International Journal of Electrical and Electronics Engineers
Volume 15, Issue No. 01, Jan-June 2023
ISSN (O) 2321-2055
ISSN (P) 2321 -2045

Wireless Sensor Network Based Safety System for Mining

[1]Patnala Venkata Veena Madhuri, [2.] Padala Sai Harshitha, [3.] Mangavalli Bhargav, [4]Maddineni Veera Palankaiah, [5]P.Varalakshmi

[1234]UG Students,[5]Assistant Professor, Department of Electronics and Communication Enginering, Tirumala Engineering, College, Jonnalagadda, Andhra Pradesh India

ABSTRACT

Mining is a hazardous industry, and safety is a significant concern. Wireless sensor networks (WSNs) have been widely used in many applications, including mining, to monitor various parameters such as temperature, humidity, gas concentration, and other environmental conditions. LoRa (Long Range) is a wireless communication technology that is well-suited for WSNs due to its long-range communication, low power consumption, and ability to penetrate obstacles. In this paper, we propose a wireless sensor network-based safety system for mining using LoRa technology. The proposed system consists of several sensor nodes, a LoRa gateway, and a central server. The sensor nodes are placed at different locations in the mine to monitor various parameters. The data collected by the sensor nodes aretransmitted to the LoRa gateway, which then sends the datato the central server for processing. The central server processes the data received from the sensor nodes and analyzes it to identify any potential safety hazards. If any safety hazards are detected, the system will generate an alert and notify the appropriate personnel. The system can also be configured to take automated actions in case of an emergency, such as shutting down equipment or activating alarms.

.**Keywords—**LoRa ,Central Server, WSN, Hazards

I. INTRODUCTION

The accident is any uncertain activity due to unavoidable circumstances and carelessness of some people. This incident is happening continuously all around the world. Alarge number of workers (approximately 2.3 million) die each year worldwide, 350,000 because of occupational accidents and approximately 2million because of occupational diseases. Production activities consist of main activities such as excavation, ground support, and haulage as well as activities such as electricity maintenance, establishing and managing pressurized room networks, communication and signalization systems. Inparticular, accidents in coal mining related to collapses, pitfires, firedamp and coal dust explosions, haulage, frequently occur in underground pits. Crystalline silica has long been a serious hazard in mining, with the risk of silicosis at its worst during dry drilling late in the nineteenth century. Silicosis has been subject to considerable investigation. Axial water-fed rock drills, wet techniques, ventilation, enclosed cabins and respiratory protection have largely controlled silicosis in developed nations.There is some evidence for accelerated silicosis in rheumatoid arthritis and of renal disease following prolonged silica exposure. There is also now good evidence that prolonged exposure to crystalline silica increases the risk of lung cancer. The Risks have now been largely controlled in developed nations by

International Journal of Electrical and Electronics Engineers
Volume 15, Issue No. 01, Jan-June 2023
ISSN (O) 2321-2055
ISSN (P) 2321 -2045

dust suppression, ventilation, and respiratory protection. Although largely historic in the developed world, the mining and milling of asbestos has caused a legacy of asbestos-related diseases, which continue tooccur today Diesel particulate exposures occur in underground mines because of diesel powered mobile equipment, used primarily for drilling and haulage. Control measures include the use of low Sulphur diesel fuel, engine maintenance and mine ventilation. Arsenic issometimes a contaminant of metal ores and has beencommercially extracted during copper smelting with an accompanying risk of lung cancer.

Underground Mining:-

In underground mining, a minimal amount of overburden is removed to gain access to the ore deposit. Access to this ore deposit is gained by tunnels or shafts. Tunnels or shafts lead to a more horizontal network of underground tunnels that directly access the ore. In an underground mining method called 'stopping' or 'block caving,' sections or blocks of rock are removed in vertical strips that leave a connected underground cavity that is usually filled with cemented aggregate and waste rock. Although underground mining is a less environmentally-destructivemeans of gaining access to an ore deposit, itis often more costly and entails greater safety risks than strip mining, including open-pit mining. While most large-scale mining projects involve open-pit mining, many large underground mines are in operation around the World.HISTORY OF WSN USING LoRa

