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UNDERGROUND MINE SAFETY ALERT SYSTEM

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ABSTRACT: - *xu*

1. INTRODUCTION: -

Mining accidents occur when minerals or metals are extracted, resulting in the deaths of tens of thousands of miners each year. Although coal mining is viewed as riskier than hard rock mining due to the unstable rock strata, methane gas availability, and coal powder, accidents can occur in any mining industry. In areas where safety protocols are not properly enforced, most deaths occur in both wealthy and poor countries. The implementation of vision technology has made it possible to prevent accidents and save lives.

It is crucial to monitor factors that could potentially cause accidents in order to ensure the safety of workers. This research presents a device that monitors conditions in coal mines that could endanger human life. Sensors and transmitters are utilized to monitor the mine, and a smart helmet with a panic button is given to each worker to use independently. When a certain value is exceeded, an alert signal is sent to a control room, and immediate action is taken. Failure to carefully control coal mining accidents could lead to a significant number of fatalities.

Coal mining has had a significant impact on the nation's economic and social development over the years. To improve safety, globally recognized academics have conducted extensive research. Human factors were found to be responsible for the majority of coal mining accidents in China, accounting for purposeful violations, poor management, and defective designs. A coal pillar-penetrating synthetic pulse radar instrument was utilized to locate concealed structures or anomalies, and a fibre optic sensor-based mine hazard warning system was created to monitor mine roof integrity and hazardous gases.

In conclusion, the mining industry must take proactive measures to ensure the safety of its workers. The implementation of new technologies, such as sensors and fibre optic sensors, can help prevent accidents and save lives. Additionally, continuous research is necessary to identify and mitigate risks associated with mining activities.

2. EXISTING TECHNIQUE: -

The existing techniques for the communication inside the underground mines. GSM, GPS, RFID, Zigbee, radar sensor networks, and other communication protocols are among them. These techniques are used for the communication inside and outside the underground mines. By integration with other techniques, the efficiency of the selected method can be improved.

GPS SYSTEM

The Global Positioning System (GPS) is the communication system with the largest coverage area, providing crucial positioning information to worldwide commercial users. While the wide coverage area of GPS is advantageous, it is less effective for underground mining, which is a drawback.

GSM TECHNOLOGY

The GSM communication technique is also capable of covering a large area, and it can be used in underground mines. However, a significant drawback of this technique is communication delay, which makes it less effective for critical environments such as underground mines.

RFID TECHNOLOGY

RFID technology is significantly better than IR for locating underground mine workers and locomotive

equipment because it does not require Line-of-Sight communication. Although RFID tracking systems are theoretically sound, a major drawback is the need to maintain RFID tags, which can be a disadvantage.

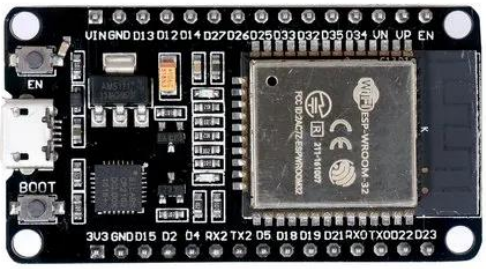
RADAR TECHNOLOGY

Radar sensor technology is more efficient for assessing environmental factors in underground mines, as it is not affected by dust and can penetrate abrasive environments with dust and mist. However, the high cost of the equipment and maintenance is the biggest issue that causes it to lag..

3. SYSTEM HARDWARE: -

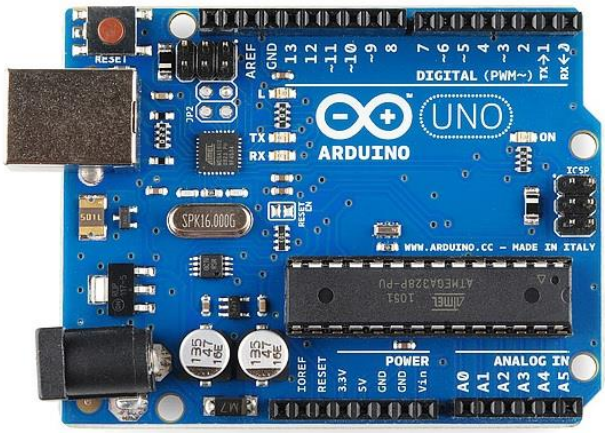
3.1. Nodemcu

Nodemcu is an open-source Lua firmware designed specifically for Internet of Things (IoT) applications. It is powered by the ESP-12E module, which is based on the 32-bit ESP8266 MCU, and features WPA/WP2 compatible 2.4 GHz Wi-Fi. The ESP-12E comes with a 3.3v SMPS unit and a programmer, making it easy to run the board on 5V via USB without the need for an additional programmer.



