Coal Mine Safety Monitoring and Alerting System

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Abstract:

As Safety is the most vital part of any type of industry. In the mining industry safety and security is a fundamental aspect of all. To avoid any type of accidents mining industry follows some basic precautions. Still accidents takes place in underground mines due to rise in temperature, increased Concentration of gases, vibrations and methane gas leakage , which lead to great loss of possession and life. Here we provide safety to worker by properly monitoring the Heartbeat and by alerting the worker and also authorities present at the lift and Control room. And by monitoring the harmful gases, Temperature and Vibrations at the lift and thereby alerting the workers and the authorities present in the control room on the fixed ground. A panic switch is also given to the worker, used when he is feeling any difficulty. The Alerts are given by using a Buzzer and a message displayed on a LCD Screen. It enhances safety in underground mines by establishing a reliable and cost effective nRF24L01 based wireless communication system, which acts as a Transceiver.

Keywords-**nRF24L01 Transceiver.**

I. INTRODUCTION

Coal is a very important natural resource to our country. The most significant uses of coal are in production of steel, generation of electricity, manufacturing of cement and also as a liquid fuel in many applications of industry. It is said that coal can help in a significant amount of economic growth of any country. In India, the future of energy department and its prosperity are integrally dependent upon mining and using coal. It is because coal is most abundant, affordable and dependent energy supply. But there are many hazardous conditions like increase in temperature and humidity, release of harmful gases. These conditions create a dangerous environment for workers to work in and pose a risk to their lives. Due to this workers are either leaving their jobs in coal mines or not at all willing to opt for such jobs as mining. This is creating lots of problems in availability of workers for the coal mining industry. Thus safety of the workers in a coal mine has become a serious issue which has to be addressed. It is very difficult to monitor all the environmental conditions continuously in a coal mine by the human beings.

This system can be used as a device in Underground Coal Mines to sense any difficulty to the worker and also the Mine area .In this system, the Heartbeat(BPM) of worker is regularly monitored. And the Temperature, Harmful gases and Vibrations of mine is properly monitored to avoid damage to life and possession. when the BPM exceeds the limit or if the concentration of harmful gases or if the Temperature goes beyond the safer level, the authorities and workers will be notified through Buzzer and detection will be displayed on LCD, thereby authorities can perform rescue operations and save the workers and other authorities present in the mine.

The Proposed system has a reliable communication system using nRF24L01 Transceivers through which the workers and authorities will be notified when there is any problem. There are three units in this system. Worker unit is used to monitor the worker, Mine unit is used to monitor the mine conditions and the Control room unit is used to alert the authorities present in the control room on the fixed ground. All these three units are controlled by Arduino UNO micro-controller.

II.LITERATURE SURVEY

Table-1

Year	No. of Accidents	No. of Deaths
2022	3	8
2021	8	28
2020	10	11
2019	17	15
2018	42	63
2017	26	31
2016	8	27

The coal industry consists of 600,000 miners and other workers. Safety in the Indian coal mines is therefore a major issue. However, there has been no notable statistical analysis of the safety records of Indian coal mines.

In the Project, IOT Based Coal Mine Safety Monitoring and Alerting System published by International Journal of Scientific Research in Science, Engineering and Technology. The System Existing system does not come with a Coal mine unit, which does not provide the accuracy of knowing mine conditions to the authorities when there is no worker present in the mine. Existing system has PIC Microcontroller, Temperature sensor, Gas Sensor and Zigbee Module within the worker unit. The Zigbee range is too low, which means it does not provide reliable communication system. We have come up with nRF24L01 Transceiver which provides long range of communication. Whenever the sensor readings goes beyond the safer level, the authorities will be notified through Buzzer and a message on LCD display.

