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Safety Helmet for Coal Miners

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ABSTRACT

Today safety of miners is a major challenge. Miners health is in danger mainly because of the emission of Toxic gases, insufficiency of oxygen and mine disasters. In this project we have designed a continuous monitoring system, which monitors the environmental parameters such as oxygen level and poisonous gases (methane, carbon dioxide and carbon monoxide). It also measures the miner's pulse rate, which is done by using the heart rate sensor. During the accidents, by using this device we get to know that how many miners are alive under the mine. This system uses Zigbee technology for wireless transmission. The parameters are detected continuously by various sensors, if any abnormal condition occurs the miner will get an alert through the buzzer present on the helmet. The values of different sensors are continuously transmitted by wireless transmitter to the remote monitoring unit which is placed outside the mine and received by the receiver module (PC).

Keywords: Heart rate sensor, Gas sensors, Zigbee and Oxygen sensor.

1. INTRODUCTION

India is the fourth largest producer of coal in the world, producing 536.5 million metric tons of coal per year. There are around 3,33,097 miners working in India. The safe production level of coal mine is still low, especially in recent years, disasters of coal mine occur frequently, which lead to great loss of possession and life, the safety problems of coal mine has gradually become to the focus that the nation and society concern on. Mining accidents can have a variety of causes, including leakage of poisonous gas, Roof fall and insufficient oxygen level. Sometimes during mine disasters miners who are alive get trapped by roof fall occurrence lost their lives due to lack of or delay in rescuing operation. So it is important to monitor the mine environment condition and minors health. The environment under underground coal mine is bad and complex, so it is more prone to accidents and natural disasters. The Smart Helmet is in use to detect the poisonous gases by using different gas sensors and there is a prototype to get to know that how many miners alive under the mine during accidents by using heart beat sensor. By integrating these two features we design a smart helmet which continuously monitor the environmental parameters such as poisonous gas level, surrounding oxygen level and pulse of the miner. It provides an early warning, which will be helpful to all miners present inside the mine to save their life before any casualty occurs. This system is highly beneficial for rescue and protection of miners.

2. WORKING

In this project, a continuous monitoring system, which monitors the environmental parameters such as oxygen level, the presence of poisonous gases (methane, carbon dioxide and carbon monoxide) and it also measures the pulse of the miners. The different sensors such as methane sensor, carbon monoxide sensor, carbon dioxide sensor, oxygen sensor and heart rate sensor are placed in the helmet of the miners [1]. It will sense and gives the values to the microcontroller. The controller compares the input values with the threshold values. If any abnormal condition occurs, it gives us an alert through the buzzer. During mine accidents, most of the miners die due to lack of or delay in rescuing operation. For this situation heart rate sensor is used to get to know how many persons alive under the mine [5]. This system uses Zigbee technology for wireless transmission. The pulse of the person is sensed by the heart rate sensor and transmit it to the monitoring system through wireless transmission. It is received by the receiver and displayed in the PC.

During coal mining consider if the emission of methane is high, the methane sensor fixed in the helmet sense the gas and gives it to the microcontroller. It compares the input value to the threshold value, due to the high value of methane level over the threshold level it alert the miner.

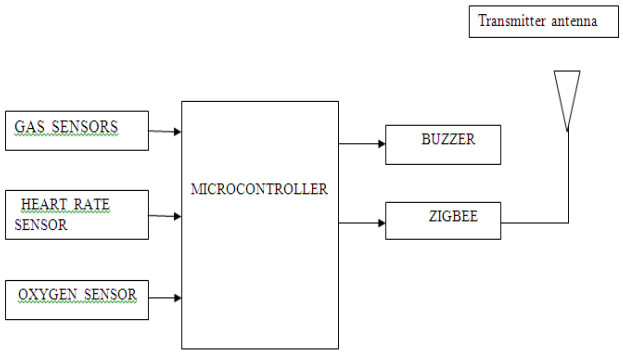

Fig.1. Block diagram of the Transmitter

2.1 Block Diagram

The Helmet section consists of different gas sensors and heart rate sensor. MSP-EXP430G2553 is used as the Processor, Inputs to the micro controller are various poisonous gases and pulse of the miner. Output pins of the controller are connected

