

# Rescue And Protection System For Coal Mine Workers By Using WSN

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## Abstract :

The proposed 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 Xbee. So there is important development in coal mine safety production which is safe and effective communication. 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 Arduino. The Arduino output is then send to the ground section. For the communication between underground section and ground section we used WSN which is Xbee.

**Keyword:-Arduino, Sensors, Power supply, Xbee etc.**

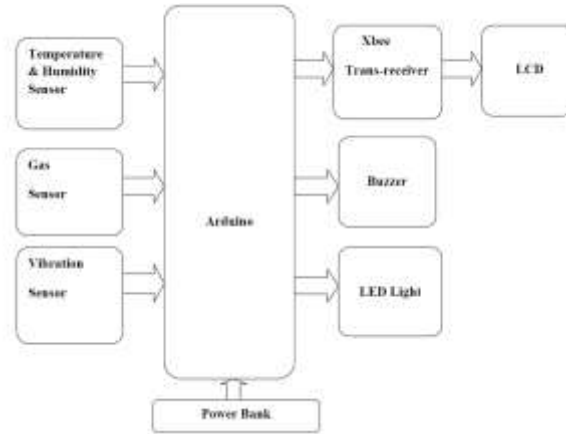
## Introduction: -

### 1.1 Problem Definition:

In any kind of industries the main aspect is the safety of workers. The main concern is an authentic communication between control room and works. It might be done with wired communication and wireless communication but, wired communication is very difficult to reinstall in case off land slide or any damage also inside the underground due to uncomfortable, installation cost as well as maintenance cost is higher .

### 1.3 Proposed Work:

The block diagram which is content different types of sensors like Temperature and Humidity sensor ,Gas sensors, Vibration sensor, Arduino , Xbee , LED light, buzzer etc. Under the normal condition sensors are in working conditions means it sense the all the parameter to respective sensors. When abnormal condition is occurs sensor sense the signal and give to the Arduino. Arduino compare the value and check which is greater than pre-determined value. If it is greater than that given value it give the signal to the buzzer as well as LED light which is start to alarming and glowing. This process starts at time in underground section simultaneously Arduino gives the signal to the Xbee. Xbee woks as trance-receiver it transmit the signal from one node to next node. The number of node is totally depends upon the total length of coal mine. After that next Xbee receive the signal it give to the next Arduino and it connect to the LCD display. All the parameter are display on the LCD display at the control panel room.



**Fig. Block Diagram**

**Objective:**

- **Rescue:** To maintain the continuity of the communication system is very much important to know the actual position and condition of the trapped workers. Whenever the sensor data exceeds the specified threshold (preset) value of temperature, carbon monoxide, methane LPG the Xbee module at remote monitoring site will transmit alert signal to local site by blowing buzzer continuously and any one of the “G, L,C” alphabets will be displayed on LED segment according to the emerging situation (G for gas, L for increasing water level, C for temperature).If monitoring unit wants to call urgently to any employee, then buzzer will ring twice and the employee number will be displayed on LED display. For example in bank account counter.
- **Protection:** To increase both safety and productivity in mines. Due to this wireless communication system, employees will be alert earlier as compare to present underground system. So rapid action will be taken by rescue team. So the chances of accidents will be reduced due to the underground mines environmental factors.
- This system is well applicable in coal mines and gold mines .The system can also be easily extended with Xbee wireless image transmission facility. In future it will improve scalability of underground environment and extend accurate position of miners. Inside mines, different parameters are intimated to the workers through voice.To provide whole interconnection, wirelessly using different topology.

## 2. Hardware Implementation



**Fig 2: Hardware model**

## 2.1 Temperature and Humidity Sensor-



**Fig 2.1 DHT11**

As per requirement of the coal mine or the condition of the coal mine there is balance between temperature and humidity so we are selecting DHT11. The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). It's fairly simple to use. The only real downside of this sensor is you can only get new data from it once every 2 seconds, so when using our library, sensor readings can be up to 2 seconds old.

### TECHNICAL DETAILS-

- Low cost
- to 5V power and I/O
- 2.5mA max current use during conversion (while requesting data)
- Good for 20-80% humidity readings with 5% accuracy
- Good for 0-50°C temperature readings  $\pm 2^\circ\text{C}$  accuracy

## 2.2 Gas Sensors-

As we are considering the coal mine there is severity of gases like CO, CH<sub>4</sub>, LPG which are dangerous for coal mine workers so according to that we have to use or have to choose the sensor which sense all the above gases. So considering this requirement we are choosing following sensor.

### 2.2.1 Gas Sensor 1-



**Fig 2.3 MQ2**

Sensitive material of MQ-2 gas sensor is SnO<sub>2</sub>, which with lower conductivity in clean air. When the target combustible gas exist, The sensor's conductivity is more higher along with the gas concentration rising. 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.

#### **TECHNICAL DETAILS-**

Detection range: 300 to 10000 PPM

Characteristics of gas: 1000 PPM isobutene

Sensitivity:  $R$  in air/ $R$  in typical gas  $\geq 5$

Sensitive resistance: 1k ohm to 20k ohm in 50PPM toluene

Ambient temperature: -20 + 55?