Wireless sensor networks (WSNs) have been used in various applications, including safety systems for mining. In recent years, the LoRa (Long Range) technology has emerged as a popular option for WSN-based safety systemsdue to its long-range communication capabilities and low power consumption. The use of WSNs for safety systems inmining began in the early 2000s, with early implementations utilizing Zigbee technology. However, , which led to the development of LoRa-based systems. This system uses a WSN comprised of LoRa-enabled sensors placed throughout the mine to monitor various safety parameters such as temperature, humidity, gas concentration, and seismic activity. The data collected by the sensors is sent to a central control room via LoRa gateways, where it is analyzed in real-time. If any safety thresholds are breached, the system can automatically trigger alarms and shut down equipment. Another example of a LoRa-based safety system is the MineSafety system, developed by a team of researchers at the Indian Institute of Technology (ISM) Dhanbad. This system utilizes a WSN comprised of LoRa-based sensors to monitor various safety parameters, such as temperature, humidity, gas concentration, and air velocity. The data collected by the sensors is transmitted wirelessly to a central control unit, where it is analyzed in real-time. If any safety thresholds are breached, the system can trigger alarms and take appropriate actions to ensure worker safety.

Overall, LoRa-based WSNs have emerged as a promising technology for safety systems in mining due to their long- range communication capabilities, low power consumption, and ability to operate in harsh underground environments. As the technology continues to improve, we can expect to see even more advanced safety systems utilizing LoRa-based WSNs in mining and other industrial applications

Background of the Project :-

The mining industry is inherently hazardous, with various potential safety risks such as gas leaks, fires, explosions, and collapses. To ensure the safety of workers and preventaccidents, it is essential to continuously monitor various environmental parameters within the mining environment, such as temperature, humidity, gas

concentration, and air quality. Traditionally, wired sensor systems have been used to monitor these parameters. However, these systems can be expensive to install and maintain, and they can alsobe hazardous if damaged or interfered with.Wireless sensor networks (WSNs) have emerged as a promising alternative to wired sensor systems in mining safety applications. WSNs are comprised of multiple small sensors that can communicate wirelessly with each other and with a central control unit. They can be easily installed without the need for extensive wiring, making them ideal for underground mining environments. LoRa (Long Range) technology has also gaine**d** popularity in recent years due to its ability to provide long-range communication capabilities with low power consumption. This makes it an ideal option for WSN- based safety systems in mining, where sensors need to communicate over long distances while conserving battery power. In a LoRa-based WSN safety system for mining, sensors are placed throughout the mining environment to continuously monitor various environmental parameters. The data collected by the sensors is transmitted wirelessly to a central control unit, where it is analyzed in real-time. If any safety thresholds are breached, the system can trigger alarms and take appropriate actions to ensure worker safety. Overall, the use of LoRa-based WSNs for safety systems in mining has the potential to significantly improve worker safety while reducing the cost and complexity of traditional wired sensor systems.

II. PROPOSED METHODOLOGY

The proposed methodology for a wireless sensor network-based safety system for mining using LoRa modules can be divided into several key steps: **Identification of critical parameters**: The first step is to identify the critical parameters that need to be monitored in the mining environment to ensure the safety of the miners. These may include temperature, humidity, gas levels, and vibration.

Design of sensor nodes: The next step is to design the sensor nodes that will be used to collect data on the identified parameters. Each sensor node will consist of a LoRa module, a sensor for data collection, and a microcontroller for data processing.

Network topology: The network topology needs to be designed to ensure adequate coverage of the mining environment. The network can be configured as a mesh network,with each node acting as a repeater to extend therange of the network.