to Buzzer and ZigBee module as shown in the fig.1. MQ-7 is the carbon monoxide sensor used which has the sensing element SnO_2 [1]. MQ-4 is used as the methane gas sensor which has the sensing element SnO_2 [1]. MG811 is used as the carbon dioxide sensor [1]. Buzzer gives an alert in emergency situation. ZigBee is used for wireless communication. The receiver section receives the data and displays it in the computer of the control room as shown in Fig.2.

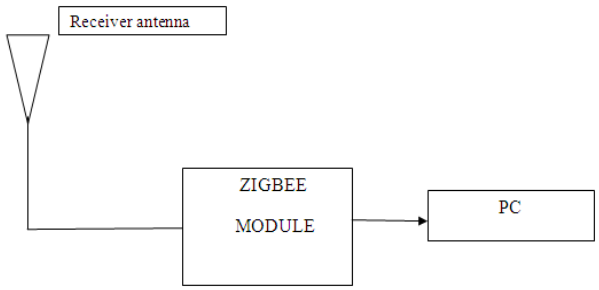

Fig.2. Block diagram of the Receiver

2.2 Circuit Diagram

The circuit diagram for the transmitter section is shown in the Fig.3.

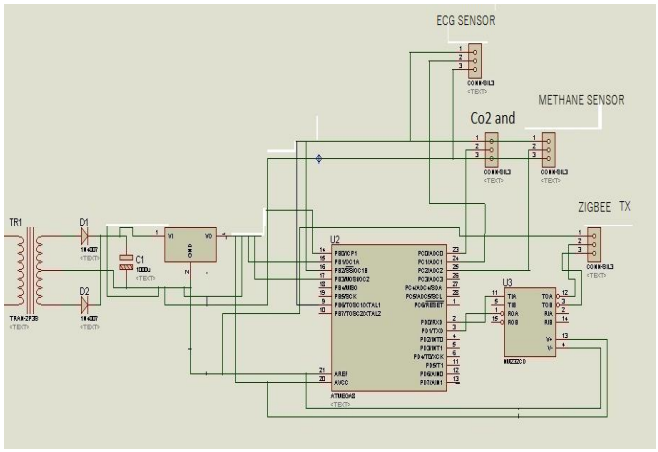

Fig.3. Circuit diagram of the transmitter section

3. HARDWARE COMPONENTS

3.1 MSP430G2553 Microcontroller

The microcontroller used here is MSP430G2553. PIC16F877A have enough I/O (Input/output) lines for current need. It is capable of initiating all intersystem communications. The master controller controls each functions of the system with a supporting device. It is also responsible for reception of commands from the host and taking necessary actions. MSP430G2553 is Low-power 16-bit MSP430 microcontroller with an 8-channel 10-bit ADC, it has on-chip comparator, touch-sense enabled I/Os, universal serial communication interface, 16kB flash memory, and 512 bytes of RAM (preloaded with a sample program). All of these features make it ideal for more advanced level A/D applications in automotive, industrial, appliances and consumer applications.

3.2 Carbon monoxide sensor (MQ-7)

Various types of sensors are available in the market in which semiconductor sensors are considered to have fast response. MQ-7 semiconductor sensor is mainly used for detecting carbon monoxide (CO). MQ-7 gas sensor composed of micro Al2O3 ceramic tube and Tin Dioxide (SnO2). Electrode and heater are fixed into a crust. The heater provides required work conditions for the work of sensitive components. 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[1].

