

Rescue and Protection in Underground Coal Mines Using Wireless Sensor Network

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ABSTRACT: The propose coal mine safety system using wireless sensor network replaces traditional coal mine safety which is wired system. This monitoring system is based on Wireless Sensor Network using ZIGBEE. So there is important development in coal mine safety production which is safe. Apart from this it is unsuitable to lay the cables which is costly and consumes more time. To solve this problem there is need to design and develop a Coal Mine Safety System using WSN. In this project there are two sections. The first section is underground section and second is ground section. In underground section the sensor senses the environmental parameters such a temperature, humidity, gas, vibration etc. This information is send to the controller. The controller output is then send to the ground section. For the communication between underground section and ground section we used WSN which is Zigbee. Ground section consists of server consisting of graphical user interface (GUI) which is created by NeatBeans platform using Java programming. Camera also attached to the server which scans the surrounding.

KEYWORDS: Wireless sensor Network, Zigbee, LPC2148.

I. INTRODUCTION

In the last few years for almost every country has one aspect that is environmental care. In last decades, without any control, accidents in industries have been increasing. So current situation in industries is more hazardous. Recently, for monitoring and control of environmental parameter in hazardous environment, modern industries require instrumentation. Because human safety and property losses are important to maintain in industrial environment.

In coal mines, whenever explosions occur, the rescue work is done by rescue worker without any prior knowledge of the environmental condition inside coal mines because mine monitoring system may be destroyed or damaged. This makes the life of rescue workers very risky. Coal mine accidents are unpredictable, due to number of factor this accidents are occur. Because of this accidents the human live is in danger. Coal mine monitoring system is wired system then the arrangement of the system become complex. When any type accidents occur we have a chance of breakages in fibers. We do not have continuously getting the information in such cases. We will not have direct contact to the Ground section. Inside mines due to uncomfortable situation the installation cost as well as maintenance cost is high for wired communication networks.

Wireless Sensor Network

Number of sensor connects to controllers and processing stations directly. An increasing number of sensors communicate with each other and share the collected data wirelessly to a processing station which is centralized. This is very much important because many network applications consist of hundreds or more number of sensor nodes, often established in remote area and inaccessible areas. Therefore, a wireless sensor has sensing component, on-board processing, communication, and storage capabilities. With these enhancements, a sensor node is responsible for data collection, network analysis, correlation. When number of sensors collectively monitors physical parameters, they create a wireless sensor network (WSN). Sensor nodes are communicate with each other and sensor node communicate with a base station using their wireless radios, allowing them to send their sensor data to remote processing, visualization, analysis, and storage systems. Figure shows two sensor fields monitoring two different geographic regions and connecting to the Internet using their base stations.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 9, September 2015

The capabilities of sensor nodes in a WSN differ in their communication capabilities, for example, using ultrasound, infrared, or radio frequency technologies with varying data rates and latencies. While simple sensors may only collect and communicate information about the observed environment, more powerful devices may also perform extensive processing and aggregation functions.

II. AIM OF PROJECT

1. A zigbee network controlled automatic system has been developed for assisting the rescue workers.
2. A coal mine system which replaces the traditional coal mine monitoring system which tend to be wired network system.
3. The underground system also collects temperature, humidity of coal mine through sensor nodes in mine.
4. To check the presence of methane gas inside the mine.
5. To save the life of worker who may die by numerous precaution taking place inside the mine.
6. To provide whole interconnection, wirelessly using different topology.

III. REVIEW OF LITERATURE

In the hazardous environment, dangerous accident occurs. Due to which consequence may be very serious and it causes loss of environment, industry and property and life of humans. For this various reasons hazardous environmental safety & security is more important. wireless sensor network in industrial site, the deployment of distributed point source where the dangerous parameters used, produced and stored is described seven characteristics, fundamental aspects for estimating and emission method were identified [1]. For measurement of temperature using Virtual Instrumentation is by Automatic Process Control in many industries [2]. This paper shows agricultural environment monitoring system for monitoring information related to the outdoors production of agriculture environment using WSN technology [3].

This research shows survey study of need related with long term stewardship & environment monitoring [4]. The aim of this paper is consideration of design for monitoring of the detection of hazardous parameter using system on chip [5]. In the wireless communication during emergencies is important for survival for example during accident traditional wired communication system is not reliable which needed wireless radio system [6].

The field of electronics gives a very good performance and this is realized using zigbee technology guided by 802.15.4 PAN. WSN replaces existing non standard technologies. The Zigbee operates in 868MHz band at a data rate of 20kbps in Europe, 2.4GHz ISM band worldwide at a 250kbps, 914MHz band at 40Kbps in USA.

