Alert And Protection In Underground Coal Mines Using Wireless Sensor Network

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ABSTRACT

The basic urgency of a better alert system in the coal mines comes with the rate of accidents that has increased in the past few decades. Security has always been an issue in such an obscure working conditions not only for the miners but for the heavy machines that are been used in the coal mines. The major reasons behind accidents and disasters found were firedamp and dust explosions, rise in temperature, mine fires, failures related to transport and mechanization. Wired technology is one such solution but even it has many disadvantages hence there is a need to develop a system which not only overcome the disadvantages of wired security system but highly ensures the security of the miners at the time of emergency through proper communication. This paper proposes a solution to many problems by using wireless Zigbee module, PIC IC 18F2520 microcontroller, and solar energy as power source. The communication between the master module in the mine and the operator who is checking the environmental parameters is done through Zigbee protocol.

1. INTRODUCTION

Coal mining is the process of extracting or taking out coal form deep down the earth surface. Underground coal mining is one of the important method of extracting coal from the ground. Majority coal production in world, around 60% of production is yield by underground coal mining.

Extraction of coal from deep seated coals has been very dangerous activity due to difficult geomining conditions of the coal deposits and cause damages in very high scale. Extraction of coals needs highly mechanized technologies. The adoption of these technologies may play a role of difficulties and challenges.

There were many accidents occurred in recent years, this include the 2007 disaster in Utah's Crandall Canyon Mine, United State where six miners were trap and more than 10 were killed. The Sago Mine disaster of 2006 is one of the worst coal mining accidents.

However, in some developing countries and in lesser developed countries, many hazards were happened leading death of miners continue ,either through direct accidents in coal mines or through adverse health consequences from working under poor conditions.

The major reasons behind these accidents are from improperly used of tools or malfunction of machines due to methane gas can be released, leading dust and gas explosion. Rise in temperature and humidity under coal mines increases the miners body temperature gradually turned into death.

So the underground coal miner safety is very important factor to be consider. For this proper enhancement and improvements is needed to overcome from these problems for sustainable underground extraction of coal.

This paper briefly discusses some of the solutions of problems like rise in temperature and humidity, gas and dust explosions by using wireless sensor network and alert system.

2. LITERATURE SURVEY

Mining has always been a very dangerous and life threatening task which can cause many casualties of human life as well as severe damage of infrastructure.([1])Alert and protection in underground coal mines using wireless sensor

network are one of the futuristic systems, hence is developed on wide scope. We do the effective system using Zigbee, smoke sensor,dust sensor and spray pump. If we think more in the miners prospective, this tool is very well designed by taking the count of dangerous and hazardous condition inside the underground mining. ([2])Time is the valuable thing right now, is pointlessly squandered in mining mishaps due to lack of alerting and security system, especially while blasting a site hence there is the need for some work in repairing this.In order to solve this problem and make the living condition inside the mine bearable we have introduced a system which will alert the operator who is operating and monitoring the mine above the underground mine in base station so that he can take proper safety measurement in order to save as many life as possible . ([3])When we talk about the death troll with the benefits of this system the death troll due to mining accident will surely decrease, our system majorly focuses on the temperature,humidity,dust,hazardous fumes from gases inside the mine.Our system constantly monitors these parameters and if something goes wrong it immediately set up the alarm..Talking about the spending limit, the cost in our grasp, is the essential thing for unraveling the troubles looked during mining. This mining security framework innovation depends on step insightful procedure.Firstly, it monitors the parameters which are required for sensors and then if the value exceeds the threshold it takes the required safety measures.([4])Further optimization in our system is that in order to save power a make our system power efficient we have used solar panels which will save the power cost. The solar panels will be charge during the day by the night they will be used as power supply. ([5])As our system mainly focuses about the safety of miner dust is an important and major concern for miner throughout the years this factor is mainly neglected hence we have introduced a spaying system in our project when the dust ratio in mine will increase the normal level the sprayer will automatically turn on and this will decrease the dust ratio and increase the visibility level.

