International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 03 | Mar 2019 www.irjet.net p-ISSN: 2395-0072

Zig-bee based Tracking and Monitoring System for Mine Worker's

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Abstract – *In coal mines the major problem is the safety of mine workers. In this paper we discuss about the parameters use for monitoring workers health, mine environment, and tracking of mine workers. Also this paper provides the solution for monitoring the workers by using various parameters such as temperature sensor and heart bit sensor, for monitoring mine environment by using carbon monoxide and methane sensor, for tracking workers by using GPS sensor. As it exceeds the level of any parameter buzzer starts buzzing, the GPS will helps to track the real time location of the miners. In this system we are using ATMEGA328P Microcontroller interfacing with zig-bee trans-receiver module and all the parameter are placed in helmet so we can trace the live reading of mine environment, miner's health, and their location.*

Key Words: **Zig-bee, miner's safety and health, GPS, etc.**

1. INTRODUCTION

Mining operations are a risky venture as far as the safety and health of workers are concerned. These risks are due to techniques used for extracting coals. These safety issues are more in underground mines. The deeper the mine, the greater is the risk. Thus, safety of workers should always be of major consideration in mining.

Underground coal mining involves a higher risk than open pit mining due to the problems of ventilation and potential for collapse. However, the utilization of heavy machinery and the methods performed during excavations result into safety risks in the mining.

Modern mines often implement several safety procedures, education, and training for workers, health and safety standards, which leads to change and improvement the safety level both in opencast and underground mining.

In India, Coal has always been the primary resource of energy, which has significantly contributed to the rapid industrial development of the country. About 70% of the power generation is dependent on it. Thus, the importance of coal in energy sector is indispensable. But the production brings with it the other by products, which proves to be a potential threat to the environment and the people associated with it.

2. LITERATURE REVIEW

[1] E. K. Stanek, "Mine Electro technology Research: The Past 17 Years", IEEE transactions on industry applications, Vol. 24, No. 5, 1988

The direct results on the mining industry of the research program sponsored by the US Bureau of Mines over the last decade and a half include increased safety, increased productivity, a better working environment for miners, and a more secure supply of minerals to the US economy. Some important technical developments in the electrical area that have taken place are: the development of mine monitoring systems; improved hard-wired and wireless communications systems; improved grounding systems including ground check monitors, reliability databases, and models for power system safety; improved power system protection and analysis; and a growing effort to use expert systems to improve the operation of mines. Side benefits of this research program include the availability of technically trained manpower, an improved body of technical knowledge, continuing education opportunities, and improved channels of communication for technical knowledge.

[2] N. Chaamwe, W. Liu, H. Jiang, "Seismic Monitoring in Underground Mines:A case of Mufulira Mine in Zambia Using wireless Sensor Networks for Seismic Monitoring", Proc. IEEE international Conference on Electronics and Information Engineering, Vol. V1, 2010

Sudden earth tremors (seismic events) and the accompanying ground falls constitute a major threat to underground mining operations in most underground mines in Zambia. Seismic monitoring is therefore an important exercise that ensures not only a safe working environment for workers but ensures the safety of communities living nearby the mines. This paper discusses seismic events monitoring at one of the biggest mines in Zambia called Mufulira Copper mine. A study on seismic monitoring was carried out at the mine through observations, interviews and record inspections. The study revealed the different methods used over a period of time and it also revealed some major causes of seismicity at the mine. The paper then proposes the use of Wireless Underground Sensor Networks (WUSNs) to monitor seismic events in underground mines. Wireless sensor networks uses sensors that are capable of not only sensing, but processing and transmitting data, hence reducing on the wiring that is characterized by the current-system.

