

# Smart Helmet for Coal Miners using Zigbee Technology

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**Abstract**— This project focuses on a mine supervising system which is based on the cost effective Zigbee system. Our project aims at developing a wireless sensor networks, realized real-time surveillance with early-warning intelligence on harmful gases, temperature, humidity in mining area and used zigbee communication to reduce potential safety problems in coal production using a Zigbee wireless technology. All these three parameters are detected continuously by temperature sensor, gas sensor, humidity sensor and if they cross the pre-defined limit, then the user gets alert as the buzzer will automatically turn on with LED indications. With a zigbee Wireless positioning devices the system might be easily extended. The values of different sensors are continuously transmitted by zigbee transmitter to the remote monitoring unit which are received by zigbee receiver module.

## 1. Introduction

The most important part of any type of industry is safety. In the mining industry safety and security is a first aspect of all. To avoid any types of unwanted conditions, every mining industry follows some basic precaution. Communication is the most vital key factor today, to monitor different parameters such as temperature, increasing humidity level, and carbon monoxide gas continuously using sensors such as LM35, gas sensor MQ2 and humidity sensor to take necessary actions accordingly to avoid any types of hazardous conditions and gives an alert using buzzer. To achieve safety in underground mines, a suitable communication system must be created between workers, moving in the mine, and a fixed base station. The wired communication network technology system will be not so effective. Under the mines due to uncomfortable situation the installation cost as well as maintenance cost is high for wired communication networks. For the successfully wireless data transmission, in this work a low cost zigbee is utilized in routers. A cost effective based wireless mine supervising system with early-warning security system on carbon monoxide, temperature, humidity in mining area is proposed.

## 2. Underground Mines Wireless Network Design Of Zigbee Wireless Technology

The ZigBee protocol is the only international IEEE 802.15.4 standard wireless sensor network protocol in existence, catering to the specific needs of low-power, low-cost, low maintenance monitoring and control systems with talks of using it in sensor networks. The network layer supports three topologies: star, cluster tree and mesh. Direct sequence spread-spectrum at 2.4 GHz (ISM), 915 MHz (the United States) and 868 MHz (Europe) is applied in industrial, scientific and medical frequency band [4]. The network layer supports three topologies: star, cluster tree and mesh.

## 3. Structure diagram of network

As shown in Figure. 1, the system consists of smart helmet, wireless stations and cable network. Wireless base station is a gateway between Zigbee wireless network and cable network. Miner's smart helmet is used as mobile wireless sensor network node which is composed of rechargeable battery, LED lamp and Zigbee communication

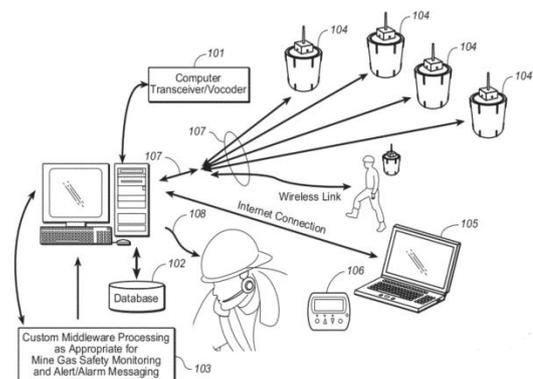


Figure 1. Structure of the system

module. So intelligent helmets could collect production parameters timely and transmit to wireless base station. It is a good Monitoring Mine Safety System both under normal circumstances and unexpected accident.

## 4. System Architecture

### 4.1. Block diagram

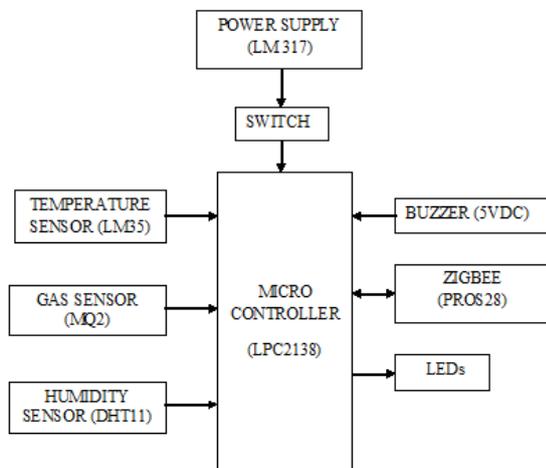


Figure 2. Block diagram of Hardware at Helmet Unit

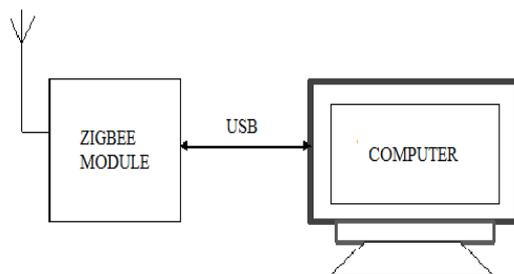


Figure 3. Block diagram of Hardware Design at Remote Monitoring Unit

## 4.2. Block diagram description

### 4.2.1. LPC2138 Microcontroller

LPC2138 microcontrollers are based on a 32/16 bit ARM7TDMI-S CPU with real time emulation and embedded trace support. It has 32 kB of on-chip static RAM and 512 kB of on-chip flash memory. It can sustain standard temperature ranges from -40°C to +85°C. The main features are Modified architecture, Inbuilt analog to digital converter, Self reprogrammable under Software Control and supports speech processing.

### 4.2.2. Temperature Sensor

We use LM35 Precision Centigrade Temperature Sensors whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 does not require any external calibration or trimming to provide typical accuracies of  $\pm 1/4^\circ\text{C}$  at room temperature and  $\pm 3/4^\circ\text{C}$  over a full -55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output and precise inherent calibration make interfacing to readout or control circuitry especially easy.