3. CIRCUIT DIAGRAM

Functional circuit diagram of the proposed system is shown below. This circuit diagram contains PIC microcontroller, buzzer, driver IC and LCD display. The commanding microcontroller manages all the peripheral operations in the circuit , where input is given from solar panel. Microcontroller will perform work like monitoring data and display that on LCD. The circuit diagram is given below in fig 1.
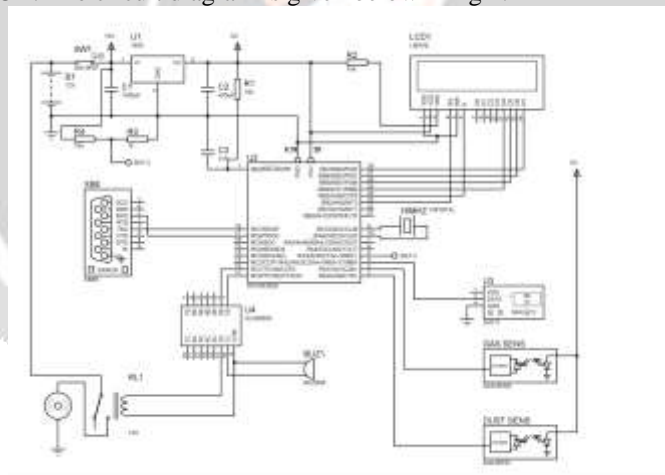
Fig -1 circuit diagram of the module

4. COMPONENTS USED

4.1 Microcontroller (PIC IC 18F2520)
The whole module works on the PIC IC18f2520. Every component on the circuit is connected to the pic ic which controls the mechanism of the devices and give the required analyzed output. The pic ic 18F2520 basically belong to the family of 'PIC18F' microcontroller. This family have high performance that is, it is used to carry out a number of tasks at a time.

4.2 Voltage regulator(IC 7805)

The PIC IC needs 5 V supply for operation, hence a voltage regulator ic7805 is used in the circuit. The IC 7805 restricts the level of output to 5V for any input values greater than 5v. It belongs to the series of 78XX voltage regulators.This ic also provides 5V supply to other devices like temperature sensor ,gas sensor ,dust sensor and LCD.

4.3 Driver IC

The ULN2003A , also called as driver IC ,is known for its high current and high voltage capacity.This IC is used mostly in driver circuits for LED display ,relays,stepper motor,etc.Since, relay is used in the module it is necessary to use ULN2003A

4.4 Solar panel

Solar panel is an assembly of photo-voltaic solar cells. The solar panel absorbs sunlight as the source of input and generates the required DC current .The solar panel gives the output of 12V which will be supplied to voltage regulator IC. The solar panel acts as a main source of power in the module.

4.5 ZigBee protocol

ZIGBEE is a communication protocol that is used to create personal area networks. It is an IEEE 802.15.4 based specification which uses small, low power and low data rate.The data from the pic ic will be transmitted through the ZigBee module to the control room. Also if any mishap occurs in the mine, a message will be sent to the authorities.

4.6 Relay

Relay is a switch which is electrically operated. The relay is used to drive the water sprayer in case the amount of dust increases in the environment.The relay is operated by the ULN2003A IC.

4.7 Sensors

Sensors like temperature & humidity ,dust and gas is used in the circuit.The temperature sensor (DHT-11) is used to sense the change in the temperature of the mine. The gas sensor will sense the level of concentration of methane in the environment. The dust sensor is used to detect the amount of dust present in the atmosphere. The output of these sensors will be transmitted to the pic ic for analysis.

4.8 LCD

LCD stands for liquid crystal display. It is used to display the output of the sensed level of temperature,gas and dust present in the mine. In this project LM01L which gives 16x2 display capacity.

4.9 Servo motor

The module consists of a servomotor to spray water incase the dust concentration increases in the atmosphere in the mine. The servo motor is a rotary actuator which provides precise control of linear or angular position, velocity and acceleration.

5. FLOWCHART AND METHODOLOGY
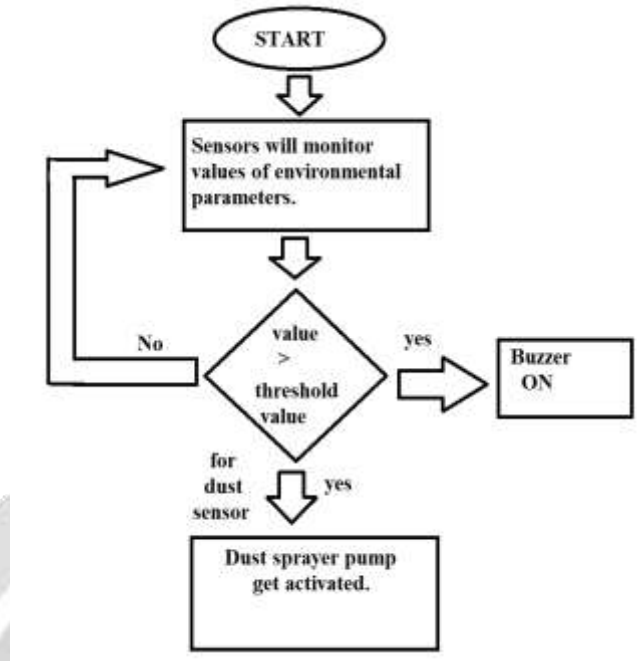
5.1 Flowchart

Fig 2. flowchart of the module

5.2 Methodology

Coal mines are very deep below the ground level. So the issue of electric power supply may take place. So to overcome this problem, power supply to the system is given by the solar panel. During the day time solar panel will charge the battery. Thus PIC microcontroller which have 28 pins will get continuous power supply. This microcontroller is programmable which can be programmed as per our requirement.

