# SMART COAL MINING SAFETY USING IoT

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***Abstract :*** Coal mining is the biggest trade in the world. Coal mining is the process of extracting minerals from the ground. In the coal mining occupational accident and hazardous events are occurs commonly. As a result of these accidents many skilled workers and laborers lost their life. There is no advent precaution measure to detect the hazardous event occurred in coal mining field and to provide an alert system. A classic model is to monitor the condition of mining fields is designed. The model consists of two sections namely nodal section and helmet section. The Helmet section consists of Infrared [IR] sensor and heartbeat sensor. If the helmet is removed accidentally that will be indicated by the Infrared [IR] sensor and heartbeat rate of the miner is detected using heartbeat sensor. Nodal section consists of Temperature, metal detector, gas and PIR sensors. These sensors will measure the environmental condition of the mining field. The sensed parameters are communicated via ZigBee. Arduino and ARM 7 controllers are placed in helmet and the nodal section respectively for the processing. The monitored parameters are uploaded to cloud for permanent storage using internet of Things [IoT].

***Keywords*- Arduino, ARM 7, ZigBee, IR sensor, Heartbeat sensor, Metal detector sensor, Temperature sensor, IoT.**

## I. INTRODUCTION

India, which is renowned for a its extensive mineral resource and mining business. In the last few years for most of the countries environmental care has become one of the biggest aspects. In last year's Industrial accident levels has been increased without any control due to lack of safety. The Primary factor in running the industry successfully is to ensure the safety of person working in that area. Underground mining comes to the same category, where the environment is hard or difficult to monitor and provide safety [1]. The accidents occur in the mining area due to different techniques used for extracting the different type of minerals. As the miner goes deep, the greater is the risk. Underground coal mining involves a greater risk than surface level mining due to the problem of ventilation and occurrences of disaster due to hazardous gases inside the ground. So, this makes the implementation of monitoring system to provide safety [1].

The older methods of mine condition monitoring involved using a person to go down and report back. However this method is harmful, because the person who is monitoring the mining field condition may also subjected to accident. An implementation is based on the wireless sensor network, can be sensible and correctly monitor the dynamic conditions of workers in the underground. The concept that we are addressing in this work is to develop a prototype of safety model so as to provide extra safety alertness to miners. Coal has always been the basic resource of energy in India, which leads to the rapid industrial development of country. The present work is good attempt in analyzing and designing a real time monitoring system of detection by using the ZigBee and IoT technology.

## II. AIM OF PROJECT

1. Safety monitoring of the mining environment.
2. Prevent from the high temperature, harmful gases and metals.
3. Real time monitoring of the mining area and can able to give the warning.
4. To save the life of miners who may die by hazardous environment explosion taking place inside the mine.

## III. LITERATURE SURVEY

These are the previous research work on different systems using different technologies for the safety of the miner and mining environment.

Yongping Wu and Guo Feng implement a coal mine monitoring using the Bluetooth wireless transmission system. As a standard combination of global short-range wireless communication, Bluetooth technology is to setup a common low-power, low-cost wireless air interface and controlling software opening system. This paper defines the development background, technical features and the structure of the protocol stack of Bluetooth technology, and proposed the solutions of the Bluetooth host controller interface (HCI) wireless communication for the difficulty of its development. At the same time, the system includes CAN bus technology maturely, has realized the combination of wired and wireless data transmission system. The main difficulty of this system is that the Bluetooth is short range wireless technology. And use of cabling is complex. When a natural calamity occurred, the cabling is damage. So the reliability and life of conventional communication module is low. Due to the harsh environment inside the mine, the installation and maintenance of the wired communication is very complicated [2].

CHENG Qiang, SUN Ji-ping, ZHANG Fan implemented a ZigBee based intelligent smart helmet for a coal miners, it is a cost effective ZigBee-based wireless mine monitoring system. This scheme uses intelligent helmets as voice terminal and ultra-

low-power nodes of wireless sensor networks. The system involves ZigBee technology to design wireless sensor networks, realized time surveillance with early-warning intelligence on methane gas, temperature, humidity in mining fields, and use speech communication to reduce safety problems in coal production. Through ZigBee one can monitor the parameters of all the information [3].

