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Arduino Based Coal Mine Safety Monitoring and Alerting System for Workers

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ABSTRACT: Coal is a major element for development, an important energy source for power generation, and it is an essential part of the manufacturing of alumina, iron, steel, cement, and other resource products necessary for modern living. The extraction of coal from the field is known as coal mining. Safety and security are critical components in the mining sector. Even they take certain precautions to avoid accidents in the underground mines. Still, accidents continue to occur in underground mines, resulting in a greater number of disasters. Temperature, gas, fire, and water are the key elements involved in many accidents. This project monitors these parameters using Arduino UNO and provides safety and alert for coal mine workers to minimize the accidents. To improve underground mine safety, a reliable communication system must be built between underground mine workers and a fixed ground system. The communication network must not be interrupted at any time or under any circumstances. A buzzer is used for alerting the mine workers. Using IoT and Buzzers, this system alerts the admin as well as the workers when any abnormalities are found inside the coal mine.

KEYWORDS: Arduino UNO, Coal mine, Monitoring, Alerting

I. INTRODUCTION

The process of Underground mining operation through human laborers is a highly unsafe scenario where the risks increase with the increase in distance from the ground. The mining operations with unsafe manners are due to different methodologies utilized by the miners for extricating diverse minerals. The longer the mine, the more prominent is the hazard. The safety measures execution is very poor, especially in the coal mine industries. Coal is an essential resource to every nation as it has many commercial applications. The most integral employments of coal are in the production of thermal power, cement, and steel production and as a fuel for numerous applications.

The coal mines have numerous risky stipulations that include high temperature and humidity, and discharge of destructive gases that make unsafe surroundings for specialists working there. Many employees are taking off their occupations in coal mines or are no longer at all inclined to pick such employments as mining. This creates a lot of challenges in the accessibility of employees for the coal mining industry. The security of laborers working in coal mine industries is increasing day by day through technologies. The progressive innovation that enables the mine monitoring methods to become more sophisticated, however, explosions in underground coal mines still happen. The accidents of calamities in coal mines are mainly due to the harsh environments and unsafe working conditions. This makes the need of employing mine checking systems at a high level for coal mines. It is quite hard to analyse all the environmental conditions constantly in a coal mine manually.

A wireless sensor network for coal mining safety systems. In this wireless sensor networks application system, there will be controllers. The controllers will detect the danger and give an alert through RF to the controller and it will raise the alarm in all tunnels and also raise a message on IoT, which will help to take action as soon as

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possible. This monitoring and alerting system are powered by an Arduino UNO (Atmega328) microcontroller. This microcontroller controls various sensors like temperature sensor, water sensor, gas sensor and fire sensor, and RF transmitter which collects temperature, humidity, fire, and gas values underground of a coal mine. The values taken from the sensors are continuously monitored by the Arduino UNO (Atmega328) microcontroller and alert the mineworkers using Buzzers, by displaying on the LCD Screen, and also monitored by the Thing view app by controlling using the IoT module.

II. LITERATURE SURVEY

As the administrators of the Coal Mine Monitoring section, Yongping Wu and Guo Feng make use of A Bluetooth wireless transmission device that has been implemented in coal mine monitoring to greatly expand the scope of the technology. Currently, the industry believes that to control costs and provide a standard in the short-range wireless networking market, Bluetooth is supposed to implement a powerful kit gap scheme, and it is also expected to provide a minimum power demand for low-cost, low-power air interfaces. This paper describes the context of the situation, as well as different technical choices, as well as the architecture of the protocol stack of Bluetooth technology. Also, the paper goes into possible solutions for the Bluetooth HCI wireless networking, which is a necessary component in the development of this technology [2]. Also at the same moment, the system has completed the integration of wired and wireless information transfer. This use of the new technologies, known as the "Wired Bus," is being employed. The problems that come along with this strategy include the main ones. For one, Bluetooth is a short-range wireless system. Even though it's difficult to work in the mine due to the abrasive environment, it is even more difficult to install and maintain the wired communication system.

The DCS Coal Mine Monitoring System was developed by Zhenzhen Sun. A computerized bus that runs on the same lines as RS485 uses a bus structure that supports multipoint and two-way communication. So, the design of such a watching device will be done using commonly available 8-bit microcontrollers. With a circuit structure that is both simple and inexpensive, you enjoy the advantages of inexpensive circuit design. Thus, on the contrary, due to the use of a master-slave network arrangement, it is almost impossible to ensure the liability of the network structure. In addition, the amount of information that can be transmitted over a line with a subpar real-time output is also limited [3-4].

The JINGLING SONG and YINGLI ZHU's design of an automated mine safety monitoring device assisted by a wireless sensing element network. MSP430F and nRF2401 have been implemented in the process design to watch for underground mine protection. Sensor teams in the device intensively track temperature, humidity, and various parameters in the underground mine. Temperature, humidity, and various parameters are monitored by sensors and sent to a wireless communication module by the microcontroller. That information is sent via cable to the far-off location where it is watched by the observers [5]. The problem with this implementation is that hardware is installed in the coal mines when disasters or roof collapses occur, and once the damage has occurred, it's impossible to repair the device. The other drawback is that the working state of the coal pit is extremely shaky, and if the gap between the manual labourer and the system is long, the miner will not receive the correct instructions.