III.HARDWARE COMPONENTS

Arduino UNO, MQ4 Gas Sensor, DHT11 Sensor, MEMS Sensor, Heartbeat Sensor, Push Button, Buzzer, LCD Module, LED, nRF24L01 Transceiver, Step down Transformer, LM7805 Voltage Regulators, Capacitors

4.BLOCK DIAGRAMS

A. WORKER UNIT:

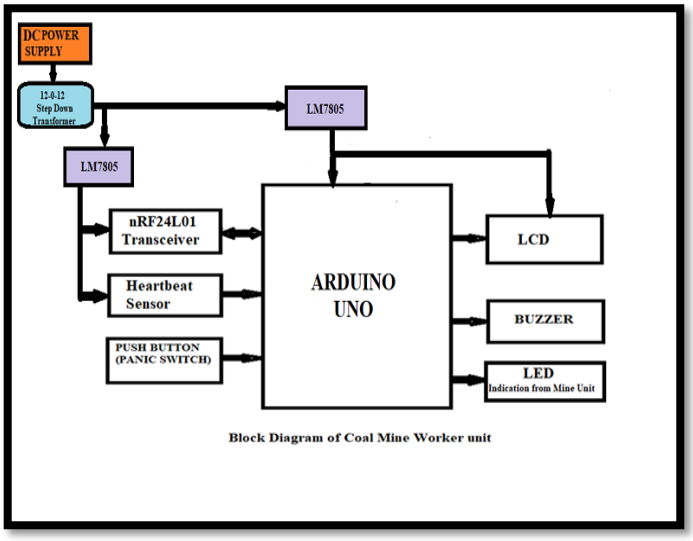


Fig 1: Block Diagram of Worker Unit

Arduino UNO is connected to a 7805 VoltageRegulator, which is connected to a 12-0-12 step down Transformer from the direct AC power supply.

1. Heartbeat sensor is connected to micro-controller in the following way:
   - D0 of sensor to D9 of micro-controller

- Vcc of sensor to output pin of Voltage Regulator
- Gnd of sensor to Gnd pin of Voltage Regulator

2. push button is connected to micro-controller in the following way:

- Positive terminal of button to D9 of micro-controller
- Negative terminal of button to GND of micro-controller

3. nRF24L01 Transceiver is connected to micro-controller in the following way:

- TXD of transceiver to TX of micro-controller
- RXD of transceiver to RX of micro-controller
- Vcc of transceiver to output pin of Voltage Regulator
- Gnd of transceiver to Gnd pin of Voltage Regulator

4. LCD is connected to micro-controller in the following way:

- RS of LCD to D12 of micro-controller
- E of LCD to D11 of micro-controller
- D87,D86,D85 and D84 of LCD to D2,D3,D4 and D5 pins of micro-controller

Other connections are done in the following way:

- Positive terminal of LED to D8 of micro-controller
- Positive terminal of Buzzer to D13 of micro-controller
- Negative of terminals of both LED and Buzzer to GND of micro-controller

B.MINE UNIT:

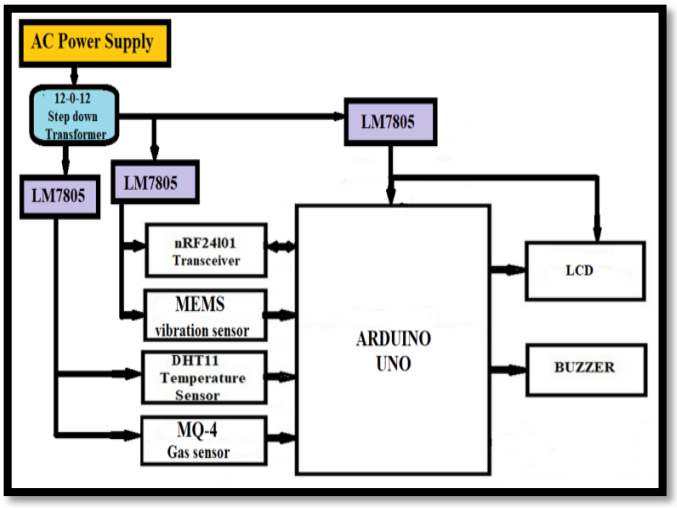


Fig 2: Block Diagram of Coal Mine Unit

Arduino UNO is connected to a 7805 Voltage Regulator, which is connected to a 12-0-12 step down Transformer from the direct AC power supply.