3.2. Arduino

Arduino is a simple microcontroller-based board that can be programmed using the Arduino Software (IDE), which is a user-friendly programming environment that uses the Wiring programming language. With Arduino, users can easily control a wide range of electronic devices, from motors and LEDs to sensors and displays, by writing and uploading code to the board's microcontroller. The board's simplicity and versatility have made it a popular choice for hobbyists, students, and professionals alike.



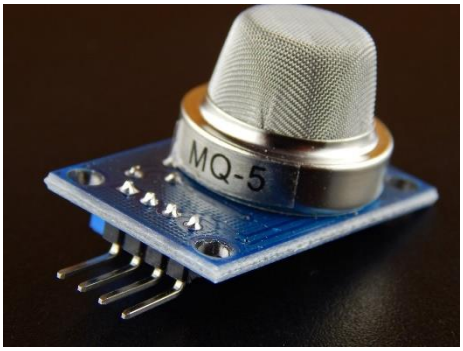
3.3. TFT DISPLAY

A TFT LCD typically consists of several layers, including a backlight, polarizing filter, color filters, glass substrate, and thin-film transistors. The thin-film transistors act as switches for each individual pixel, allowing for precise control of the display. This active matrix design allows for faster refresh rates, higher resolution, and better color accuracy compared to passive matrix displays. TFT LCDs are commonly used in applications such as computer monitors, televisions, smartphones, and digital cameras.



3.4 GAS SENSOR

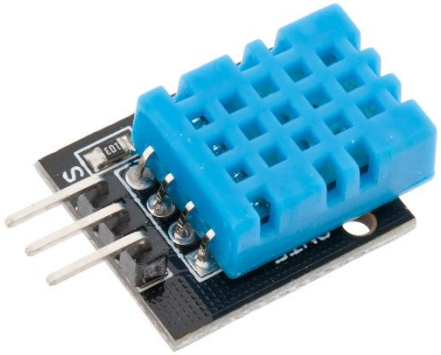
The MQ2 gas sensor is a Metal Oxide Semiconductor (MOS) type gas sensor. It consists of a sensing material that changes its resistance when it comes into contact with the gas. This change in resistance is then measured by a simple voltage divider circuit to determine the gas concentration. The MQ2 gas sensor is widely used for detecting various gases such as LPG, propane, methane, alcohol, smoke, and others.





3.5. DHT-11

The DHT11 is a low-cost digital sensor that is commonly used to measure temperature and humidity in various applications. It is designed to be easy to use and can be interfaced with a wide range of microcontrollers, including Arduino and Raspberry Pi. The sensor consists of a capacitive humidity sensor and a thermistor to measure temperature. It provides digital output for both temperature and humidity, which can be read through a single wire interface. The DHT11 sensor module also includes a pull-up resistor and a power-on LED, making it easy to use and debug.



3.7. MOISTURE SENSOR

Moisture sensors are commonly used in agriculture, gardening, and landscaping to monitor soil moisture levels and ensure that plants receive the appropriate amount of water. They work by measuring the electrical conductivity between two or more probes inserted into the soil, which varies depending on the amount of moisture in the soil. This information can then be used to trigger irrigation systems or alert farmers and gardeners when it's time to water their plants.



3.6. ULTRASONIC SENSOR

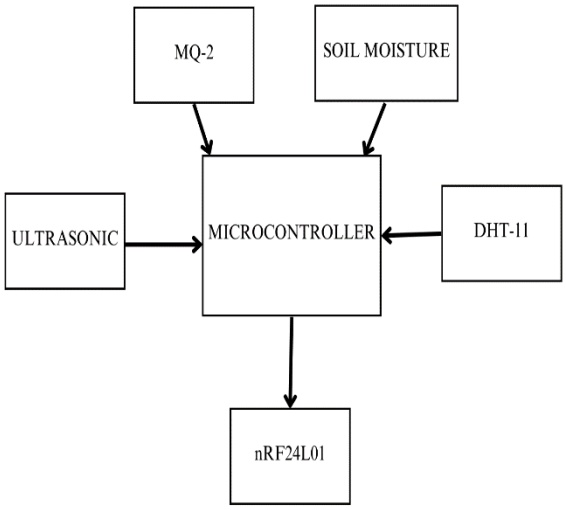
Ultrasonic sensors are widely used in distance measurement applications, as they are reliable, accurate, and relatively inexpensive. They work by emitting a high-frequency sound wave (usually in the range of 40 kHz to 200 kHz) and then measuring the time it takes for the sound wave to bounce back after hitting a nearby object. By knowing the speed of sound in air, the distance to the object can be calculated using the formula: distance = speed of sound x time taken / 2. Ultrasonic sensors are commonly used in robotics, automation, and automotive applications, among others.