IV. SYSTEM OVERVIEW

The proposed system consists of two sections as a discussed earlier one is Underground Section and Ground Section. The block diagram of Underground section is shown above which consist of Sensor section consisting of Temperature sensor that is Thermistor, Humidity sensor, Gas Sensor, Vibration sensor. And Controller is also used for controlling purpose. It consists of Device driver and Zigbee transmitter.

The Underground section consists of Zigbee Receiver, PC, camera attached to PC, and Android Phone. Brief description of each block is given below.

International Journal of Innovative Research in Science, Engineering and Technology

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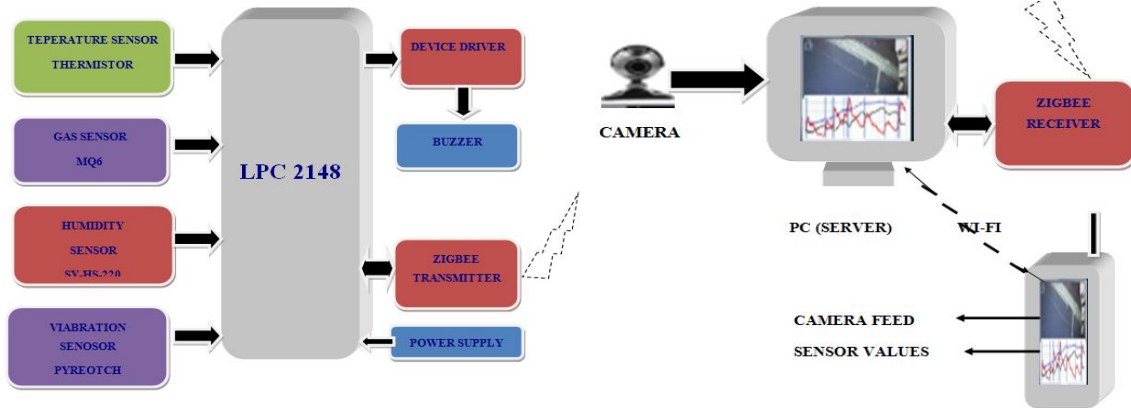


Fig 1 Underground Section

Fig 2. Ground Section

The Underground section includes controller, the number of sensors that includes humidity sensor, temperature sensor, vibration sensor and gas sensor. This also includes the device driver, Buzzer and motor, Zigbee transceiver.

The Ground section includes administrator PC which acts as a server, Zigbee transceiver and there is one GUI which is running on android application.

1. Underground Section-

In the underground section, the parameters like temperature, humidity, Gas are measure by means of respective sensor and the output voltage measured by them is directly connected to the ADC of the ARM as the output voltage never exceeds 5V, there is no need of the signal conditioning circuit. The number of people inside the coal mine is monitored. During the hazard this information will be useful. Information regarding the safety measures like wearing oxygen helmet etc. will be already given to the workers so that they can save their life. If any of the received parameters are beyond the ultra limit, then a Buzzer will be ON, giving warning o the people. The parameters are transmitted to the ground section through a zigbee transceiver

2. Ground Section

In the Ground section Zigbee transceiver receives the information and sends to the administrator. The monitor connected to the administrator displays information in the ground section. This administrator is also connected to the admin's android phone through Wi-Fi network for continuous monitoring. Also the camera connected to the administrator continuously scans the surrounding and send it on the admin android application for precaution purpose.

In the Ground Section on the Server PC there is Neat bean platform. When we run a project Login frame is open so we have to fill password when password matches then we have to go to welcome form otherwise we have to cancel from it. Then on the welcome frame there is com port selection. When we entered proper com port then main form is open. On this main form frame 4 options are available as follows

1. Test Device
2. Test Sensor
3. Test Webcam
4. Control/ Monitor of Administrator

When we choose test Device option then there is control of on/ off the device. When we choose the Test Sensor options then sensor output is available on screen with the progress bar. When we press Test webcam option then the camera feed is available which scans the surrounding of server. When we press the fourth option that is control/ monitor of administrator then there is all control and monitoring options are available.

When administrator is not available at the server or it is away from the server then for continuous monitoring, Android application is created which is running on the android phone. When administrator opens that application then first he should enter IP address of PC that is Server's IP address. When this both address matches then second welcome

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frame is open which wants the password of application? So administrator must enter that password. When the password matches then second frame opens. On that there are two options

1. Check connection
2. Control/ Monitor Devices and Sensor

Check connection checks the whether the Connection is established in the PC and android phone. Control and monitor menu control the output devices that is ON/OFF control and monitor sensor output and also sets the threshold values

V. DESIGN OF HARDWARE

1. Temperature sensor

In this system we used temperature sensor as a thermistor. The name thermistor is formed by thermal resistor which is a temperature sensitive resistor. This thermistor detects small change in temperature. The change in small change in temperature. The change in temperature is measured by change in resistance of the device. Here it may be noted NTC thermistor has a resistance of about 10k Ω and 100k Ω at 50 $^{\circ}$ C to 150 $^{\circ}$ C. It is connected to PIN no 13 that is P0.28.

