

# INTELLIGENT HELMET FOR COAL MINERS USING ZIGBEE TECHNIQUE

1.GARIMA TIWARI 2. RUTUJA KSHIRSAGAR 3. M.P.GAJARE

<sup>1</sup> B.E. Student, Department of Electronics & Telecommunication, AISSMS Institute of information technology, Savitribai Phule Pune University, Pune, India <sup>2</sup> B.E. Student, Department of Electronics & Telecommunication, AISSMS Institute of information technology, Savitribai Phule Pune University, Pune, India <sup>3</sup> Professor, Department of Electronics & telecommunication, AISSMS Institute of information technology, Savitribai Phule University, Pune, India.

**Abstract:** *disasters are common in coal mine because of complexity in nature of the environment. Such disasters include suffocation, gas poisoning, roof collapse and gas explosions. Such calamities cause loss extremely important lives and money. Hence safety is the priority work in the mine. The main objective of the project is to design a wireless helmet for coal miners using ZigBee wireless technology. An intelligent helmet is used as a system with sensor network. The system adapted a ZigBee module to keep an early check on various parameters like methane, carbon monoxide, temperature and humidity inside the mine. The values sensed by the sensors will be displayed on a computer which will be located in the central control room which will monitor the conditions inside the mine on a continuous basis. This design will help the centralized management to check the real time environment parameters so as to take safety steps in advance.*

**Keywords:** ZigBee, pic microcontroller, sensors, coal mines.

## I.INTRODUCTION:

In all the industries, the major factor is safety, coal mines are no exception to it, many accidents happen in the coal mines during working in them. Accidents take place due to several reasons such as excessive harmful gases, humidity variations or due to temperature changes. So the people who work in the mines have to face several severe problems due to reasons above.

Previously, there have been various systems that were designed for the safety of people inside the mines such as sensors were employed at the coal sites but they got damaged due to environmental conditions. Later robots were suggested but they were very expensive for small countries. The wired system was even proposed which was found to be ineffective mainly during a natural calamity or a roof fall occurrences. So the dependability and life of this communication system is very deprived. Due to the harsh environment inside the mine, the installation and maintenance of this wired system is very problematic. Also it is very difficult and overpriced to reinstall the entire system inside the mine after a triumph or any other damage befallen.

So there was a need of designing a system to provide security to the people who work in the coal mines. The aim of the project is to provide a solution by providing a wireless communication and safety monitoring system. The people must wear the helmet while working in the coal mines. Keeping all these aspects in mind we designed a system that is intelligent helmet for coal miners using ZigBee technology for monitoring the harmful gases, abnormal temperature conditions and the humidity levels in the air. This design will surely improve safety features of the system. In our design, the helmet is having the circuit with three sensors i.e. temperature, humidity and gas to monitor the conditions in coal mine. If there comes any hazardous situation in the mine, the helmet provides the information to the control station through the ZigBee transmitter and the control station will alert the coal miner using the ZigBee receiver by making the buzzer active which is placed in the helmet so that a miner can rescue his life from the abnormalities.

## II.WORKING PRINCIPLE:

The security system consists of a helmet, on which the sensor circuits are mounted. There are 2 sections namely: transmitter and the receiver section. The transmitter section contains a microcontroller which receives input from various sensors like gas sensor, temperature sensor, and humidity sensor. The information sent by the helmet is received by the control room at a fixed base station and displayed on a computer. The control room computer will identify the data received through the RS232 terminal and display it in the monitor. The computer will display the values of temperature, humidity and gas.

## III.BLOCK DIAGRAM:

The helmet section consists of gas, temperature and humidity sensors. PIC18F4520 microcontroller is used as the processor [1]. Inputs to the processor are values of humidity, gas and temperature sensors. Output pins of the controller are connected to LCD display and ZigBee module as shown in the fig.1. MQ-4 is the gas sensor used which senses the presence of gases like methane and carbon monoxide, as these gases goes undetected by human sense organs as they are colourless and odourless. Humidity sensor is DHT11. LM35 is used as temperature sensor because of its high range and easy availability.

ZigBee is used for wireless communication which is interfaced through MAX 232. The receiver section receives the data and displays it in the computer of the control room as shown in fig.