Jingjiang Song, Yingli Zhu proposed system for safety coal mining based on wireless sensor network. The sensors present in the module monitors the condition in the mining area like gas, temperature, metal, obstacles and report it to the wireless communication module using controllers. The sensed information is sent to monitoring centre by cable. The problem with this type of implementation is that hardware part is placed inside the mining area, when a natural disasters or falling of roof occurred, the system gets damaged. So the reliability communication system is poor. Main problem with the system is it produces more noise during working condition and if the distance of miner and implemented system is long, miner not get proper message [4].

Madhu developed a coal mine safety monitoring system by utilizing Temperature, humidity and the amount of carbon-dioxide present are checked. If any uncertain condition occurs then message is sent with the help of GSM to the forest and fire departments [5].

U.A Rane and Vaibhav proposed a Coal mine monitoring using ARM 7 and ZigBee for underground coal mining. They developed a system for sensing different environmental parameters of underground mines like temperature, humidity and gas. The sensed data is digitalized by analog to digital converter ARM7. Which gives fast execution and low power platform. The sensed will also be displayed on monitoring LCD. The communication will takes place using wireless sensor network [6].

## IV. PROPOSED SYSTEM

The way for preventing coal mine accidents is the prediction of outburst by implementing microcontrollers and sensors and to generate a buzzer system before critical atmospheric level. A continuous and real time monitoring is needed which requires some effective and accurate sensing module. Many methods are adopted to detect the presence of these poisonous gas, among them use of semiconductor type gas sensor is very much effective. These sensors can be placed in the coal mine area but some time these create some problems in mining too. Accidental damage of the sensor modules often took place. Another method is the use of robot. These robots are efficient but cost of robot is too high.

However, there is another method of getting efficient and low cost solution of sensor implantation; it is on the safety helmet of the coal mine laborers. A smart safety helmet, having array of sensors to sense data and a wireless module to transmit it is designed. The helmet is the only safety thing miners tend to keep on, this is where the new safety equipment was added on to. The project is created based on mainly two Modules and they are Helmet and Ground Modules.

The Ground module includes temperature sensor, metal detector sensor, PIR sensor as shown in Fig-1. PIR motion sensor, it alerts the human beings during the time of bomb blast. If any metal and poisonous gas detected that will also be sensed and through the wireless transmission, sensed data is also sent to the miner and it will display on LCD. The sensed data is displayed on LCD and alerts the particular miner who has encountered the hazardous event. Also it uploads data to the cloud for permanent storage using IoT.