2. Humidity

The amount of water vapor is expressed in terms of humidity. Here we used SY-HS-220 humidity sensor. This module converts the relative humidity to the output voltage. In daily language humidity is normally taken to mean relative humidity. Relative humidity is defined as the ratio of partial pressure of water vapor to saturated vapor pressure as prescribed temperature. Humidity sensor is on pin no 15 that is P0.30.

3. Gas sensor

In hazardous environment, there are number of toxic gases are present which causes accident. In coal mines, methane, carbon monoxide are present. So for the detection of these gases MQ6 sensor is used in this project. This sensor has a fast response. It is a stable sensor and have a long life. It requires simple drive circuit. This sensor is used in gas leakage detection of equipments in industry and suitable for detection of LPG, iso-butane, propane, LNG. MQ6 is interfaced to the one pin of LPC 2148.

4. Vibration Sensor

In the hazardous environment sometimes vibrations are created. So to sense this vibration and to avoid accidents and to save life of humans, vibration sensor is used over here. This vibration sensor directly gives digital output. And it has sensitivity adjust model. When the output valid signal is high then LED goes out. It has adjustable sensitivity. Vibration detection range is wide, non-directional. Working voltage is 5V DC.

5. Controller

In this project we used the 32 bit ARM7TDMI which is the member of Advanced Risk Machine (ARM). The ARM offer high performance for very low power consumption an price. There are two types of architecture one is Reduced Instruction Set Computer (RISC). The ARM architecture uses RISC principle because of instruction set and related decode mechanism. is much simpler than those of Micro programmed CISC[7]. This simplicity feature results in a high instruction throughput and good real time interrupt response from small and cost effective chip. Pipelining is implemented so that all the parts of processing and memory system can operate continuously. The ARM7TDMI processor employs a unique architectural strategy known as a THUMB which makes it ideally suited to high volume application with memory restrictions or applications where code density is an issue[9].

6. Zigbee

Zigbee is a new wireless technology guided by the IEEE 802.15.4 Personnel Area Networks Standard. It is primarily designed for wide ranging automation applications. It currently operates in 868 MHz band at a data rate of 20kbps in Europe, 914 MHz band at 40Kbps in USA and 2.4Ghz ISM band worldwide at a maximum data rate of 250kbps. The Zigbee specification operates in 2.4 GHz radio band- the same band as 802.11b standard, Bluetooth, microwave & some other devices. It is capable of connecting 255 devices Range of transceiver is 30-70m in urban areas and 1 to 1.5km in outdoor i.e line of sight. The transceiver has an on-chip antenna & it operates t a frequency of 2.4 GHz [10]. Zigbee technology is slower than 802.11b but it consumes significantly low power [11]. Here a pair of Zigbee module is used one transmit data and another to receive the data.

7. Buzzer

International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 4, Issue 9, September 2015

Whenever the toxic gases , temperature, humidity and vibration crosses its threshold level then buzzers ON for alerting the people present in coal mines.

7. Power supply

In this we used Arm as controller which require 3.3V Power supply. So the 230V ac is fed to the step-down transformer output of this is given to the bridge rectifier. The output is given to the filter capacitor. The capacitor used here is 1000uf capacitor. The output of this filter is then applied to the regulator. Here we used LM7812 and LM7805. For other modules power is regulated by variable regulated supply.

VI. SOFTWARE DESIGN

The software platform used for software designing is as follows-

- A. Keil microvision 4
- B. Flash program utility

A. Keil microvision 4

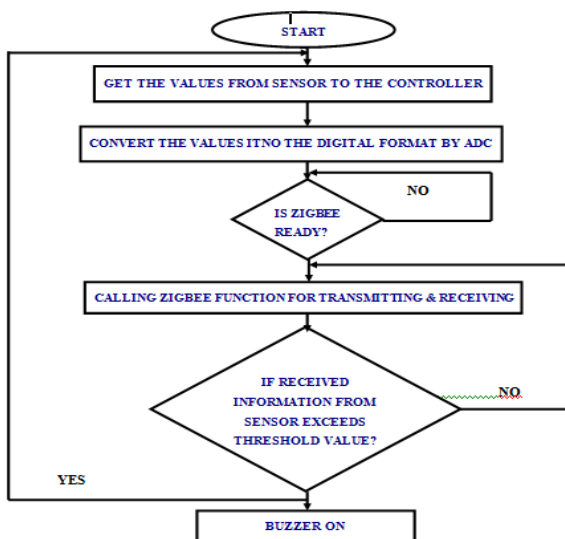
Window based software development platform is microvision 4. It consist of robust and modern editor with project manager and make facility tool[11]. For developing the embedded applications it consist of different tools such as C/C++ compiler, macro assembler, Linker locator, Hex file generator. Microvision 4 provides Integrated Development environment for the development process of embedded applications. Keil can be used to create sources file automatically compile, link and convert using option set with an easy to use user interface. And finally simulate or perform the debugging on the hardware with the access to C variables and memory. KIEL Greatly simplifies the process of creating and testing an embedded applications.

