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IOT & LORA BASED MINE WORKER SAFETY SECURITY SYSTEM

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ABSTRACT

Our proposed system for ensuring mine worker safety demonstrates a sophisticated approach, integrating cutting-edge technology to address the inherent risks associated with mining environments. By employing smoke sensors such as the MQ-6 and MQ-135 to monitor air quality and semiconductor gas sensors to detect hazardous gases, you're proactively safeguarding workers from potential health hazards.

Utilizing a microcontroller to activate alarms when sensor readings surpass predetermined thresholds adds an additional layer of protection, ensuring timely responses to emerging dangers. Furthermore, the implementation of LoRa technology for long-range data transmission to a central monitoring station and subsequent upload to a web platform via the Internet of Things enables real-time surveillance and intervention.

The incorporation of an emergency switch for miners to signal distress is a critical safety feature, enabling swift responses to unforeseen incidents underground. Your consideration of factors like transmission range, battery longevity, durability, and cost-effectiveness in selecting LoRa technology underscores a meticulous approach to optimizing both safety and operational efficiency.

Keywords: LoRa Technology, Mining Safety, Detect hazardous gases

INTRODUCTION

Underground mining poses significant risks to workers, particularly in coal mines where safety protocols are often lacking. Despite this, coal remains essential for various industries. Hazardous conditions such as high temperatures and gas emissions persist, deterring many from working in coal mines and complicating staffing.

To address safety concerns, robust inspection systems are necessary, but manually assessing coal mine environments is challenging. Wireless communication technologies offer a solution, enabling efficient monitoring and intervention.

A proposed approach integrates advanced sensors to monitor workers' health and gas levels in real-time, transmitting data via the Internet of Things (IoT) for prompt response. This system utilizes LoRa technology for wireless communication, replacing traditional wired networks for ease of setup and maintenance**.**

PREVIOUS WORKS

Safety protocols in port operations primarily focus on protecting equipment, while worker safety relies on switches and sensors G. Chen et al. (2008). However, constant movement and associated risks make it challenging to supervise port personnel effectively T. Porselvi, et al. (2021). To address this, an intelligent alarm system and IoT-based warning system provide real-time activity details N. V. K. Reddy et al. (2021) to workers in case of threats.

For underground coal miners, an intelligent system continuously monitors humidity and airborne gas components to detect hazardous levels. It alerts ground control and workers when specific thresholds are exceeded, mitigating risks of obstruction, gas poisoning, collapse, suffocation, and explosions. L. R. Prando et al. (2019)

Consideration of worker health parameters, such as BMI, age, and chronic illness, tailor safety measures accordingly. Real-time tracking systems address gaps in occupational health knowledge, providing data on diseases, disability, and sick leave. Zourmand et al. (2019)

Detection systems for gases like H2S, CO, and methane instantly alert workers if levels exceed safe limits, aiming to swiftly identify emergencies and disperse hazardous gases T. Zhuang et al. (2019). Waste alerting systems further mitigate air pollution, while smartphone applications with Wi-Fi modules monitor gas sensor properties, contributing to safety enhancement and potential for smart city development. R. K. Kodali and S. Sahu (2018)

PROPOSED METHODOLOGY

Our paper comprises two key nodes: a monitoring node and a transmission node. The transmission node utilizes Arduino to collect data from sensors, while the monitoring node receives this data via a LoRa transmitter. At the transmission node, a LoRa receiver captures data from the transmitter and subsequently transfers it to the cloud through a WIFI module.