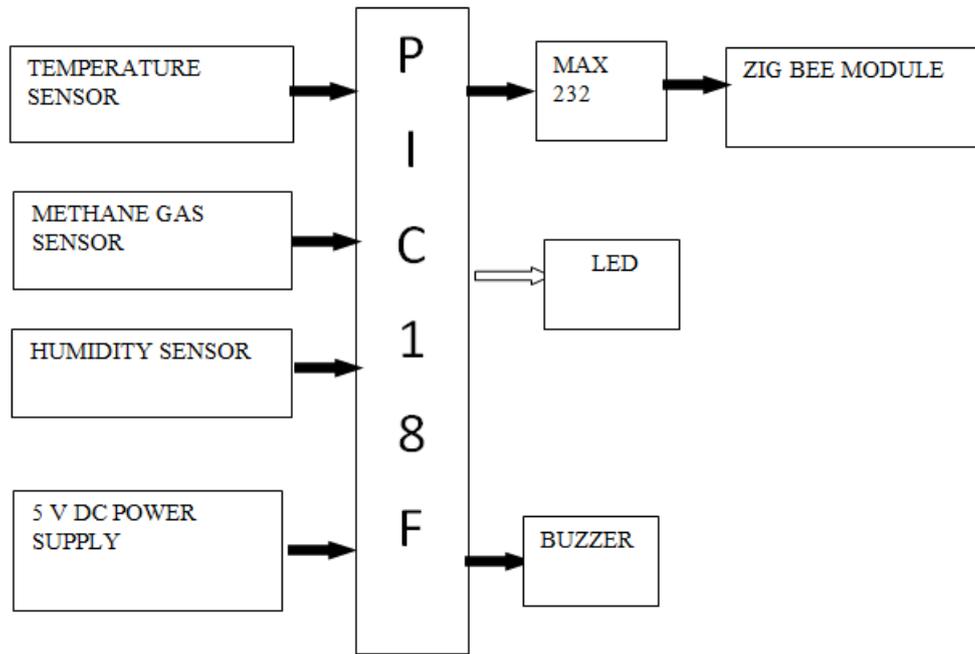
BLOCK DIAGRAM AT HELMET UNIT

FIG.1

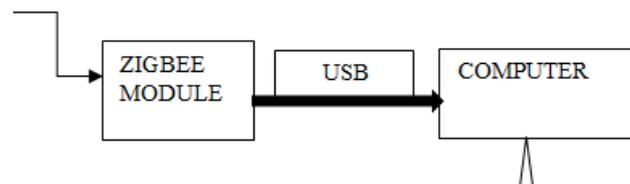
BLOCK DIAGRAM AT REMOTE MONITORING UNIT

FIG.2

**IV.HARDWARE:****A) PIC MICROCONTROLLER:**

PIC (Pronounced as "pick") is a family of microcontrollers made by Microchip Technology, derived from the PIC1650 originally developed by General Instrument's Microelectronics Division. The name PIC initially referred to peripheral interface component, and then it was corrected as programmable intelligent controller. The first parts of the family were available in 1976; by 2013 the company had shipped more than twelve billion individual parts, used in a wide variety of embedded systems.

Early models of PIC had read-only memory (ROM) or field-programmable EPROM for program storage, some with provision for erasing memory. All current models use flash memory for program storage, and newer models allow the PIC to reprogram itself. Program memory and data memory are separated. Data memory is 8-bit, 16-bit, and, in latest models, 32-bit wide. Program instructions vary in bit-count by family of PIC, and may be 12, 14, 16, or 24 bits long. The instruction set also varies by model, with more powerful chips adding instructions for digital signal processing functions.

**PIC18F4550 FEATURES:****CPU**

- Up to 10 MIPS Performance at 3V
- C compiler optimized RISC architecture
- 8x8 Single Cycle Hardware Multiply

**System**

- Internal oscillator support-31 kHz to 8MHz with 4xPLL
- Fail-Safe Clock Monitor- allows safe shutdown if clock fails
- Watchdog Timer with separate RC oscillator
- Wide operating Voltage range; 2.0V to 5.5V

Nano Watt Power Managed Modes

- Run, Idle and SLEEP modes
- Idle mode currents down to 5.8uA typical
- Sleep mode currents down to 0.1uA typical

Analog Features

- 10-bit ADC, 13 channels, 100K samples per second
- Programmable Low Voltage Detection Module
- Programmable Brown-Out-Reset Module
- Two Analog Comparators multiplexing

Peripherals

- Master Synchronous Serial Port supports SPI and I2C master and slave mode
- EUSART module including LIN bus support
- Four Timer modules
- Up to 5 PWM outputs
- Up to 2 Capture / Compare