III. IMPLEMENTATION

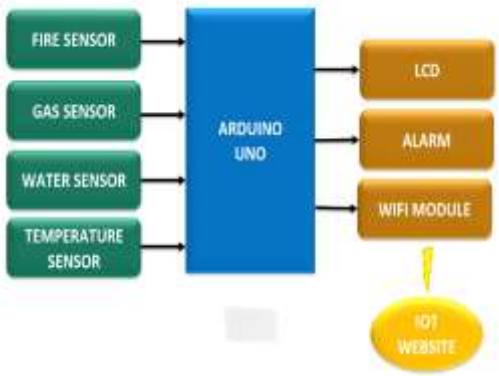

Figure 1: Block Diagram

IoT Based Coal Mine Safety Monitoring and Alerting System project consists the sensors like temperature sensor, water sensor, fire sensor, and gas sensor. The module also has an LCD, all the sensor data is displayed on the LCD screen by the Arduino controller.

In the proposed system the main controller in the module is an Arduino board. The module is installed inside the coal mine. The module contains the sensors like temperature sensor, water sensor, fire sensor, and gas sensor. The module also has an LCD, all the sensor data is displayed on the LCD screen by the Arduino controller. The Arduino also sends the sensor data to the remote IoT server using the Wi-Fi module from time to time. If any of the

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sensor values exceeds a particular threshold level, the buzzer is turned on to notify the concerned officer. The system has an IoT platform installed on it that displays the relevant data using the GUI which helps the users in monitoring and system control. The proposed system as shown in the Fig.

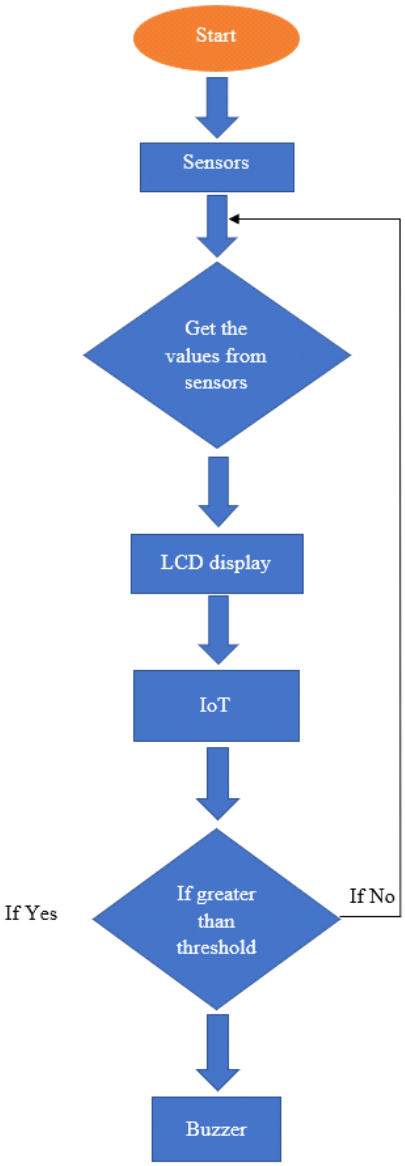

Figure 2: Flowchart Diagram

From the above graph, it is seen that whenever the parameters exceed the threshold limit i.e., then the designed system will show the alert message on the lcd display and a buzzer will sound. Also, the IoT website gives this information to distant people hence it helps to prevent hazards.

IV. RESULTS

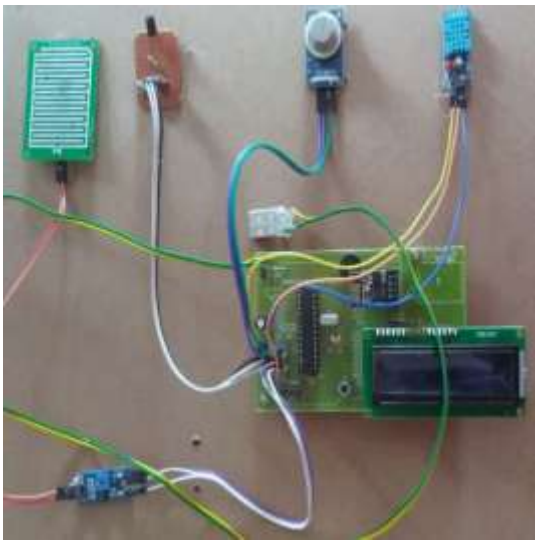

Figure 3: System Model

The design of hardware components are done and processed by Arduino UNO. The software implementation is by Arduino IDE tool. Here are the figures of the results.

Figure 4: System Readings

V. CONCLUSION & FUTURE SCOPE

5.1 Conclusion

This system consists of various sensors to monitor the safety while operating in coal mines. This system consists of devices that monitor the conditions such as temperature, humidity, water, fire and gas inside the coal mine and alerts the workers. It also has applications to view the readings remotely. This system is wireless hence it has the advantages that wireless systems have such as being economical and having low maintenance.

5.2 Future Scope

Future work of this research includes additional enhancement of the framework by employing different advanced sensors for analysing the underground mines. New developing connectivity improvements can be used for quick

information transfer in combination with acute sensors for identifying mining conditions. Additionally, new IoT-enabled frameworks might be built for more application areas.

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