Coal Mine Safety And Health Monitoring System Using LoRa

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Abstract: Coal is used as a fuel by many industries. The category includes the underground mining business. It is crucial to keep an eye on the working conditions in coal mine since the complexity of the mine environment. Also the air quality becomes an important factor in mining areas where the health conditions of workers is prominently considered. The composition of many toxic gases under the mining areas like total volatile organic compound (TVOC) and carbon-di-oxide creating significant role in health system of the workers. In this proposed, smart helmet has been developed for mining workers using LoRaWAN technology used to improve security and safety in coal mine. It also senses parameters like heavy vibrations, temperature, humidity, flame, smoke, hazardous gases, heart rate and respiratory rate. To overcome this issue, the device helps to alert the users from a dangerous mine environment. LoRa enables seamless communication and quick identification of potential risk because to its long range capabilities.

Keywords: Smart Helmet, Coal Mine Workers, Safety And Health Monitoring, Lora WAN.
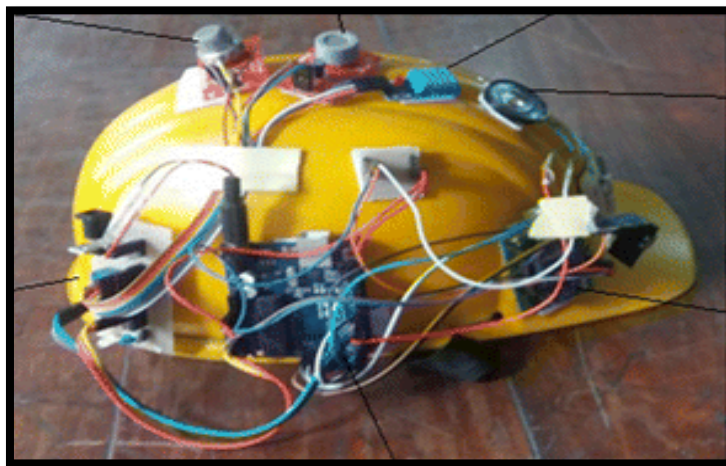
I. INTRODUCTION

Fig. 1 Smart Helmet

Communication plays an important role in monitoring and safety for any industries. The mining operations with unsafe manners are due to different methodologies utilized by the miners for extricating diverse minerals. The deeper the mine, the larger is the risk. The process of Underground mining operation through human labours is a highly unsafe condition where the risks increase with the increase in distance from the ground. However, it also presents significant occupational hazards, particularly in underground mining environment where condition can rapidly become hazardous. Despite advancement in safety protocols, accidents related to hazards gases, fires, various vibration in land, increase temperature and unstable environmental conditions still pose significant risks to miners lives and well-being.

The protection of miners need to always be of major consideration in any structure of mining. Safety has long been a top priority in the mining sector, particularly in sub-surface mining. Each year, mining accidents claimed the lives of thousands of miners. In response to these challenges, coal mining safety monitoring and health system utilizing using LoRa (Long-Range) technology. LoRa offers distinct advantages for communication in underground environments, including its long-range capabilities, low power consumption and ability to penetrate obstacles in mining. This project uses a wireless sensor network to try and accomplish the environmental condition. By deploying LoRa based systems, mines can achieve real-time monitoring of critical parameters over extensive distance without the need for complex wiring infrastructure. Coal has constantly been the most important resource of electricity in India, which has significantly contributed to the rapid industrial development of the country. Furthermore, the integration of IOT (Internet of things) notification capability ensures that designated personnel receive immediate alerts, displays the parameters in transmitter section. Among other important difficulties, a wireless sensor network can handle staff orientation, synchronization monitoring, real-time work surface monitoring, communication capacity, and mobile data transmission.

II. LITERATURE REVIEW

1. *T. Porselvi et al Conference Paper: May 2021. IoT Based Coal Mine Safety and Health Monitoring System using LoRa WAN.* Today, the safety of miner workers is a significant challenge. Miner's health and life are helpless against a few basic issues, which incorporates the working environment. If any smoke sensor value goes beyond the threshold range at that point the microcontroller will allow an alert to the person through a buzzer and sends the information to the monitoring section through the Lora WAN. Internet of things enables an explicit interconnection between various machines, devices, and Internet-based services and also this technology also help further exploited to benefit people to do work easily

2. *G.Pradeep Kumar et al 2021 J. Phys.: Conf. Ser. 1916 012089 A Smart Helmet for the Mining Industry using LoRa WAN.* The air quality factor in mining area particularly on emission of harmful gases. Harmful gases affect respiratory tract, damage the lungs and causes skin disease. Also to monitoring these indicators allows for timely assessment of underground workers' health status, prediction, and prevention of potential health issues, ensuring they can work in a safe environment, so the Smart helmet is invented.

3. *B. Bommirani et al Lora Based Coal Mine Safety Monitoring and Security System Using Smart Helmet, volume 2, Issue 4, April 2024.* The miners are unaware of the environmental factors like pressure changes, Temperature changes and various dangerous gases. The goal of this project is to create smart helmet to detect hazardous event, keep eye on the environment and update data from sensor. The use of a compact humidity & temperature sensor ensures a lightweight and power efficient circuit while the use of RF module helps in wireless communication between staff and ground control

4. *M. Dhanalakshmi et al A Smart Helmet For Improving Safety In Mining Industry, vol. 2, no. 3, 2017.* Wireless communication in underground mining is costless and so effective in communicating with each other's. During hazardous conditions, a buzzer in the mine workers' helmets gives a signal to the workers to avoid such things communication is done between mining people. If any bulky object falls on a mineworker's head even after putting on a helmet, the individual may become injured and could die if immediate treatment isn't provided. So, this smart helmet is built in such a way that it will notice all types of dangerous events with the assistance of devices that are mounted on it.