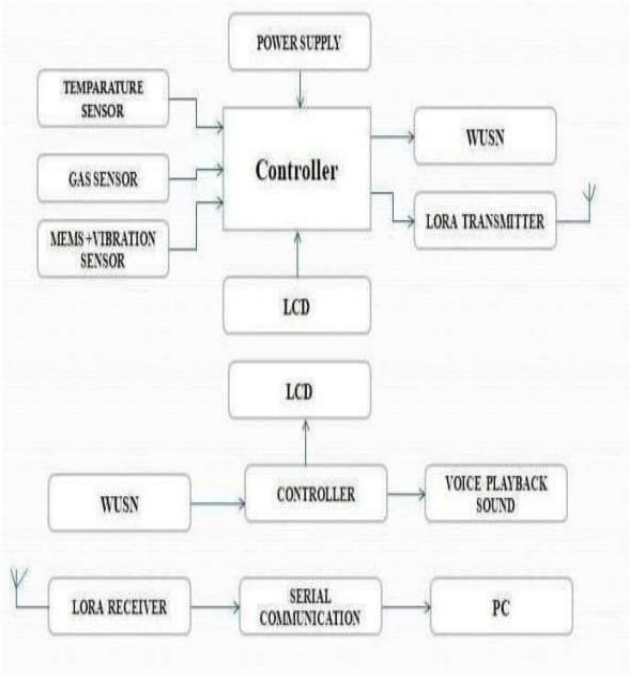
Data transmission: The LoRa modules will transmit thecollected data wirelessly to a central control unit, whichwill receive and process the data. The LoRa technologyenables long range communication with minimal powerconsumption, making it ideal for the mining **Maintenance and calibration**: The system will need tobe regularly maintained and calibrated to ensure thesensors are functioning correctly and the data is accurate.The proposed methodology for a wireless sensornetwork-based safety system for mining using LoRamodules is a multi-disciplinary approach that requiresexpertise in areas such as wireless sensor networks, dataanalytics, signal processing, and mining engineering..

Data processing: The central control unit will process the collected data and provide real time alerts and notifications to the mining operators in case of any potential safety hazards. The system can also be configured to automatically trigger alarms and initiate emergency response protocols

International Journal of Electrical and Electronics Engineers
Volume 15, Issue No. 01, Jan-June 2023
ISSN (O) 2321-2055
ISSN (P) 2321 -2045

III. BLOCK CHAIN FUNCTIONALITIES

In this project Arduino Uno is the heart of the kit. It relates to the power supply and the sensors like gas sensor, Temperature sensor, LDR sensor is given as inputs, GPS, LoRa, buzzer is given as outputs. The gas sensor is used to monitor whether there is leakage of gas or not. The temperature sensor is used to monitor whether the temperature is high or not. The humidity sensor is used to monitor the humidity at the region. They are being connected to wireless underground sensor network (WUSN) transmitter and receiver in which there is flow of data from one part to the other part. Finally, the values that are being predicted can be viewed through personal computer for further rescue. When an event occurs first the vibration sensor measures the event recordings and alerts the micro controller unit, if major event is detected then the buzzer will gets activated and it sends the message to the user through LoRa module.



Temperature Sensor and Humidity sensor:

DHT11 is a low-cost digital sensor for sensing temperature and humidity. This sensor is used to measure humidity and temperature instantaneously. DHT11 humidity and temperature sensor is available as a sensor and as a module. The difference between this sensor and module is the pull-up resistor and a power-on LED. DHT11 is a relative humidity sensor. To measure the surrounding air this sensor uses a thermistor and a capacitive humidity sensor

Gas Sensor:

Gas sensors (also known as gas detectors) are electronic devices that detect and identify different types of gasses. They are commonly used to detect toxic or explosivegasses and measure gas concentration. Gas sensors vary widely in size (portable and fixed), range, and sensing ability.

International Journal of Electrical and Electronics Engineers
Volume 15, Issue No. 01, Jan-June 2023
ISSN (O) 2321-2055
ISSN (P) 2321 -2045

Arduino UNO:-

The Arduino microcontroller is a simple to use yet powerful single board computer that has gained considerable traction within the hobby and professional market. . The Microcontroller used here is an Arduino Uno. The UNO may be a Microcontroller board supported ATMEGA 328P. The ATMEGA 328P has 32kB of non-volatile storage for storing code. The board has 14 digital input and output pins, 8 analog inputs, 16 MHz quartz crystal, USB, an ICSP circuit and a reset button. The Uno are often programmed with the Arduino software.

LoRa:

LoRa technology was developed by a company called Semtech and it is a new wireless protocol designed specifically for long-range. This technology will enablepublic or multi-tenant networks to connect a number of applications running on the same network. Lora Alliance was formed to standardize LPWAN (Low Power WideArea Networks) for IoT and is a non-profit association which features membership from a number of key market shareholders such as CISCO, Micro Chip, IBM, ST Micro, SEMTECH, Orange mobile and many more.