3.3 Methane gas sensor (MQ-4)

MQ-4 gas sensor composed of ceramic tube and Tin Dioxide. Electrode and heater are fixed into a layer. The heater provides required work conditions for the work of sensitive components.SnO2 is used as a sensing element. When the target combustible gas present, the conductivity of sensor is higher along with the gas concentration rising. The MQ-4 sensor has 6 pins in which 4 of them are used to fetch signals and other 2 are used for providing heating current [1].

3.4 Carbon Dioxide Sensor (MG811)

This CO_2 sensor is designed by DF Robot engineer. The MG-811 sensor is highly sensitive to CO2 and less sensitive to alcohol and CO. The MG-811 sensor has low humidity and temperature dependency. Its structure same as MQ-7 but parts material are different. This sensor composed by solid electrolyte layer, Heater, Platinum Lead, Gold electrodes, Porcelain Tube, 100m double-layer steeliness net, Nickel and copper plated ring [4].

3.5 Zigbee Module

ZigBee is a specification for a suite of high-level communication protocols used to create personal area networks built from small, low-power digital radios. Though its low power consumption limits transmission distances to 10–100 meters line-of-sight, depending on power output and environmental characteristics, ZigBee devices can transmit data over long distances by passing data through a mesh network of intermediate devices to reach more distant ones. ZigBee is typically used in low data rate applications that require long battery life and secure networking (ZigBee networks are secured by 128 bit symmetric encryption keys). ZigBee has a defined rate of 250kbit/s, best suited for intermittent data transmissions from a sensor or input device [6]. Applications include wireless light switches, electrical meters with in-home-displays, traffic management systems, and other consumer and industrial equipment that require short-range low-rate wireless data transfer.

Sensor	Model	Threshold Exposure Level
Methane	MQ-4	1000 PPM
Carbon monoxide	MQ-7	200 PPM
Carbon dioxide	MG811	15000 PPM
Oxygen	MG811	Below 160000 PPM
Pulse	-	Below 94 BPM & Above 160BPM

Table.1. Sensors and their Exposure Limit

4. EXPERIMENTAL SETUP

Hardware setup of the overall system is shown in the fig.4 and the sensors and their exposure limit is shown in the Table.1.

Fig.4. Hardware setup of the overall system

5. CONCLUSION

Thus this system will enhances the security system for underground coal miners. A larger area and more depth inside hazardous underground mines are now can be covered and potential accidents can be controlled effectively. The sensor and Zigbee module can be preferably installed over the helmet of mine worker. Proper monitoring can help to take appropriate actions more rapidly and smartly if any abnormal situation occurs. The system also can be easily extended with ZigBee wireless image transmission facility in future.

REFERENCES

[1] Sumit Kumar & Srivastava "Real Time Monitoring System for Mine Safety using Wireless Sensor Network (Multi-Gas Detector)", *International Journal of Science, Engineering and Technology Research (IJSETR),* January 2016 .

[2] Shirish Gaidhane , Mahendra Dhame & Prof. Rizwana Qureshi "Smart Helmet for Coal Miners using Zigbee Technology" *Imperial Journal of Interdisciplinary Research (IJIR)* Vol-2, Issue-6, 2016.

[3] Binisha Balan and Neethu Varghese and Reshma Gangadharan "Intelligent safety system for coal miners" *International Journal of Engineering and Innovative Technology (IJEIT)* Volume 4, Issue 9, March 2015.

[4] Pranoti Anandrao Salankar, Sheeja S. Suresh "Zigbee Based Underground Mines Parameter Monitoring System for Rescue and Protection" *IEEE 2013.*

[5] Abhishek Pal, Sachin Kumar "Health Monitoring Device for Underground Coal Miners" *International Journal of Technology Enhancements and Emerging Engineering Research,* Vol 3, Issue 07.

[6] Kiran Kishore V, E Narasimha and Y Shruthi "Smart Helmet for Coal Miners Using Zigbee Technology *International Journal for Research in Science & Advanced Technologies,* Issue-2, Volume-2.