### 4.1Ground Module

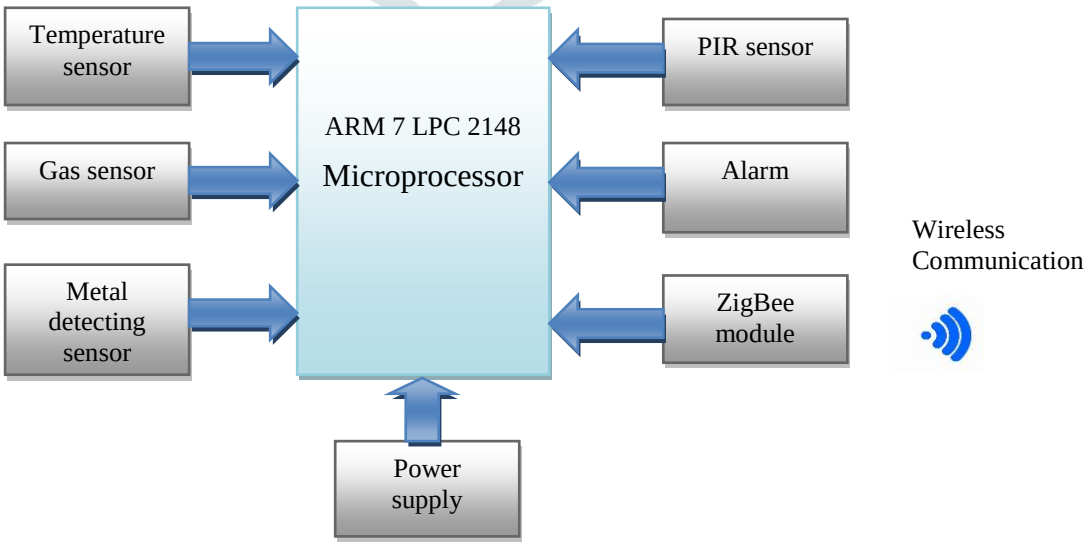


Fig-1 Block diagram of Ground module

### 4.2 Helmet Module

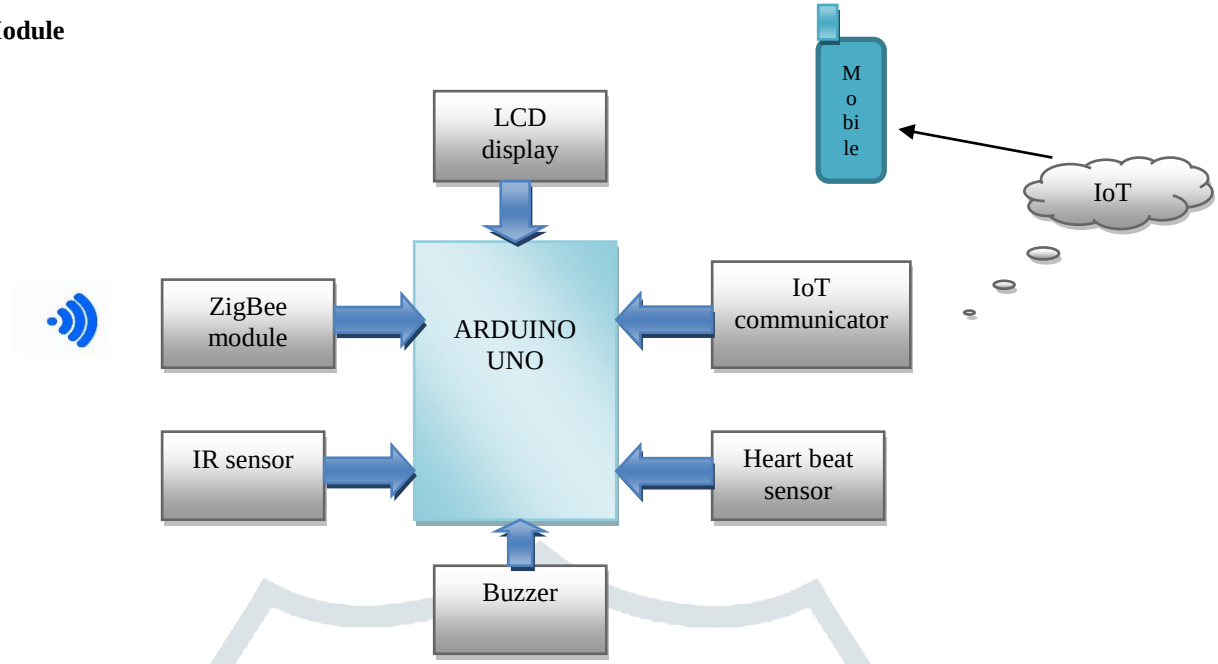


Fig-2 Block Diagram of helmet module

The helmet Module has a sensor network, which includes the sensors like-IR sensor; Heart beat sensor, Buzzer and IoT communicator (Wi-Fi) as shown in Fig-2. If the helmet of the miner is removed accidentally that information will be send to the monitoring center using IR sensor. Heartbeat sensor is used to measure the heartbeat rate of the miner. In the helmet Module ESP8266 module is used to connect the IoT, In the IoT blynk is used it is open source IoT. Through the blynk all the variation of sensed data can be monitored and can take precautionary to save the miner.

