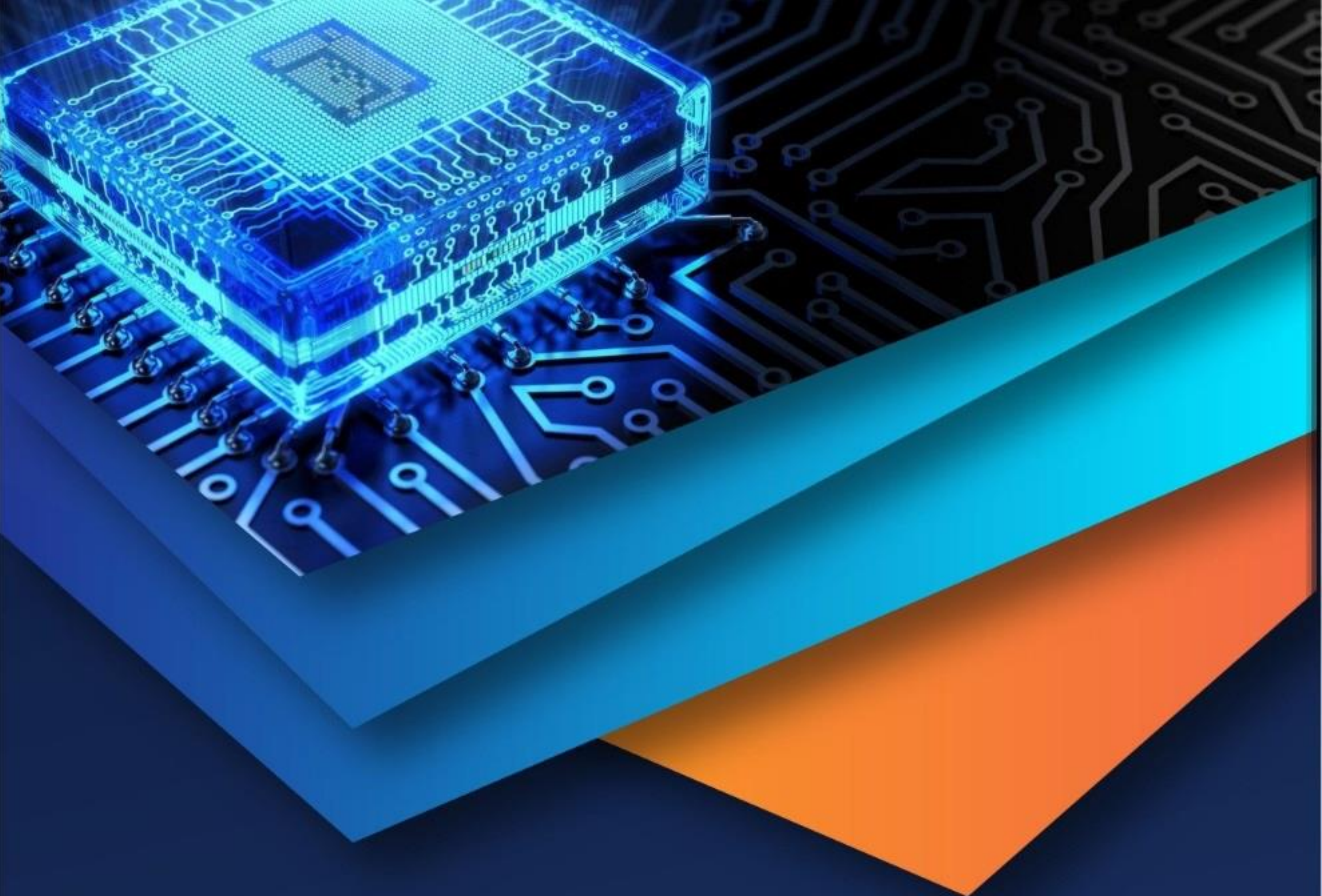
REFERENCES

[1] S. Ingle, S. Salankar and S. Prasad, "To design and develop LoRa-based system for remote safety monitoring," 2022 10th International Conference on Emerging Trends in Engineering andTechnology - Signal and Information Processing (ICETET-SIP-22), 2022, pp. 01-05.
[2] R. Hussain, F. M. Zakai and A. Iqbal, "Demystifying Mining Sustainability Through Efficient And Low Cost IoT Based Safety Implementations," 2022 Global Conference on Wireless and Optical Technologies (GCWOT), 2022, pp. 1-6.
[3] M. R. I. Prince and M. R. Islam, "Web Socket Based IoT Temperature and Humidity Monitoring System for Underground Coal Mine," 2021 5th International Conference on Electrical Information and Communication Technology (EICT), 2021, pp. 1-5.
[4] T. Porselvi, S. G. CS, J. B, P. K and S. B. S, "IoT Based Coal Mine Safety and Health Monitoring System using LoRa WAN," 2021 3rd International Conference on Signal Processing and Communication (ICPSC), 2021, pp. 49-53.
[5] A. H. Soomro and M. T. Jilani, "Application of IoT and Artificial Neural Networks (ANN) for Monitoring of Underground Coal Mines," 2020 International Conference on Information Science and Communication Technology (ICISCT), 2020, pp. 1-8.
[6] R. K. Kodali and S. Sahu, "IoT based Safety System for Coal Mines," 2018 International Conference On Communication, Computing and Internet of Things (IC3IoT), 2018, pp. 147-150.
[7] G. E. M. Abro, S. A. Shaikh, S. Soomro, G. Abid, K. Kumar and F. Ahmed, "Prototyping IOT Based Smart Wearable Jacket Design for Securing the Life of Coal Miners," 2018 International Conference on Computing, Electronics & Communications Engineering (iCCECE), 2018, pp. 134-137.
[8] A. Zhang, "Research on the Architecture of Internet of Things Applied in Coal Mine," 2016 International Conference on Information System and Artificial Intelligence (ISAI), 2016, pp. 21-23.
[9] U. Rai, K. Miglani, A. Saha, B. Sahoo and M. Vergin Raja Sarobin, "ReachOut Smart Safety Device," 2018 6th Edition of International Conference on Wireless Networks & Embedded Systems (WECON), 2018, pp. 131-134.



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