ADC CONVERTER

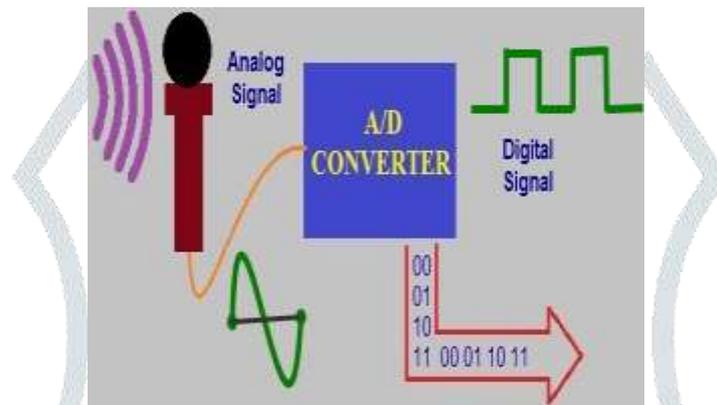


FIG.3

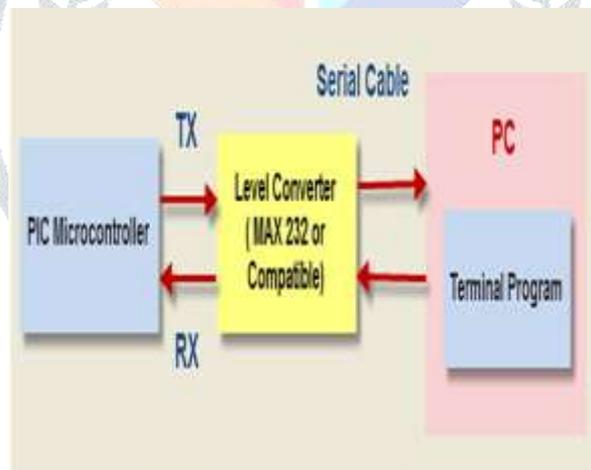


FIG.4



FIG.5



### C) METHANE GAS SENSOR (MQ4):

A **gas detector** is a device that discovers the existence of gases in any area, often as part of a safety system. This type of apparatus is used to discover a leaking of gas or other emissions and can interface with a control system so a process can be automatically shut down. A gas detector can sound an alarm to operators in the area where the leak is occurring, giving them the opportunity to leave. This type of device is important because there are many gases that can be harmful to organic life, such as humans or animals.

MQ-4 gas sensor is made of ceramic tube and Tin Dioxide. Electrode and heater are fixed onto a layer. The heater offers required work circumstances for the work of sensitive modules. SnO<sub>2</sub> is used as a sensing element. When the target combustible gas is present, the conductivity of sensor gets higher as the gas concentration increases. The MQ-4 sensor contains 6 pins out of which 4 are used to procure signals and rest 2 are used for providing the heating current.

#### ➤ Salient Features:

- High sensitivity to CH<sub>4</sub> and Natural gas
- sensitivity to alcohol as well as smoke
- Fast response
- Steady and long life
- Simple drive circuit



1 = GND  
2 = DOUT  
3 = AOUT  
4 = Vcc

(bottom view)

FIG.9



FIG.10

### D)ZIGBEE MODULE:

How came the word ZIGBEE??

The domestic honeybee, a colonial insect, lives in a hive that contains a queen, a few male drones, and thousands of worker bees. The method they used to convey new-found food sources to other members of the colony was said as the ZigBee Principle. Using this silent, but powerful communication system, bees were able to share information such as the location, distance, and direction of the food hence on the similar lines the ZigBee technology was developed in which the information is transmitted as well as received wirelessly.

#### ZIGBEE ARCHITECTURE:

There are basically three areas of architectural responsibility in ZigBee engineering effort. The physical and MAC layers take whole of the advantage of the physical radio specified by IEEE 802.15.4. The 802.15.4 specification describes a peer-to-peer radio using Direct Sequence Spread Spectrum. The specification also calls out the data rates, channelization, and modulation techniques to be employed.

The ZigBee Alliance provides the logical network, security, and application software, which are implemented in a firmware stack.

It is the ZigBee stack that creates the mesh networking capability. Each and every microcontroller/RF chip combination necessitates its own ZigBee stack due to the differences in microcontrollers and RFchips. Typically, the ZigBee stack is included with either the microcontroller or RF chip. The application layer is defined by profiles, of which there are two types:

- Public profiles: are those certified by the ZigBee Alliance for interoperability purposes,
- Private profiles: are for use in closed systems.