4.WORKING OF PROPOSED METHOD: -

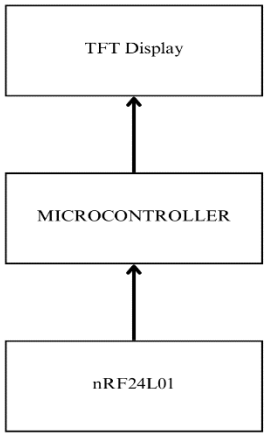
The safety of miners working in underground environments is of utmost importance, and effective sensing systems and localization strategies are necessary to ensure their safety. In order to improve communication in these environments, radio frequency technology has been suggested as a viable solution. To achieve this, a monitoring and warning system has been proposed which utilizes an Arduino Uno and NRF module for data transmission, and includes a range of sensors such as the MQ-2, DTH11 humidity and humidity sensor, ultrasonic sensor, and soil moisture sensor to detect changes in the environment. These sensors will monitor crucial factors such as temperature and gas concentration in real-time, and the data will be

relayed to individual miners via a display equipped with a microcontroller. In addition to this, the control room will receive the data through the NRF module to enable effective and efficient decision-making. The system will be powered by a DC power supply, ensuring that the voltage is supplied continuously to the circuit. This system will enhance the safety of miners and prevent potential risks associated with working in underground environments.

TRANSMITTER

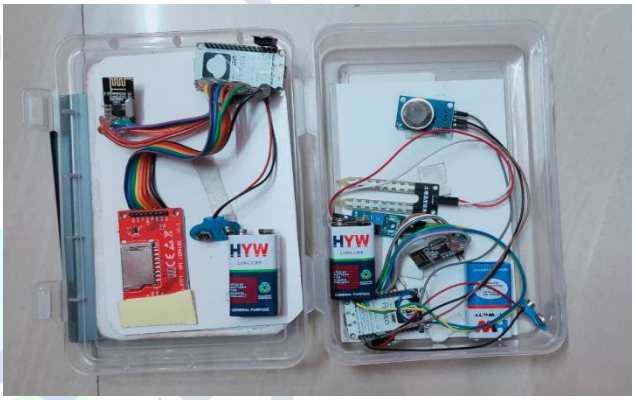


RECEIVER



5. RESULT: -

The real-time monitoring system for mines is implemented to ensure the safety of mine workers. To improve real-time sensing, multiple sensors are employed to measure temperature, humidity, vibration, and light intensity. For measuring air temperature and humidity, thermistor (Rt 60) sensors are used, LDR sensors are used for measuring light intensity, and piezoelectric sensors are used for measuring vibration in underground mines. The values of the sensing elements are transmitted to the control room, where appropriate measures are taken to ensure the safety of the mine workers. Using RSSI data, the location of the workers can be tracked. If the readings of parameters such as temperature and humidity exceed their preset threshold values, a voice alarm system issues a warning. Therefore, this technique can prevent disasters in underground mines worldwide.



6. CONCLUSION: -

Safety has always been a significant concern in the mining industry, especially in underground mining. Despite advancements, accidents continue to occur, with fatalities being a common occurrence. The issue is not limited to a specific region; for example, Chinese miners experience 5,000 deaths annually due to mining accidents. The availability of safety equipment is vast; however, our prototype has a distinct advantage as it allows for constant worker monitoring in mines. The device tracks environmental fluctuations and triggers appropriate safety measures while providing location data to the rescue team. Future implementations of the control room module could expand its functionality. Additionally, adding more sensors could further enhance the smart helmet's safety capabilities. RF technology is an affordable communication method and can be the saviour of underground miners worldwide. Two recent examples of fatal accidents in the mining industry are the 2009 Heilongjiang mine explosion in China and the 2010 Upper Big Branch Mine catastrophe in the United States.

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