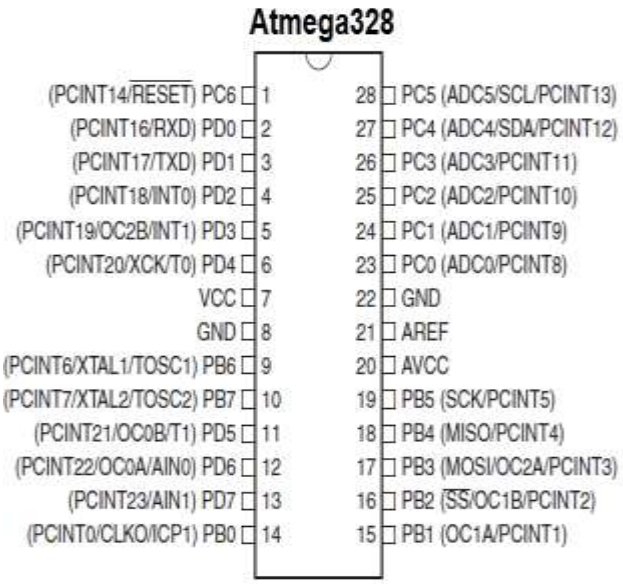
[3] S. Wei, L. Li-li, "Multi-parameter Monitoring System for Coal Mine based on Wireless Sensor Network Technology", Proc. international IEEE Conference on Industrial Mechatronics and Automation, 2009

According to the characteristics of coal mine environment, in this paper we propose a multi-parameter wireless sensor network monitoring system based on ZigBee technology for coal mine tunnel. The system can real-time monitor the underground environment and production parameters and intelligently give early warning by using a variety of sensors and wireless sensor network. It is flexible to add sensors and enhance stability of monitoring computer software through RS- 485 communication protocol and hardware modular. Experiments have proved feasibility and good stability of the system.

3. THEROTICAL STUDY

3.1 ATmega328 microcontroller

The ATMEGA328P is a single chip microcontroller created by Atmel in the mega AVR family. It has a modified Harvard architecture 8-bit RISC processor core.



Pin description

VCC is a digital voltage supply.

AVCC is a supply voltage pin for analog to digital converter.

GND denotes Ground and it has a 0V.

Port A consists of the pins from PA0 to PA7. These pins serve as analog input to analog to digital converters. If analog to digital converter is not used, port A acts as an eight (8) bit bidirectional input/output port.

Port B consists of the pins from PB0 to PB7. This port is an 8 bit bidirectional port having an internal pull-up resistor.

Port C consists of the pins from PC0 to PC7. The output buffers of port C has symmetrical drive characteristics with source capability as well high sink.

Port D consists of the pins from PD0 to PD7**.** It is also an 8 bit input/output port having an internal pull-up resistor.

3.2 Zee-bee Pro S2B

The Zee-bee Pro S2B module is a wireless sensor network, which operates within the Zig-bee protocol and support the unique need of low cost and low power. This module requires minimum power and provides reliable delivery of data between devices. It operates at 2.4GHz frequency band.

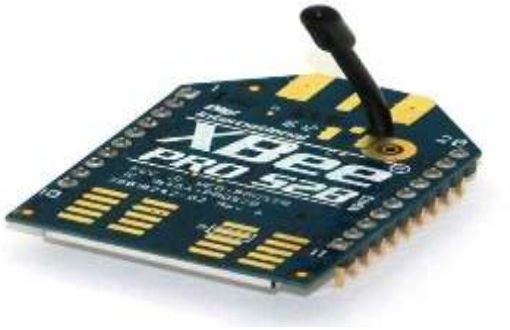


Fig -1: Zig-bee Pro S2B

3.3 Carbon Monoxide Sensor (MQ7)

MQ7 semiconductor sensor is mainly used for detecting carbon monoxide (CO). The conductivity of sensor is higher along with the gas concentration rising. When the sensor, heated by 5V it reaches at high temperature, it cleans the other gases adsorbed under low temperature. The MQ-7 have 6 pins in which 4 of them are used to fetch signals and other 2 are used for providing heating current.

Fig -2: MQ-7 sensor, MQ7 Module

3.4 Methane Sensor (MQ4)

This is a simple to use compressed natural gas (CNG) sensor, suitable for sensing natural gas (composed of mostly Methane [CH4]) concentrations in the air. The MQ-4 can detect natural gas concentrations anywhere from 200 to

10000ppm. This sensor has a high sensitivity and fast response time. The sensor's output is an analog resistance. The drive circuit is very simple; all you need to do is power the heater coil with 5V, add a load resistance, and connect the output to an ADC.