Measure the voltage  $\leq 24V$

#### **2.2.2 Gas Sensor 2-**



**Fig 2.2 MQ7**

This is a simple-to-use Carbon Monoxide (CO) sensor, suitable for sensing CO concentrations in the air. The MQ-7 can detect CO-gas concentrations anywhere from 20 to 2000ppm.

#### TECHNICAL DETAILS-

- High sensitivity to CH<sub>4</sub>, Natural gas
- Small sensitivity to alcohol, smoke
- Fast response
- Stable and long life
- Simple drive circuit

### 2.3 Vibration Sensor-



**Fig 2.4 SW-18010P**

SW-18010P series are spring type, no directional vibration sensor trigger switch, any angle can trigger. Switch is open circuit OFF-state, when it is static, when external force to touch and corresponding vibration, or movement speed achieve adequate (partial) centrifugal force, conductive pick feet will produce instant conductivity is instant ON-state, when external force disappear, switch back to open circuit OFF-state. Switch have the identification P at the bottom, for completely airtight; In the normal, switch life can reach 20,0000 cycles lifespan.

This series Switches have trigger high sensitivity Apply to security devices toys electronic scales products when external force to touch and corresponding vibration, or movement speed achieve adequate (partial) centrifugal force, conductive pick feet will produce instant conductivity is instant ON-state.

#### TECHNICAL DETAILS-

- Voltage: <12v
- Current: <50Ma

- Operating lifespan :above 50000 hour

## 2.4 Arduino Uno-



**Fig 2.5 ARDUINO UNO**

Arduino Uno is a microcontroller board. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. The board can operate on an external supply of 6 to 20 volts. We are using the 12V supply for Arduino.

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Uno's digital pins. Arduino is programmed by using the software 'Arduino'. The main function of Arduino in our project is to receive the signal from sensors and send the signal to Xbee.

## 2.5 Xbee Trans-Receiver-



**Fig 2.6 XBEE**

While considering that we have to give signal so the communication is essential. So for better communication we are using wireless network and transmitting and receiving signal by using Xbee. This is an advanced way for communication which gives very fast communication rather than wired communication.

Now we are selected XBEE 2mw wire antenna series 2 improve on the power output and data protocol. Series 2 allow you to create complex mesh network based on Xbee mesh firmware. These modules allows a very reliable and simple communication between Arduino, computer system really with serial port .Point to point and multipoint network are supported.

#### TECHNICAL DETAILS-

- 3.3v @ 40mA
- 250kbps max data rate
- 2mw output
- 400ft(120m ) Range
- 8digital I/O pins
- Built-in antenna

#### 2.6 LED Light-



**Fig 2.7 LED**

A light emitting diode (LED) is essentially a PN junction semiconductor diode that emits light when current is applied. It is the solid state device that controls current without heated elements and is therefore very reliable. LEDs are highly monochromatic, emitting a pure colour in a narrow frequency range. LEDs are made up from gallium-based crystal that contain one or more additional materials such as phosphorus to produce a distinct colour.

#### TECHNICAL DETAILS-

- Light output - 1400 Lumen
- Beam angle- 150 degree
- CRI-80
- Starting time- <0.5

#### 2.7 Buzzer-



**Fig 2.8 BUZZER**

This buzzer is used in our project is that to indicate the dangerous conditions occur in the coal mine. The buzzer exhibits the reverse piezoelectric effect. The normal piezoelectric effect is generating electricity from sequencing a crystal. The buzzer is also called beeper is an audio signaling device. Which may be mechanical, electromechanical, or piezoelectric, Typical use of buzzers and beepers include alarm device ,timer etc.

### 2.8 LCD Display-



**Fig 2.9 LCD DISPLAY**

Liquid crystal display(LCD) are passive display technology. By manipulating this light ,they display images using very little power. This has made LCDs the preferred technology whenever Low power consumption and compact size are critical. This LCD is used for display the value of all parameter at control panel room.

### Application

The several applications of this project are as follows:-

1. We can use this project in industrial application also with different sensors.
2. In Power Plant
3. In Chemical Industry

### Future scope

A major risk that can cause a large amount of damage in the mine environment is fire. An additional subsystem that could be considered for addition to the mines safety system is fire suppression. This would include the use of a controllable fire retardant system.

While the wireless communication implemented in this design shows success with urban/indoor communication, in order to enhance the system even further, multiple identical node could be introduced. This would turn the topology into mesh network. By using the proprietary technology from the manufacture of the Xbee module .This would allow for a sensor node to be out of range with the collection node, but as long as that sensor node can communicate to another sensor node, the data can be passed along from the end sensor node to the



collection node through intermediary sensor nodes. This would increase the communication range inside the mine. We can mount the kit on worker's helmet also.

### Conclusion

The main purpose of this project is to protect the life of workers from the hazardous situations which occurs during mining process. We will get to know the different environmental conditions of coal mines from which we have to protect the workers, for that we have different methods of mine security.

Traditional mine security can be effectively replaced by the surveillance and safety system. Wireless sensor network applied in monitoring coal mine security breaks through the traditional methods and ideas, which improve the practical ability and flexibility of monitoring system. This system is reliable, faithful, uninterrupted, economical and user friendly. Xbee based wireless transmission is most suitable for underground coal mines for its low power, low cost and more safety. Proper monitoring and conversation is possible between the workers and the ground staff which can help to take appropriate actions more rapidly and smartly.

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