III. PROPOSED METHODOLOGY

The proposed system consists of two sections namely Transmitter Section, and Receiver Section (monitoring section). Transmitter Section Consists of various sensors to monitor the health status of the miner's and the receiver section is the total monitoring section. In the mine worker section various sensors are employed to monitor the different types of hazardous levels in the mine and the sensor measures values given to the microcontroller. If the sensor's values increase beyond the threshold range, then the microcontroller will give an alert to the person through a buzzer and send the data to the monitoring section through the LoRaWAN module. The received data is uploaded to the webpage through IOT.
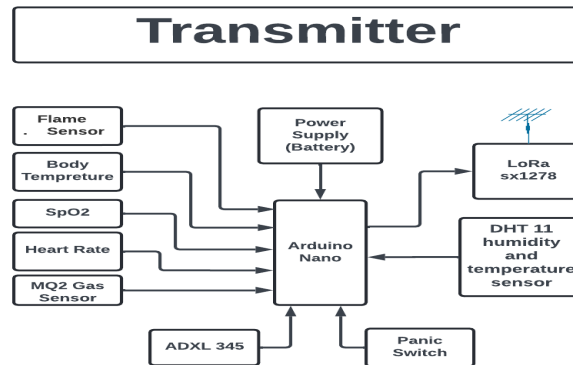
A. TRANSMITTER SECTION

Fig.2 Block Diagram Of Transmitter

In this proposed transmitter section various sensors like Heartbeat Sensor, Gas Sensor, Vibration Sensor, and DHT11 Sensor, Flame sensor, SpO2 sensor are employed to monitor miner's status. which are connected to the Arduino Nano and Arduino Nano drives all the parameter values to the LoraWAN which is connected to the Arduino itself. The sensors are programmed with a certain range of values, when the sensor outputs go above or below the buzzer is turned ON. The transmitter section also consists of a switch that helps the person to trigger an alarm which is placed in the receiver section in case of emergency.
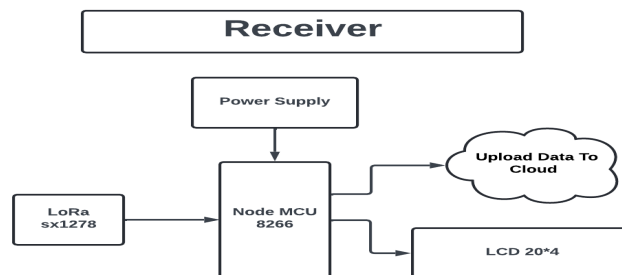
B. RECEIVER SECTION

Fig.3 Block Diagram Of Receiver

In the Receiver Section all the information transmitted from the transmitter section is received by the Lora receiver present in the receiver section which consists of the buzzer and LCD display. The values of the different parameters are displayed continuously on the LCD screen which helps the person in the control room to monitor the health condition of a miner and surrounding parameters for taking necessary and appropriate steps in case of emergency.

IV. WORKING PRINCIPLE

In order to ensure the safety of miners in demanding and dangerous environments, this system makes use of LoRa's long-range communication capabilities and low power consumption to provide real- time monitoring and rapid alerts. LoRa technology uses dispersed sensor nodes all over the mine. Numerous sensors are installed on these nodes to keep an eye on vital indicators like smoke, heartrate, vibration, temperature and humidity etc. throughout the mine to monitor environmental parameters and track miner's safety. Such as Heartbeat sensors are engineered to produce digital outputs of the heartbeat when a finger is positioned on the device. These digital outputs are communicated to the microcontroller directly to measure the Beats per Minute (BPM). This system is based on the principle of light modulation by blood flow through the finger at each pulse. the ADXL345 accelerometer sensor were employed to provide vibration information at the observatory in real-time.

These sensors transmit data wirelessly using LoRa technology. where the MQ 2 Gas sensor along with other sensors senses the overall environment of the coal mine. After sensing the conditions the input values are then given to the Arduino Nano microcontroller Then the data forwarded to a central monitoring station where it is analyzed and visualized.

If any hazards or anomalies are detected, the system generates alerts and alarms to notify both the mines and the control room. For example, the system can automatically send alerts to all relevant personnel and display critical information on screens in the control room if a gas leak is detected or if a miner's location is compromised. The monitoring system also facilitates prompt emergency response by providing critical information about the location and nature of the hazards.

V. RESULT

A coal mine where the air can get stuffy and dangerous gases might sneak in. To keep workers safe, using some sensors. These sensors sense the parameters like temperature, humidity, flame, smoke, hazardous gases, worker location, heart rate, respiratory rate, heavy vibrations and smoke. The sensors will transmit the data wirelessly to a central monitoring station using LoRa technology. Then the system will be able to collect the data, display the data on LCD display, identify the potential hazards and alert the workers and supervisors of potential dangers. The LoRa is a suitable technology for this application, as it is able to provide long-range communication and low power consumption.

VI. CONCLUSION

A coal mine safety system is implemented using smoke sensors, respiratory sensors, heartbeat sensors for obtaining and health parameters environmental conditions. It represents a major advancement in improving the security and safety of mining operations. Numerous significant benefits are provided by this technology, such as long-range communication, low power consumption, and adaptability to difficult subterranean environments. A smart alert system is implemented for the safety of mineworkers by alerting them at the right time to escape from the mining environment in case of any accidents. The environment and health status of the mineworkers have continuously updated on the IoT web page. was possible to improve communication between miners and the outside world, monitor the miners' performances and connectivity between managers, track the real-time position of miners using wireless technology. To sum up, implementing this technology is essential to developing a safer and more efficient coal mining sector.

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