IoT based Underground Coalmine Safety System

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Abstract. Safety of a person is primary concern in any industry especially in underground coal mining industry. Underground communication is necessary to monitor underground environmental and health parameter and take necessary actions accordingly to avoid any types of hazard. The application designs a warning system for coalmine safety based on IOT. The underground system determines environment and health condition of workers. This system observes the environmental parameters such as gas and vibrations and the health parameters such as heart rate, temperature. The collected information is send to the processor to save them and for remote users to inquire.

1. Introduction

Mining is defined as the process of obtaining coal or other minerals from a mine. The activities carried out in order to obtain these minerals have a threat to them. The average mine worker is exposed to the rough underground environment which can sometimes experience an injury or cause loss of life. A portion of these fatalities can be accredited to human error. However, there are situations that are ordered by the ambient conditions underground that can be blamed for these accidents. These conditions are onerous to monitor without placing someone’s life at risk. The older methods of mine condition monitoring involves a person to go down and report back. This method is however dangerous because a person who is monitoring a specific dynamite could be injured by that very same hazard. Coal mining assumes crucial part in the vast majority to meet the vitality requests. Be that as it may, a similar mining industry is encountering numerous issues which primarily incorporate the excavator’s wellbeing. Particularly, the underground mine condition is exceptionally mind boggling. The emanations of harmful gases like methane and carbon monoxide dependably happen in coal mine. The convergence of these gases above security limit level makes chance about digger’s wellbeing and life. Subsequently a perpetual checking of such esteems is vital.

The peculiar natural parameters of mine framework, for example, methane, carbon monoxide, temperature, oxygen etcetera, are right now employing the customary link transmission. Therefore methane, carbon monoxide gas gathering zone monetarized mining face, for example, the dead link security parameters cannot be checked and cannot forecast the caution. Mining pursuit movement is answerable to high dangers due to its size, vulnerability, unpredictability, high expenses and excavator’s wellbeing. The clearance of lethal gases from the coal crease thus prompts air contamination in mine territory. It extremely influences excavator’s wellbeing. The more heartfelt a mine is, the more terrible and more hazardous digger’s work and costly excavator’s work is. The high temperature of the earth’s middle raises the temperature of the underground mine and it will be difficult to work. [6]
There are mainly two methods for extorting the coal from earth-surface mine and underground mine. Most of the surface mines are open-pit or open-cast mine. The surface mine are entirely open and regulated from the surface of the earth. The advantages of surface mines are increasing productivity, low operating cost and good safety condition. [3-5] Most of the coal is extracted using surface model.

In case coal is very deep surface underground method is used. The underground mines are sustained or unsupported mines. In supported method artificial pillars are used for support of the opening. Sustained mining methods are often used in mines with weak rock structure. The artificial supports are not available for unsupported mining method. Unsupported methods are used in those areas where strong rock structure are available. Underground coal mining involves a high risk than surface mining due to the problems of airing and potential for collapse. The maximum accident occurs in underground mines

2. Related Works
In coal mines, the eloquent emergence is of methane. The methane discharged amidst and in the wake of mining operations is called Coal mine methane (CMM). Later, there have been numerous mortalities in underground coal mine blasts in which methane was a contributing element. Additionally methane is 21 times more intense for ozone depleting substance outflows. The centralization of methane if went through a range in the proximity of 5% and 15%, it might prompt blast. This scope of methane is known as the savage range. Methane can be touched off effectually in this range with the approach of a start source to make a vicious methane blast that may spread within the sight of flammable coal clean. Further, seizing this gas won't just diminish ozone depleting substance discharges, however can be utilized as extra vitality source in not so distant future that generally will be lost.

“Zigbee Based Underground Mines Parameter Monitoring System for Rescue and Protection”. This Project is based on continuous tracking of underground coal mines parameter such as carbon monoxide, temperature, water level and use wireless Zigbee technology for technology for communication. [2] A microcontroller stationed system is used for collecting and storing data using corresponding sensors and making decision accordingly, based on which the mine worker is illuminated through different alarm tone as well as LED display system. The communication system is reliable based on Zigbee, IEEE 802.15.4 standard.

This is used for transmission between the hardware circuit fitted in the local site and the remote monitoring site through routers. The system is highly beneficial for salvage and protection of miners.
“Zigbee based intelligent helmet for coal miners”. The aim of the project is to design a wireless helmet for coal miners using Zigbee wireless technology. The system is a value powerful Zigbee-primarily based wireless mine supervising system.

This system has been successfully tested and has shown quick response to the hazardous parameters variation. We can show that this system will greatly help in reducing future casualties caused by sudden changes in these parameters and help make the work safer. The compact and efficient design ensures the practical implementation of the system. The system was tested for following predetermined range. However, depending on the environment of various coal mines, it can be changed according to the requirements using easy software editing.

3. Framework methodology

This proposed underground coalmine safety system using IoT. The designed systems are deposited in different parts of the mine. The sensors sense the environment and health conditions such as temperature, heart rate, vibration, gas etc., and this information is send to the microcontroller and it displays in the LCD. The controller sends the information to control system via IOT and control system sends alert to mine work area when sensors exceeds the threshold level. This system concentrates in monitoring the parameters checking which will be helpful in saving one’s life and this information is sent to the IOT server for first aid.

4. System Requirements

**Software Used**
- OS: Windows 7,8,10
- TOOL: Arduino IDE

**Hardware Used**
- Temperature Sensor
5. Framework methodology

The designed systems are situated in different parts of the mine. The sensors will perceive the environment conditions such as temperature, vibration, gas etc., and this information is dispatched to the microcontroller and it displays in the LCD. The controller sends the information to Node MCU and modem sends the information to server when sensors exceeds the threshold level. In the control block diagram unit all the main data processing are carried out. We use four sensors, Temperature sensor, Gas sensor, Heart beat sensor, vibration sensor. The temperature sensor used in this system is LM35 which continuously scans the environmental temperature. The graphical representation of this data is shown on the server with date and time. The gases present in coal mine environment are harmful and may cause consequential issues to the health of the worker when reached further the safety value. The gas sensors used here is the MQ2 sensor which is used to estimate the methane and CO content in the environment. The heart rate sensor is used to continuously compute the activity of the heart. A Graph is plotted in accordance with the sensed data. The data sensed by the sensor is processed and then send to the web server through the Wi-Fi link module. At the monitor unit the think speak application is installed onto the PC/mobile and here we can see the real time plots of each sensor. [1]

6. Working

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7. Result

This system contains temperature sensor, gas sensor, vibration sensor, node MCU, LCD display and microcontroller. We transmit the data using program prepared in Embedded C through serial port. This serial port is connected to sensor network. On the receiver side, same data is transferred through node MCU. Whenever sensor receives data, on the LCD screen it is shown to view. After the microcontroller reads the data it transmits to the modem.
8. Conclusion
In our project, as we are hoarding the values of the parameters in the processor, the stored values can be used to detect the hazards and to analyze the health condition of the mine workers. As we are passing the information to the personnel regarding the measures to be taken in case of a hazard, it will be useful for them to save their life and prevent from the environmental accident zone. At the monitor unit the think speak application is installed onto the PC/mobile and here we can see the real time plots of each sensor. The think-speak application is very easy to use, you need to just enter the channel ID and here you get your plots with the date and time information.

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