Lcd Display:

A liquid crystal display (LCD) is a thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector. Each pixel consists of a column of liquid crystal molecules suspended between two transparent electrodes, and two polarizing filters.

Relay:

A relay is an electrical switch that is operated by an electromagnet. It is used to control the flow of electricity in a circuit by opening or closing one or more contacts. Relays are often used in applications where a low-power signal needs to control a high-power circuit, or when a circuit needs to be isolated from the control.

Buzzer:- An Arduino buzzer is also called a piezo buzzer. It is basically a tiny speaker that you can connect directly to an Arduino. You can make it sound a tone at a frequency you set. The buzzer produces sound based on reverse of the piezoelectric effect. A buzzer or beeper is a signaling device, usually electronic, typically used in automobiles, household appliances such as a microwave oven, or game shows.

IV. WORKING

The Wireless Sensor Network (WSN) based safety system for mining using LoRa technology works by deploying a network of wireless sensor nodes throughout a mining site. The Sensor nodes are equipped with various sensors to monitor environmental conditions such as gas levels, temperature, and humidity. The sensor nodes use LoRa technology to communicate with a central monitoring station **Deployment of Sensor Nodes**: The first step involves the deployment of wireless sensor nodes throughout the mining site. These sensor nodes are strategically placed to monitor different environmental conditions and are connected wirelessly to a central monitoring station.

Environmental Monitoring: The sensor nodes continuously monitor the environmental conditions, suchas gas levels, temperature, and humidity, in real-time. The sensor data is collected and transmitted wirelessly to the central monitoring station.

Data Collection and Analysis: The central monitoringstation receives the sensor data from all the sensor nodes and analyzes it in real-time. The data is processed using data analytics techniques to detect patterns and

International Journal of Electrical and Electronics Engineers
Volume 15, Issue No. 01, Jan-June 2023
ISSN (O) 2321-2055
ISSN (P) 2321 -2045

anomalies that could indicate potential hazards.

Alert Generation: If the system detects any potential hazard based on the analyzed data an alert is generated and sent to the miners and other relevant stakeholders via a communication channel. The alert message can include information on the location and nature of the hazard

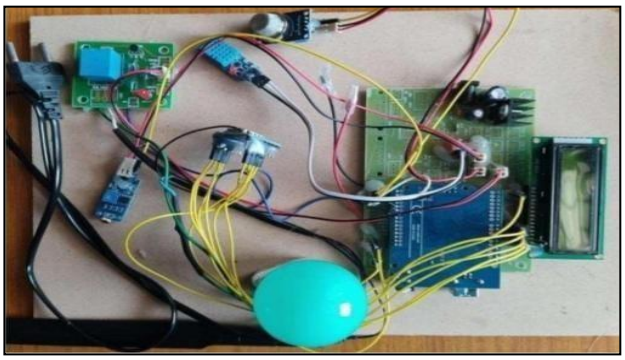
to enable prompt and effective response.

Action and Response:

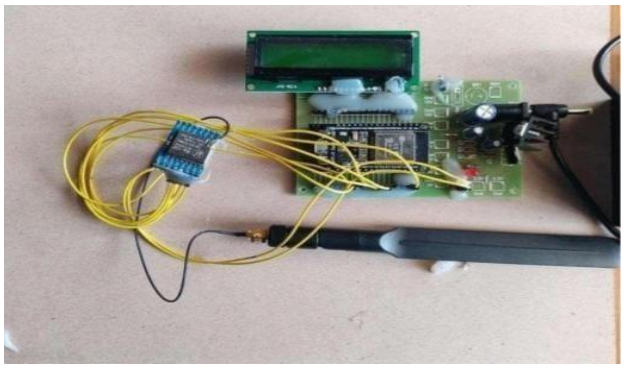
The WSN-based safety system for mining using LoRa technology provides a robust and reliable means of monitoring environmental conditions in real time and providing early warning of potential hazards, thereby improving safety for miners and other stakeholders working in the mining industry