A word about the ZigBee Alliance: The following discussion includes options that require access to intellectual property available only to members of the ZigBee Alliance. There are three types of membership; all companies that plan to release products incorporating ZigBee technology must become at least adopting members, an entry-level membership that provides such benefits as access to specifications and developer conferences/workshops.

ZigBee provides various exciting and unique benefits for wireless applications.

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[1]. 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. 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.

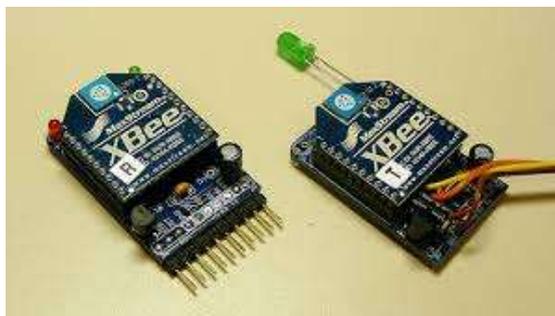


FIG 11

#### E) HUMIDITY SENSOR (DHT11):

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 air, 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.

#### Specification

- Supply Voltage: +5 V
- Temperature range :0-50 °C error of  $\pm 2$  °C
- Humidity :20-90% RH  $\pm 5$ % RH error
- Interface: Digital

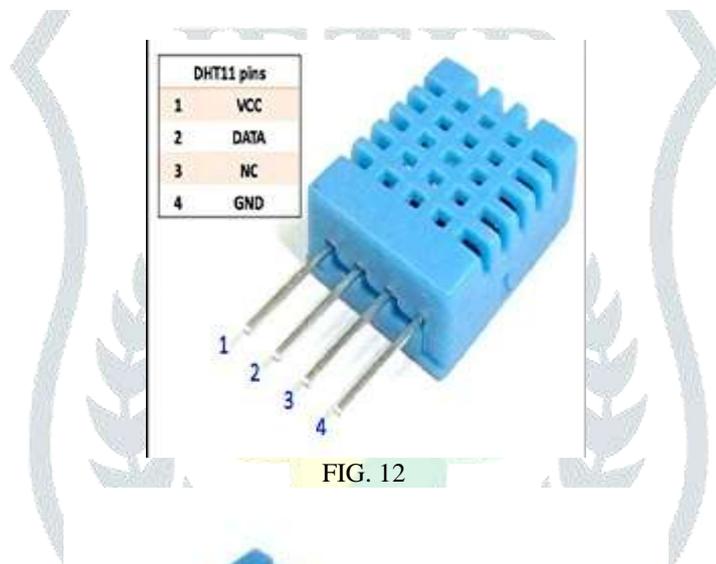


FIG. 12

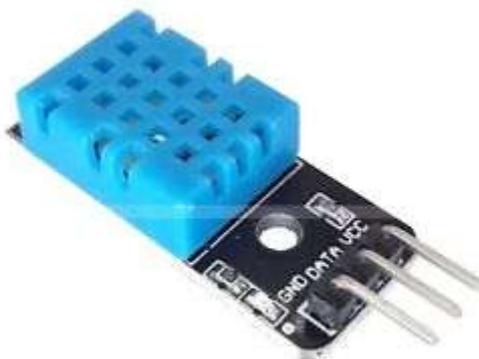


FIG. 13

#### F) LIQUID CRYSTAL DISPLAY:

Pin Symbol Function

1. Vss ground (0 V)
2. Vdd power (4.5 – 5.5 V)
3. Vo contrast adjustment
4. RS H/L register select signal
5. R/W H/L read/write signal
6. E H/L enable signal
- 7-14 .DB0 – DB7 H/L data bus for 4- or 8-bit mode
15. A (LED+) backlight anode
16. K (LED-) backlight cathode

This LCD can be operated in 4 or 8-bit data mode. In 4-bit mode 4 most significant data bits are used while in 8-bit mode all 8 data pins are connected to microcontroller. In this project we have used 4-bit mode of operation. In 4-bit mode each data or command byte is loaded in 2 iterations of 4 bit each. We can read & write data to LCD but to keep things simple we have hardwired R/W line to ground for only writing. It means we can only print on LCD but cannot read back content written in LCD RAM [2].