1. MQ-4 Gas sensor is connected to micro-controller in the following way:

- D0 of sensor to D7 of micro-controller
- Vcc of sensor to output pin of Voltage Regulator
- Gnd of sensor to Gnd pin of Voltage Regulator

2. 2.DHT11 Temperature and Humidity sensor is connected to micro-controller in the following way:

- DATA of sensor to D7 of micro-controller
- Vcc of sensor to output pin of Voltage Regulator
- Gnd of sensor to Gnd pin of Voltage Regulator

33. MEMS Vibration sensor is connected to micro-controller in the following way:

- X-out of sensor to A0 of micro-controller
- Y-out of sensor to A1 of micro-controller
- Vcc of sensor to output pin of Voltage Regulator

- Gnd of sensor to Gnd pin of Voltage Regulator

4 4. nRF24L01 Transceiver is connected to micro-controller in the following way:

- TXD of transceiver to TX of micro-controller
- RXD of transceiver to RX of micro-controller
- Vcc of transceiver to output pin of Voltage Regulator
- Gnd of transceiver to Gnd pin of Voltage Regulator

5. LCD is connected to micro-controller in the following way:

- RS of LCD to D12 of micro-controller
- E of LCD to D11 of micro-controller
- D87,D86,D85 and D84 of LCD to D2,D3,D4 and D5 pins of micro-controller

6. Buzzer is connected to micro-controller in the following way:

- Positive terminal of Buzzer to D13 of micro-controller
- Negative of terminal Buzzer to GND of micro-controller

C.CONTROL UNIT:

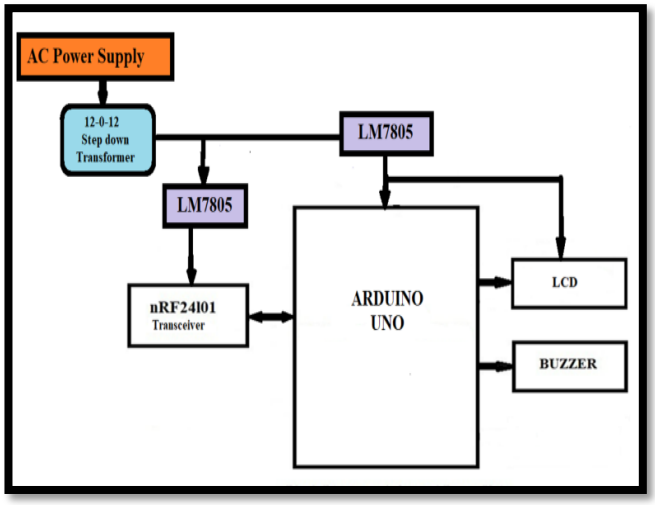


Fig 3: Block Diagram of Control Room Unit

Arduino UNO is connected to a 7805 Voltage Regulator, which is connected to a 12-0-12 step down Transformer from the direct AC power supply.

1. nRF24L01 Transceiver is connected to micro-controller in the following way:

- TXD of transceiver to TX of micro-controller
- RXD of transceiver to RX of micro-controller
- Vcc of transceiver to output pin of Voltage Regulator
- Gnd of transceiver to Gnd pin of Voltage Regulator

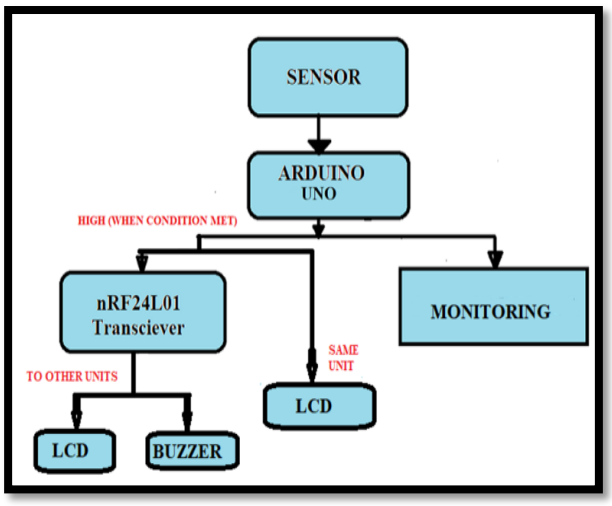
2. LCD is connected to micro-controller in the following way:

- RS of LCD to D12 of micro-controller
- E of LCD to D11 of micro-controller
- D87,D86,D85 and D84 of LCD to D2,D3,D4 and D5 pins of micro-controller

3. Buzzer is connected to micro-controller in the following way:

- Positive terminal of Buzzer to D13 of micro-controller
- Negative of terminal Buzzer to GND of micro-controller

V.DATAFLOW DIAGRAM



VI. WORKING

The Arduino UNO microcontroller can be powered by a 12-0-12 Step down Transformer (since a 5V voltage regulator is present). And other connections are made as given architecture diagram. The Arduino IDE supports Arduino UNO board. The program with corresponding libraries is to be downloaded and some settings like the board used, flash size and upload speed are to be changed accordingly.