Fig -3: Methane Sensor (MQ4)

3.5 Pulse Sensor

The heart beat sensor used here is 1157 Heart beat sensor. This sensor is designed to give digital output of heart beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes in unison with each heartbeat. This digital output can be connected to microcontroller directly to measure the Beats per Minute (BPM) rate. It works on the principle of Light modulation by blood flow through finger at each pulse.

Fig -4: Pulse Sensor

3.6 Temperature Sensor

The core functionality of the DS18B20 is its direct-to-digital temperature sensor. The resolution of the DS18B20 is configurable (9, 10, 11, or 12 bits), with 12-bit readings the factory default state. This equates to a temperature resolution of 0.5°C, 0.25°C, 0.125°C, or 0.0625°C. Following the issuance of the Convert T [44h] command, a temperature conversion is performed and the thermal data is stored in the scratchpad memory in a 16-bit, sign-extended two's complement format.

Fig -5: Temperature Sensor

3.7 GPS neo 6m

The Ublox NEO-6M GPS engine on this board is a quite good one, with the high precision binary output. It has also high sensitivity for indoor applications. UBLOX NEO-6M GPS Module has a battery for power backup and EEPROM for storing configuration settings. The antenna is connected to the module through a UFL cable which allows for flexibility in mounting the GPS such that the antenna will always see the sky for best performance.

Fig -6: GPS Neo 6m

3.8 Piezo Buzzer

The piezo buzzer produces sound based on reverse of the piezoelectric effect. The generation of pressure variation or strain by the application of electric potential across a piezoelectric material is the underlying principle. These buzzers can be used alert a user of an event corresponding to a switching action, counter signal or sensor input. They are also used in alarm circuits.

Fig -7: Piezo Buzzer

4. EXPERIMENTAL STUDY

4.1 Block Diagram

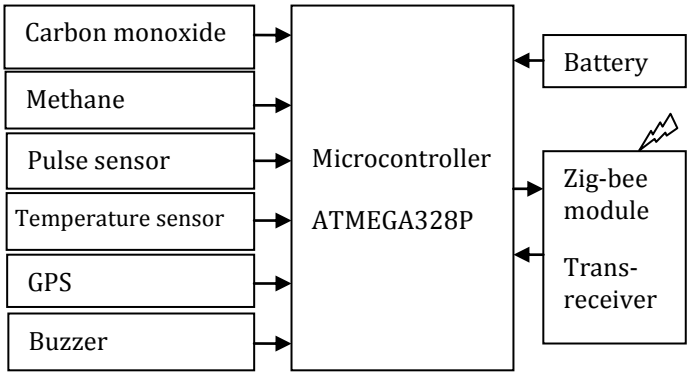


Fig -8: Transmitter Block Diagram

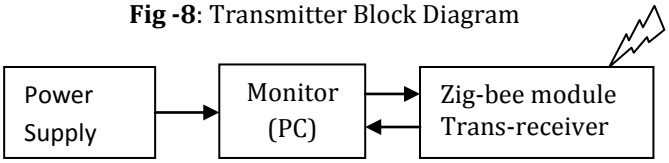
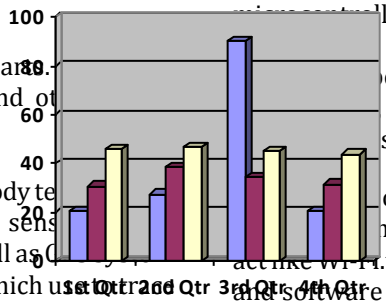


Fig -9: Receiver Block Diagram

4.2 Description of Block Diagram

The above block diagram consists of two parts. board attached to underground miners and ot Ground Control System.

The board attached to miners consist of body te sensor, pulse rate sensor and methane gas sens sensors are fed to the microcontroller as well as G also gives it output to the microcontroller which u the location of workers.



According to the set values in the microcontroller it gives output like beep alarms and buzzer as the levels of body temperature, pulse rate, and methane gas goes beyond set values.

The microcontroller use here is ATMEGA328P with high-performance Microchip Pico Power 8-bit AVR RISC-based microcontroller combines 32KB ISP flash memory with read-while-write capabilities, 1024B EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, a 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts.

ZigBee module is used to transmit and receive data according to sensors and act like Wi-Fi.