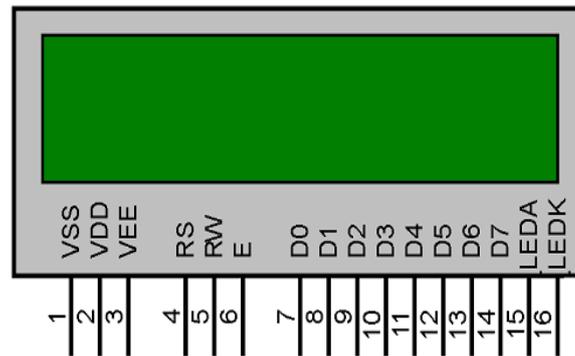


FIG. 14

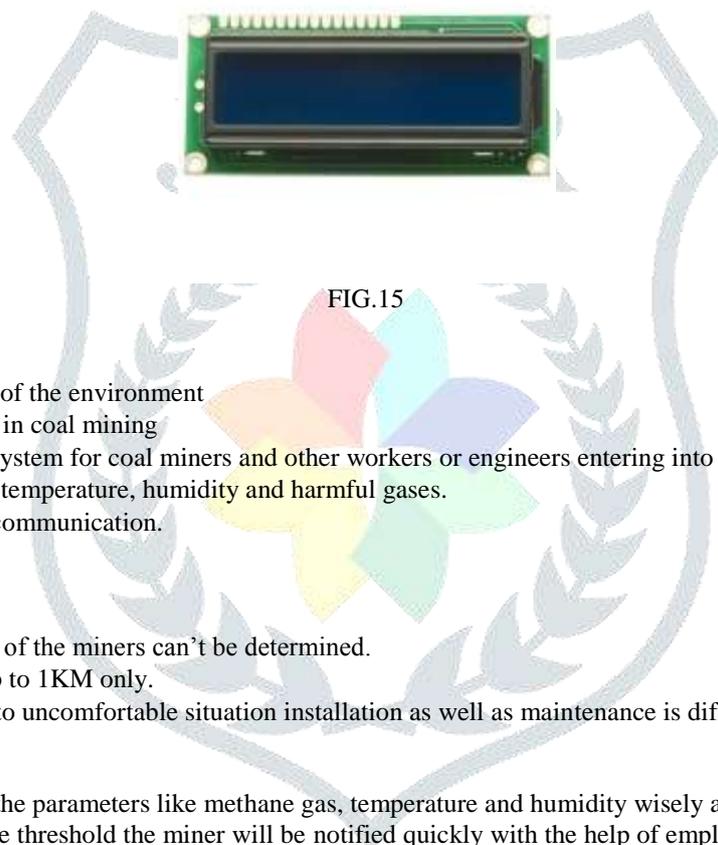


FIG.15

#### V.ADVANTAGES:

- Safety monitoring of the environment
- Improved services in coal mining
- Provides a safety system for coal miners and other workers or engineers entering into coal mine.
- Prevent form high temperature, humidity and harmful gases.
- Reliable wireless communication.

#### VI. DISADVANTAGES:

- The exact location of the miners can't be determined.
- ZigBee range is up to 1KM only.
- Inside mines, due to uncomfortable situation installation as well as maintenance is difficult.

#### VII.EXPECTED RESULTS:

The system will be able to sense all the parameters like methane gas, temperature and humidity wisely and should transmit it to the receiver. if any if the parameter rises above the threshold the miner will be notified quickly with the help of employed buzzer in the system.

#### VIII.CONCLUSION:

The hardworking miners who work deep down the earth surface in coal mines have to face various environmental parameters which are quite dangerous for their life. They have the danger from methane, carbon monoxide and temperature as well the humidity present in the mines. So the main aim of our project is provide a strong security for those people. the purpose is to provide a solution as wireless communication and safety monitoring system. we have arranged our total circuit over the helmet of the person who'll be working in the mine. We have used ZigBee module for the transmission and reception if the radio frequencies. It is a new wireless technology guided by IEEE 802.15.40 it is currently operates 2.4 GHZ in worldwide at a maximum data rate up to 250 kbps.appropriate monitoring can comfort us to take necessary steps more rapidly and smartly if any abnormal situation occurs.

#### IX.FUTURE SCOPE:

1. 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.
2. In future, with the help of ZigBee module and GUI (software part), we can avoid railways accidents, road accidents, submarine accidents etc.
3. We can also add a global positioning system (GPS) to get the exact location of miner.
4. A communication system can be used so that the miner can communicate with the person in control room.

**REFERENCES:**

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