Flow Chart of the system

V. RESULTS AND ANALYSIS



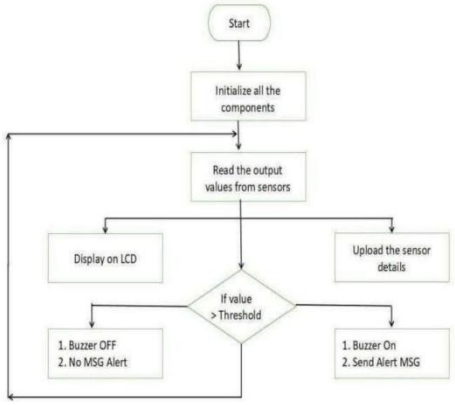
Transmitter



Receiver

The link http://projectsfactoryserver.in/index.php we can able to observe the state of temperature ,gas and LDR sensor. After circuit initialization the sensor starts testing for the abnormalities if the parameters limit exceeds threshold the buzzer will indicate an alert by making sound and all the details will be updated for the examination of parameters. The output will be displayed.

International Journal of Electrical and Electronics Engineers
Volume 15, Issue No. 01, Jan-June 2023
ISSN (O) 2321-2055
ISSN (P) 2321 -2045



VI. CONCLUSION

The basic idea for the life saving measures for theminers and the concerned authorities and also the cost their total resource cost. The sensors used for demonstration of concept are general. TheMQ-2 gas sensor is more sensitive to carbon monoxide but can sense methane, butane, LPG ,hydrogen, smoke, etc. We found more heating of sensor if operated for long time. It is noise free and has low power platform. With use of sophisticated sensors, the system can work with more accuracy in real time. It can be modified in industrial monitoring as well. A real time monitoring system is developed to provide clearer and more point- to-point perspective of the underground mine. This system is displaying the parameters on the monitoring unit; it will be helpful to all miners present inside the mine to save their life before any casualty occurs. Alarm triggers when a sensor value crosses the threshold level. Therefore, a complete mine safety system was constructed such that the system is compactand modular, using a combination of mechanical hardware, electronic hardware and specific software.This system can measure ambient characteristics inside the mine environment and communicate thembetween two nodes using the ZigBee communicationprotocol .The temperature, humidity, airflow and noise sensor measurements have an accuracy of 89.01%, 98.55%, 90.5%, 89.53% and a resolution of 0.105◦C,0.12% RH, 0.05m/s and 0.23 dB SPLrespectively.silica has long been a serious hazard in mining, with the risk of silicosis at its worst during dry drilling late in the nineteenth century. Silicosis has been subject toconsiderable investigation. Axial water-fed rock drills,wet techniques, ventilation, enclosed cabins andrespiratory protection have largely controlled silicosisin developed nations.

REFERENCES

[1] 1T. Porselvi, Et al, "IoT Based Coal Mine Safety and Health Monitoring System using LoRaWAN," Proc. of 2021 3rd International Conference on Signal Processing and Communication (ICPSC), (pp. 49-54), 2021.

[2] A. H. Ansari, Karishma Shaikh, Pooja Kadu, Nikam Rishikesh, "IOT Based Coal Mine Safety Monitoring and Alerting System", International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET), Online ISSN : 2394- 4099, Print ISSN: 2395- 1990, Volume 8 Issue 3, (pp. 404-410), May-June 2021.

[3] A. H. Soomro and M. T. Jilani, "Application of IoT and Artificial Neural Networks (ANN)for Monitoring of Underground Coal Mines," Proc. of 2020 International Conference on Information Science and Communication Technology (ICISCT), (pp. 1- 8), 2020

[4] A. Singh and D. Kumar (2018, March). "IoT in miningfor sensing, monitoring and prediction of underground minesroof support". 4th International Conference on Recent Advances in Information Technology (RAIT), (pp. 1-5),IEEE, 2018.

[5] Y. Li-min , L. Anqi, Zheng & Hui , "Design of monitoring system for coal mine safety based on wireless sensor network".

[6] S. R. Deokar, and J. S. Wakode, "Coal mine safety monitoring and alerting system".International Research Journal of Engineering and Technology (IRJET), 2017.

[7] Valdo Henriques and Reza Malekian, "Mine safety system using wireless sensor network",IEEE, (pp. 1-12), 2016

[8] Wei S, "Multi-parameter monitoring system for coal mine based on wireless sensor network technology". International Conference on Industrial Mechanics and Automation.