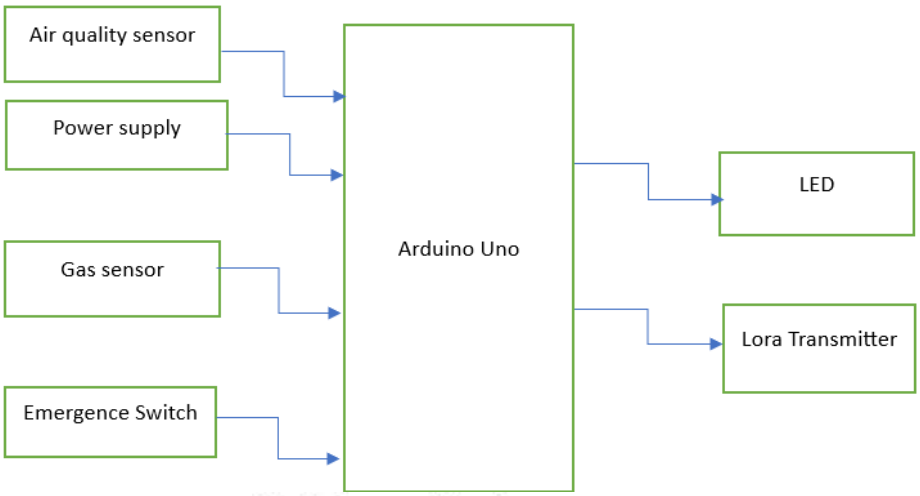
Within the mine worker areas, various smoke and gas sensors, such as the MQ6 and MQ-135, are employed to monitor different levels of smoke and gases. These sensors relay their data to the ATmega328 microcontroller, which in turn transmits it to the monitoring section via the LoRa module. An alarm is activated if the smoke sensor readings surpass predefined thresholds.

LoRa, an open network protocol developed by the LoRa Alliance, serves as the backbone of our network, supporting the Media Access Control (MAC) layer. Acting as the lower physical layer, LoRa enables long-distance communication links and governs energy systems, communication routes, and data speeds across diverse devices.

Research on LoRa predominantly focuses on coverage assessments and its versatility in various settings, ranging from expansive smart city initiatives to compact, cost-effective tracking solutions. However, there remains a scarcity of literature addressing LoRa's application in post-disaster communication, decentralized networks, network management, and adaptive data rates, posing challenges for scientists and researchers.

The MQ6 gas sensor specializes in detecting concentrations of butane and LPG commonly found in residential and industrial settings, while the MQ-135 sensor is adept at sensing gases like ammonia, sulphur dioxide, and carbon monoxide. These Metal Oxide Semiconductor (MOS) sensors play a pivotal role in monitoring air quality and ensuring the safety of workers in hazardous environments.

Block diagram of Transmitter



Block diagram of Receiver

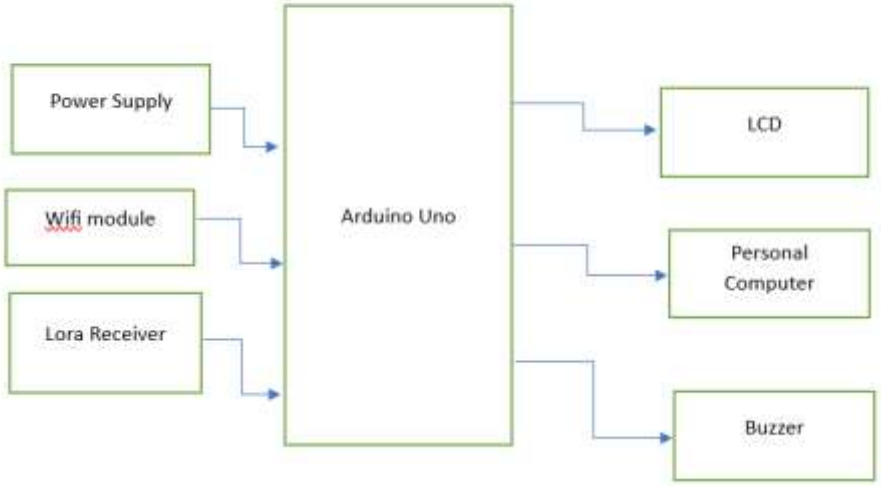


Fig 3.1 Transmitter

Fig 3.2 Receiver

A Hardware:

The buzzers sound when the amount of data from the smoke sensor surpasses the 200 thresholds, which is the specified value. This indicates that something is abnormal in the surroundings. The LoRa technology is utilized to periodically record the data obtained from coal miners and the internal environment of the mine within the monitoring region.