B. Flash program utility

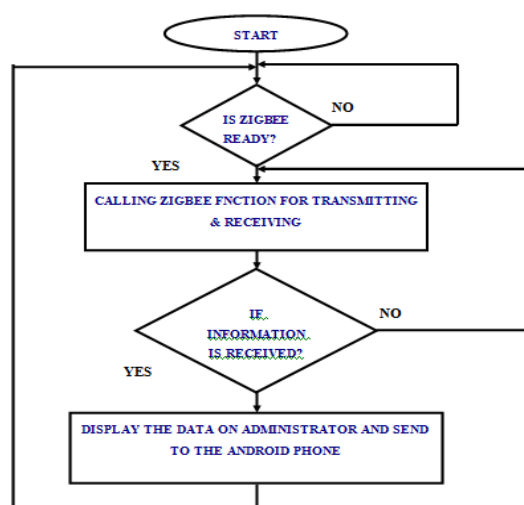
For downloading the application program into ROM Flash program utility tool is necessary. The program code generated in C language after processing produces object code in hex form. It is referred as . hex file. To burn this hex code in the Flash ROM of the controller the facility is provided with Kiel microvisison 4. For programming with the older versions the same task is completed with the help of software called Flash Magic.

VII. DESIGN FLOW

This includes the algorithm for Underground section. In underground 4 sensors are connected which senses environmental parameter .



Flowchart 1 for Underground section

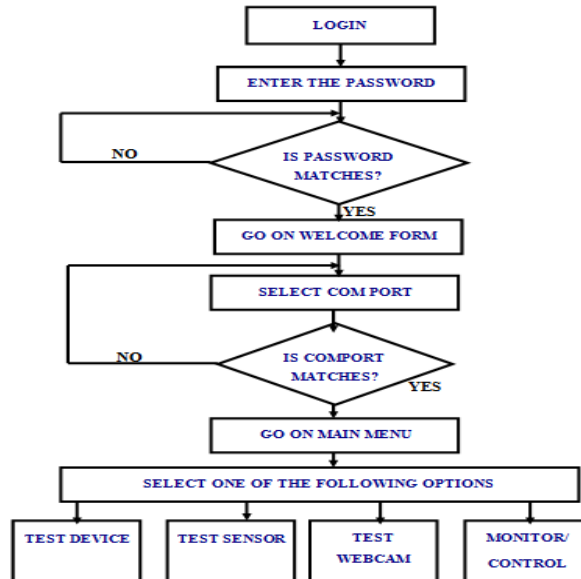


Flow-chart 2 for Ground Section

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Flowchart 3. GUI running on neatbeans platform and Eclipse

VIII.RESULT & CONCLUSION

Table 1. Result for Normal conditions from underground section condition from underground section

Sr. No	Name of Sensor	Threshold value Set By Admin	Actual Value	Hardware changes	Remark
1	Temperature sensor	127	21	Buzzer off	In safe condition
2	Gas Sensor	127	44	Buzzer off	In safe condition
3	Humidity Sensor	127	71	Buzzer off	In safe condition
4	Vibration Sensor	127	00	Buzzer off	In safe condition

Table 2. Result of for Abnormal

Sr. No	Name of Sensor	Threshold value Set By Admin	Actual Value	Hardware changes	Remark
1	Temperature sensor	20	21	Buzzer on	In Dangerous condition
2	Gas Sensor	40	44	Buzzer on	In Dangerous condition
3	Humidity Sensor	45	71	Buzzer on	In Dangerous condition
4	Vibration Sensor	127	00	Buzzer off	In safe condition

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Fig 3. Snapshot for Administrator Control

The proposed work is coal mine safety monitoring system based on Wireless sensor network, and hardware and software design of wireless sensor network are described in detail. This system can detect the concentration of gas, temperature, humidity and vibration in underground coal mine tunnels. Wireless sensor networks applied in monitoring of coal mine security breaks the traditional method and ideas, which improves the practical ability and flexibility of monitoring system

This system can not only monitor all kinds of parameters under coal mine, but also indicate alarm automatically when environment parameters are abnormal to exceed the limitation, which help to improve the level of monitoring safety system production and reduce accident in coal mine. Therefore, the coal mine safety system meets the need of coal mine safety monitoring system. So traditional mine security system can be effectively replaced by the surveillance and safety system

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