The code is written and then uploaded onto the microcontroller. Now, the sensors starts measuring the respective readings and gives it to the microcontroller 60by Arduino UNO using inbuilt (library) code. Then the nRF24L01 module which is connected to the board connects to the Transceiver of another unit with the details provided in the code, using which the microcontroller sends the data on the LCD display.

When the RF Communication system is available, the data measured by the sensors it is fed to the Transceivers. Thus, the data measured at a place by a sensor can be accessed by the user from anywhere.

The LCD and Buzzer are triggered when any of the sensor present in worker unit or Mine unit detects a reading level which is beyond the safer levels i.e, The heartbeat is less than 60BPM or greater than 100BPM, or when the worker uses panic switch, or when the concentration of methane gas is increased or when the Temperature reaches more than 45°C. Then the nRF24L01 module is used to send alerts to the workers and authorities. Based on the alert, the authorities can perform actions such as medicating the worker or rescuing the workers present inside the mine, if there is any dangerous situation in the coalmine, which decreases the number of accidents and deaths in the coal mine.

VII. RESULTS

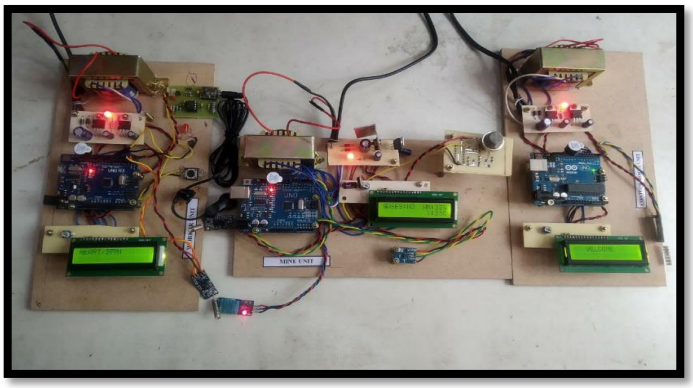


Fig 1: Starting phase of system

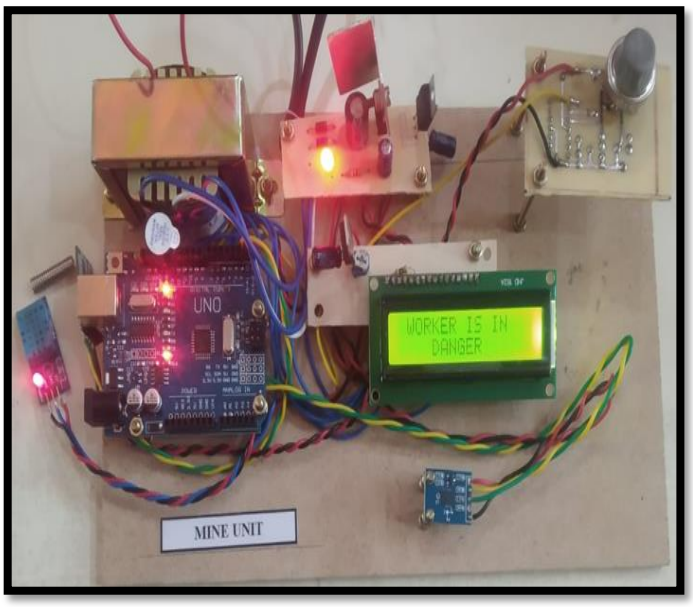


Fig 2: LCD display of Mine unit, when the worker is in danger

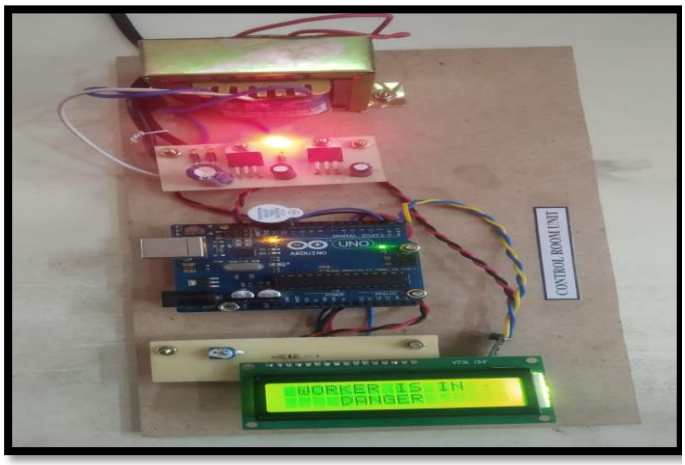


Fig 3: LCD display of Control Room unit, when the worker is in danger

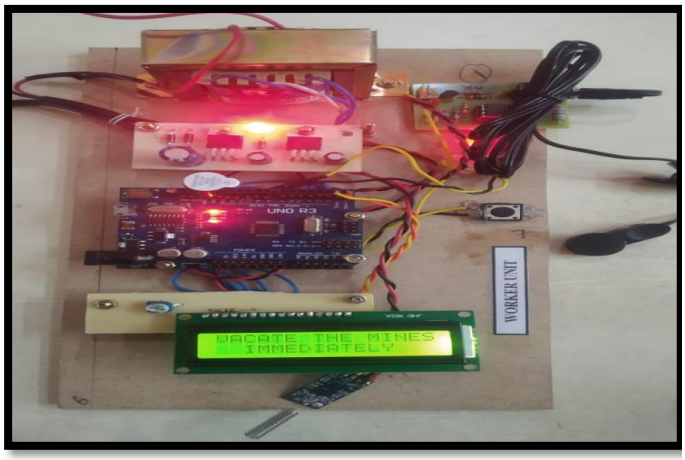


Fig 4: LCD display of Worker unit, due to MQ-4 Gas sensor

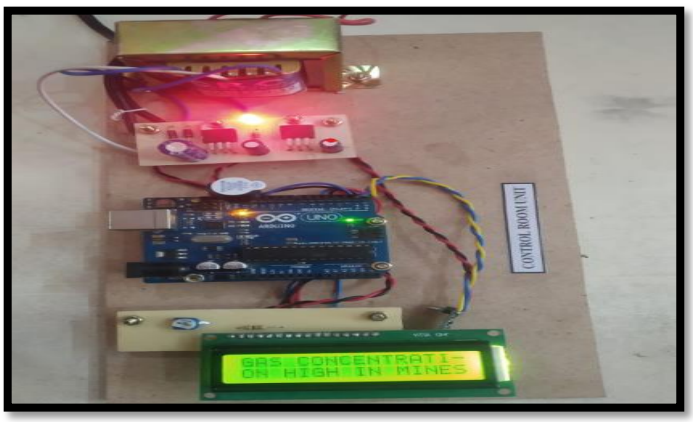


Fig 5: LCD display of Control Room unit, due to MQ-4 Gas sensor

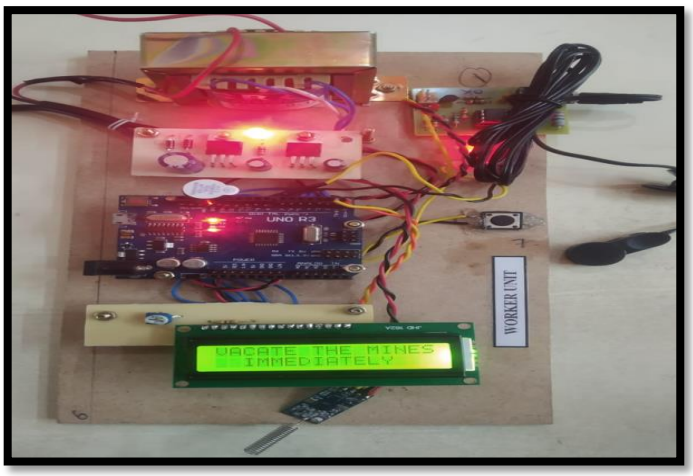


Fig 6: LCD display of Worker unit, due to MEMS sensor

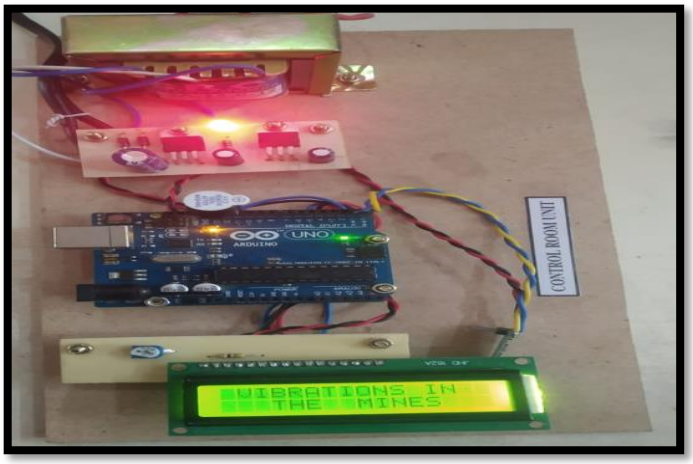


Fig 7: LCD display of Control Room unit, due to MEMS sensor

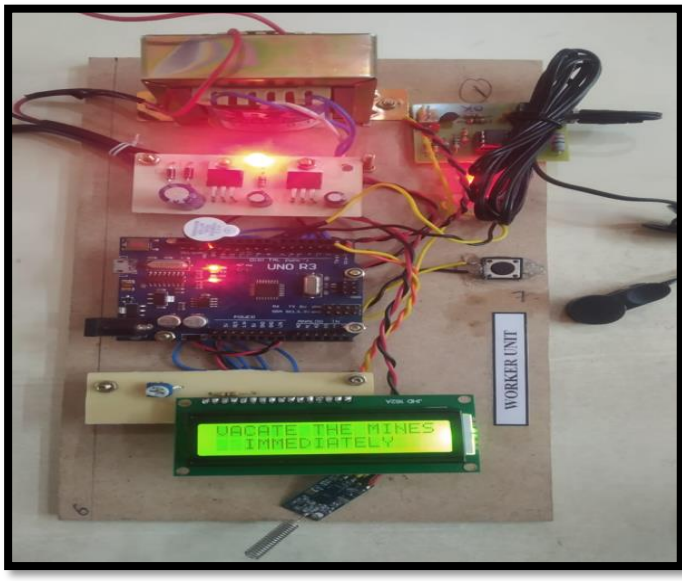


Fig 8: LCD display of Worker unit, due to DHT11 Temperature sensor

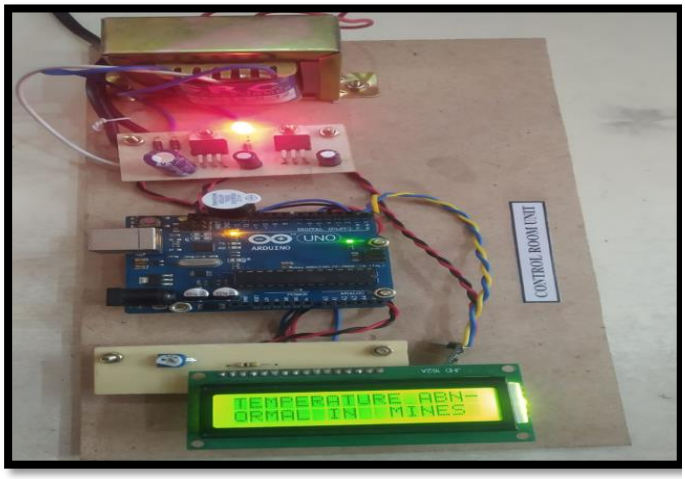


Fig 9: LCD display of Control Room unit, due to DHT11 Temperature sensor

VIII. FUTURE SCOPE

The developments for this future work of this experimentation may incorporate, greater improvements for the framework by utilizing other progressed sensors in order to check the underground Dangers. Likewise, each and every underground tasks could be completed from the beginning. New creation of correspondence advancements could be utilized for fast information with the help of keen sensors for detecting the coal mine conditions. In addition, more IOT empowered features could be added for further development uses.

IX. CONCLUSION

Coal mine security framework is actualized utilizing Gas sensor, Heartbeat sensor, Temperature and Humidity sensor and MEMS sensor to expand the wellbeing of the coal mineshaft representatives and to guard them. The use of IoT in this project allows continuous monitoring of the coalmine and also alerting the workers.

- The designed system not only monitors the conditions of mine but also helps in monitoring the health condition of the workers.
- The designed system sends the alerts to the authorities present in the mine and also in the control room present on the ground.
- The designed system is cost effective
- The designed system provides reliable communication between the mine area and fixed ground using nRF24L01 Transceivers.

Hence the proposed system reduces the death rate and disease alerts for the workers in the mining industry.

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