### 4.2.3. Humidity Sensor

The DHT11 is a Low Voltage Humidity Sensors operate down to 2.7 V. It is designed specifically for high volume OEM (Original Equipment Manufacturer) users. With a typical current draw of only 200  $\mu\text{A}$ , the DHT11 is ideally suited for many low drain, battery operated systems. The DHT11 delivers instrumentation-quality RH (Relative Humidity) sensing performance in a competitively priced, solderable SMD.

### 4.2.4. Gas Sensor

We use a MQ2 gas sensor which has a lower conductivity in clean air. When the target combustible gas exists, the sensor's conductivity is more higher along with the gas concentration rising. Please use simple electro circuit, Convert change of conductivity to correspond output signal of gas concentration. MQ-2 gas sensor has high sensitivity to LPG, Propane and Hydrogen, also could be used to Methane and other combustible steam, it is with low cost and suitable for different application.

### 4.2.5. Zigbee Module

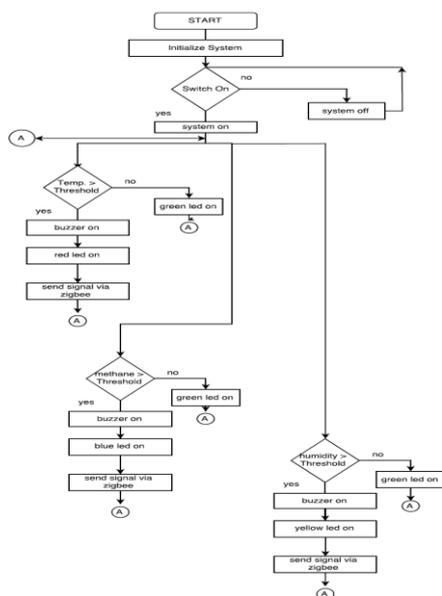
Zigbee is low-cost and low-powered mesh network. It is widely used for controlling and monitoring applications where it covers 10-100 meters within the range. This communication system is less expensive and simpler than the other short range wireless sensor networks such as Bluetooth and WiFi. Zigbee communication is specially built for control and sensor networks on IEEE 802.15.4 standard for wireless personal area networks (WPANs).

## 5. Description of the System

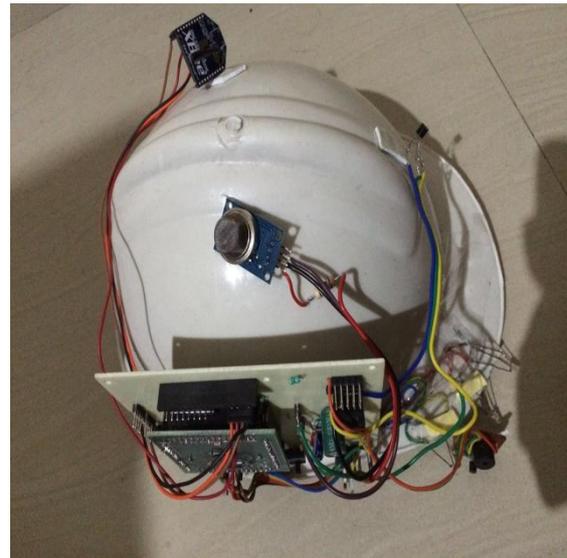
As shown in Figure 2, helmet unit consists of microcontroller (LPC2138), Zigbee communication module, temperature sensor (LM35), humidity sensor (DHT11), gas sensor (MQ2), power supply (LM317), switch and LED. Three sensors (temperature,

humidity, gas) which are connected to the microcontroller LPC2138. These three sensors are connected to the adc ports of microcontroller to convert the analog values into digital form. Three bidirectional LED's indicating the danger and normal conditions & a buzzer is also connected to the microcontroller for alarm system. The sensors available in the helmet collect the temperature, humidity and gas information and send this information to the remote monitoring unit. Low rate Zigbee is used for wireless data transmission. When the control center detects the parameters are abnormal then they can make an alert to the coal miner through the same Zigbee module. LED lights are indicating a danger situation with a buzzer alert. A temperature sensor (LM35) value is set to the 45 degree Celsius, if temperature goes beyond this limit an LED is associated with this sensor which is already in green condition which will be turns into red and a buzzer will be alerted to a miner. And the same condition is happened with other sensors. Three LED's already in green state showing the normal safe conditions but if any sensor crosses their limit they immediately turns into red. The data of three sensors are continuously sends to the monitoring unit using Zigbee module. If the danger condition founds by monitoring unit the safety actions will be taken immediately. As shown in Figure 3, zigbee receiver module is connected to the computer via USB cable. The values of different sensors sends by zigbee transmitter are received by computer using zigbee receiver module. We can see the values on computer using software named as Flash Magic.

## 6. Flowchart of System



## 7. Hardware Snap



## 8. Future Scope

The system also can be easily extended with ZigBee wireless image transmission facility in future. It will improve scalability of underground environment and extend accurate position of miners. In future, with the help of Zigbee module and GUI (software part), we can avoid railways accidents, road accidents, submarine accidents etc.

## 9. Conclusion

As the system requirement and the required components can be easily made available this project can be implemented easily. It will provide the safety to coal miners and change the way of their working as well as system controlling the various environmental changes in mines. It has been presented the original design of the low power ZigBee wireless sensor system with an extremely reduced cost. It is reliable system with quick and easy installation. The system might be easily extended. With ZigBee wireless positioning devices, it will improve system scalability and extend accurate position of underground miners in future.

## 10. References

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