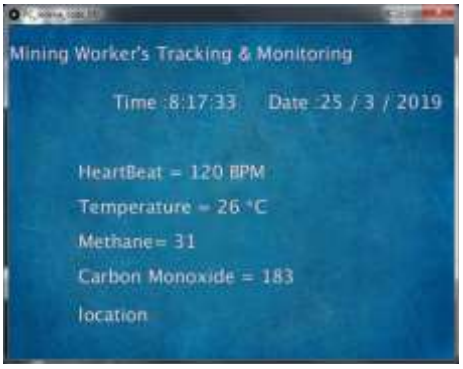
ZigBee module connected in coal mine like it forming a mesh topology due to which long distance issue in mine will be eliminated range of ZigBee is up to 30-100 m.

In case of underground specifically, because of the low resistance of earth material, the transmitting signal may be weak enough not to reach properly at the ground center. But it is overcome by forming the mesh wireless network. So some more ZigBee's are required throughout the path as routers, which will act as receiver and transmitter in case of non-linear route inside mines. These routers are required to be fixed over the walls of the underground mines.

4.3 Working of Proposed System

Proposed system works on the network formed by using zig-bee modules .firstly system is provided with the power supply of the 12V and 1000 f capacitor which eliminates the fluctuations in the supply also we used the 7805 IC to provide the regulated power supply. In our proposed system we used the ATMEGA 328 controller .here we connect the various sensors like MQ7 (methane sensor), MQ4 (carbon monoxide sensor), DS 18 temperature sensor and16*2 display the various signals are given to the signal pins of the controller as well as GPS system also gives it output to the ller which use to trace the location of workers. the set values in the microcontroller it gives eep alarms and buzzer as the levels of body pulse rate, Carbon monoxide and methane gas set values.

operates between 1.8-5.5 volts. Zig-Bee module nsmit and receive data according to sensors and act like Wi-Fi.to establish the connection between hardware and software we are using the java programming in which we are using the front end and back end techniques for the input and the storage of the data. Also we are using the processing software to run and execute the program we are writing the results and various windows we are getting on the software are as follows:



When we access the GPS neo 6m the live location of the system is displayed also we can view this location as a satellite view or a map view the captured screen short of the Google map is given below:

5. RESULT AND DISCUSSION

The sensor and zigbee module can be preferably installed over the helmet of mine worker. Proper monitoring and conversation is possible between the workers and the ground staff which can help to take appropriate actions more rapidly and smartly; it will improve scalability of underground environment and extend accurate position. It is more helpful than other systems as even uneducated people will clearly know about the message

This paper gives a system related to safety and security of underground mines. The system is reliable, faithful, uninterrupted, economical and user friendly. A larger area and more depth inside hazardous underground mines are now can be covered and potential accidents can be controlled effectively. The system combined the low power, low cost Zig-bee based high frequency wireless data transmission technology with modern age MEMES based small size sensors.

6. CONCLUTIONS

Traditional mine security system can be effectively replaced by the surveillance and safety system proposed in the paper. This paper gives a system related to safety and security of underground mines. The system is reliable, faithful, uninterrupted, economical and user friendly. A larger area and more depth inside hazardous underground mines are now can be covered and potential accidents can be controlled effectively. The system combined the low power, low cost Zig-bee based high frequency wireless data transmission technology with modern age MEMES based small size sensors.

The study on real time monitoring of toxic gases and other parameters present in underground mine has analyzed using wireless network. A real time monitoring system is developed to provide clearer and more point to point perspective of the underground mine. This system is displaying the parameters on the LCD at the underground section where sensor unit is installed as well as on the monitoring unit; it will be helpful to all miners present inside the mine to save their life before any casualty occurs.

REFERENCES

[1] E. K. Stanek, “Mine Electro technology Research: The Past 17 Years” , IEEE transactions on industry applications, Vol. 24, No. 5, 1988

[2] N. Chaamwe, W. Liu, H. Jiang, “Seismic Monitoring in Underground Mines:A case of Mufulira Mine in Zambia Using wireless Sensor Networks for Seismic Monitoring”, Proc. IEEE international Conference on Electronics and Information Engineering, Vol. V1, 2010

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