RESULT

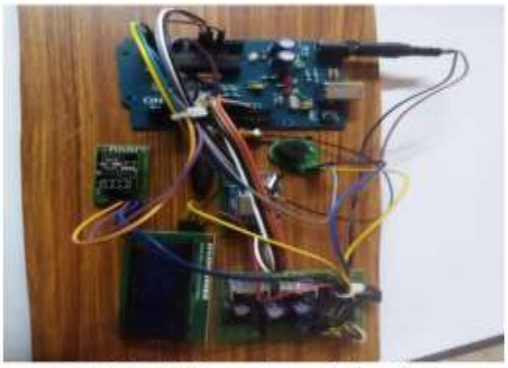


Fig.1.Receiver block

Fig.2. Transmitter block

Fig 4.1 Transmitter and Receiver Blocks

The air quality and gas levels are shown on the LCD screen for easy monitoring. Switch devices controlled by the cloud handle signals. If there are any abnormal conditions, notifications are sent to authorized individuals' email addresses. The air quality threshold is set to less than 200. If it goes beyond this limit, an alarm will sound through the buzzer. Similarly, if gas levels rise above 200, the sensors will trigger after a 1000-second delay, similar to temperature readings.

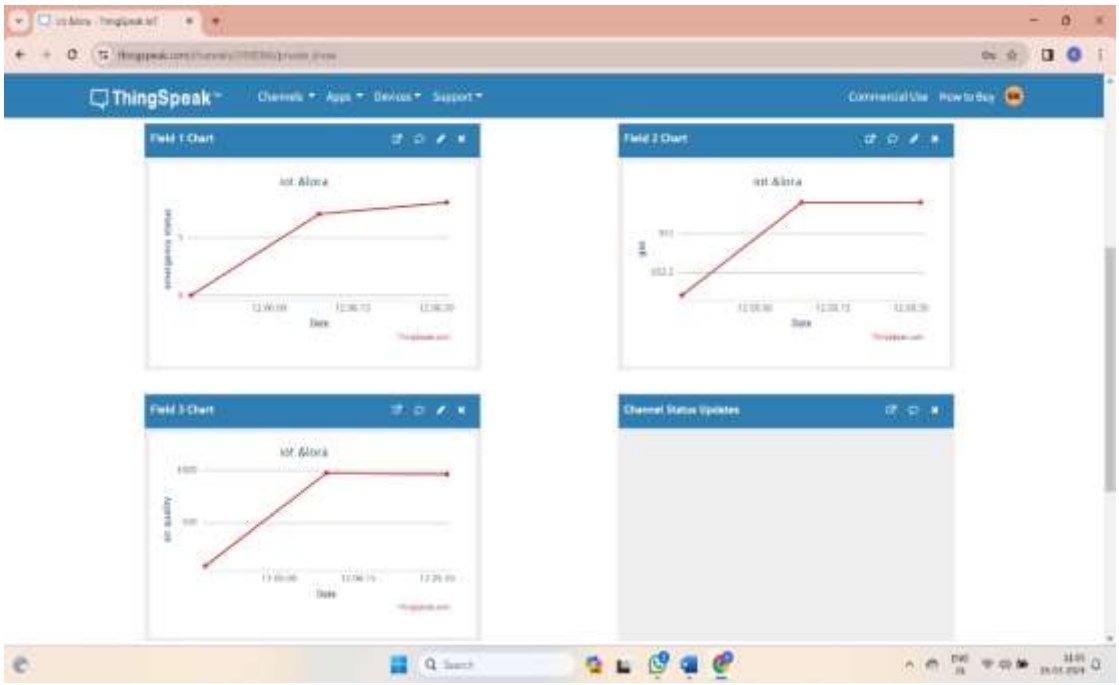


Fig.4.2.cloud response in things speak

CONCLUSION

A significant advancement in ensuring the safety of mine workers in hazardous environments has been made with the development and implementation of a safety system that utilizes LoRa and IoT technologies. This system includes sensors like the MQ6 and MQ135, an emergency switch, buzzer, and a WIFI module connected to the Thing speak cloud.

The safety system provides real-time monitoring of the environment, detecting potential risks such as hazardous gases, and enabling quick responses in emergencies by integrating various technologies. Sensors like the MQ6 and MQ135 ensure accurate and timely gas detection, while an emergency switch and alarm facilitate rapid alerting and evacuation.

By centralizing data management, analysis, and visualization through the WIFI module's connection to the Thing speak cloud platform, mine operators can take proactive steps to reduce hazards and make informed decisions. Moreover, the cloud connectivity allows for remote monitoring and control of the safety system, improving situational awareness and enabling prompt actions even from locations off-site.

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