Sensors which are connected in the module that is temperature-humidity sensor, gas sensor, dust sensor will monitor the concentration of respective parameter in the underground coal mines. Recorded values of environmental parameters will get displayed on 16*2 LCD display which is programmable. If the concentration of any of the above parameter rises above threshold value then, the alert will be given through the buzzer. 16*2 LCD will also show the parameter whose concentration is increasing in underground coal mine above threshold value.

In case of dust sensor and temperature sensor, when the concentration of dust or temperature increases in the environment of underground coal mine, the buzzer will get activated and immediately spray pump will start working. Dust sprayer is connected in the module through wired connection. Spray pump is connected to the driver IC via relay. Relay acts as a switch. On the basis of monitored value of dust sensor and temperature sensor, microcontroller will instruct whether to act as open circuit or close circuit. Dust sprayer will settle down the dust in the coal mine. If value of temperature sensor crosses threshold value spray pump get activated because, if temperature in underground coal mine rises then it may catch fire. Therefore water sprayer is used.So that it will act as extinguisher. For the safety purpose message will be sent using WSN(Wireless Sensor Network) means using ZIGBEE module.

6. FUTURE SCOPE AND SUGGESTIONS

6.1 Suggestion 1

We can add more parameter such as using RFID stickers in mining vehicles so if they come to close to each other at a point in which accident can happen in that case the buzzer will buzz and alert the driver.

6.2 Suggestion 2

Instead to water we can also use AggreBind is water based cross linking styrene acrylic environment friendly polymer for dust suppression because it has excellent property to bind with dust particles which will help in dust

7. ADVANTAGES

As we know that coal is one of the most used non-renewable natural resource in Indian subcontinent. According to a survey which was conducted in 2016-2017 by Indian energy book the coal consumption of India is Electricity-59%,Iron& Steel- 7%,Cement- 4%,Others- 10%,Non-elect- 20% .To make sure the supply meets this demand India has to produce sufficient amount of coal but security is one of the main concern regarding individuals who are working in coal mines. Below are the advantages of the security system due to which the loss of life will reduce during mining accidents.

1. The wireless nature of the system make it more handy and portable also make it suitable in case of mining accidents.

2. Zigbee used in this system covers longer distance than Wi-Fi which was used in earlier system. It covers 10-100m range. Zigbee is more cost efficient as compare to Wi-Fi and Bluetooth.

3. The temperature and humidity sensor keeps the supervisor aware of the environmental condition inside.

4. The dust sensor has the advantage to sense the dust level higher than the threshold.

5. The sprayer will help to lower the dust level in order to make the environment inside the coal mine humane.

6. The buzzer will alert the mine work so they can immediately vacant the mine in case any mishap happens.

8.DISADVANTAGES

Because of the wired framework the network become more complex. At this point when any fire mishaps happen there,there might be an opportunity of catching fire in fiber wires. We don't have coherence in getting the data in such cases also importantly we don't even have direct contact to the base station. Inside mines because of inhumane and unpredictable circumstance the establishment cost for wired correspondence is also higher. Presently we propose a wireless framework for coal mines to refresh the circumstance present from underground coal mines to ground station quickly by sending the data on the coal mineshaft application.

9. CONCLUSIONS

In this paper we proposed a solution by providing an alert system in which an operator above the mine can monitor the parameters such as gas, temperature, dust and humidity. If any of the parameters increased above their threshold values, a message will be sent to the operator. In case of emergency a buzzer will be on to make the miners alert about the change in parameters. The entire communication is done with the help of Zigbee module which is IEEE 802.15.4 standard giving optimum connectivity of network as well as power. We also provided an alternative of power source that is solar panel which will charge the battery in day time and that battery can be used at night, thus providing a renewable way. Hence in such a restricted environment scenario where issue of miner's safety is limited we tried to provide an alert system that will solve this problem.

10. ACKNOWLEDGEMENT

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