### 4.1 Flow Chart

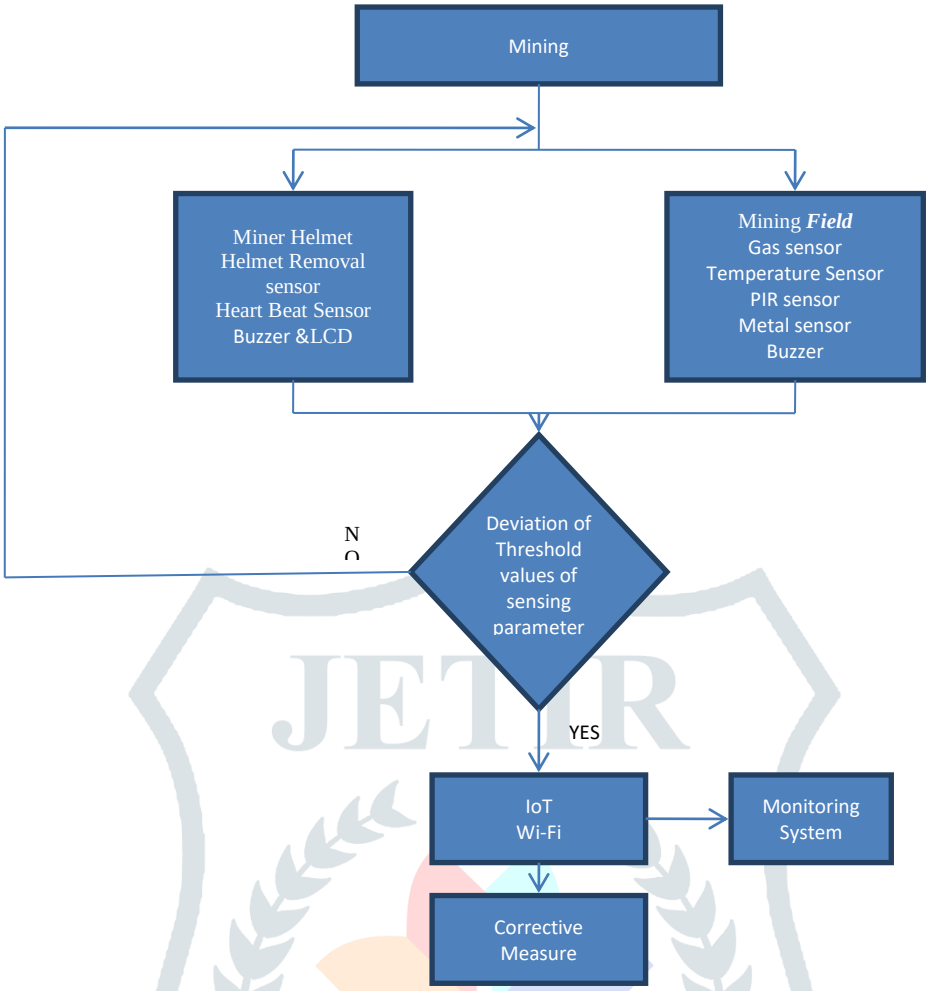


Fig-3 Flow Chart

The flow chart the mining consists of two Modules miner helmet and miner field. In these Modules, Miner Helmet consists of IR sensor, Heart beat sensor, Buzzer and LCD. If the miner helmet is removed then it senses through the IR sensor and it alert the miner through the buzz ring. The Heart beat sensor sense the miner Heart beat (bpm), it is displayed in the LCD. In the mining field the Nodal Module consists of Gas sensor, Temperature sensor, PIR sensor, Metal sensor and Buzzer. The Gas sensor check the quality of air in the mining field, if any toxic gas is present then it alert the miner through the displaying in LCD.

Temperature sensor senses the temperature of mining area and also used to check temperature condition to bomb blast. PIR is used detect the motion in mining area and also it is very important to know the any human beings is present in the mining area to bomb blasting time. Metal sensor is used to detect the metals in mining field after the bomb blast. In these, if any deviations of threshold values from sensors is occurred. If yes, then it will be also it is displayed in the LCD. By taking corrective measure can safeguard the miner from the accidents occurred displayed in monitor Module using IoT through Wi-Fi to take corrective measure to miner and in the mining area. If not occurred, then it go back to do the normal continuous checking process of the sensor threshold values as shown in Fig-3.

## V. RESULTS

Hardware connections and the results obtained from proposed system are shown below

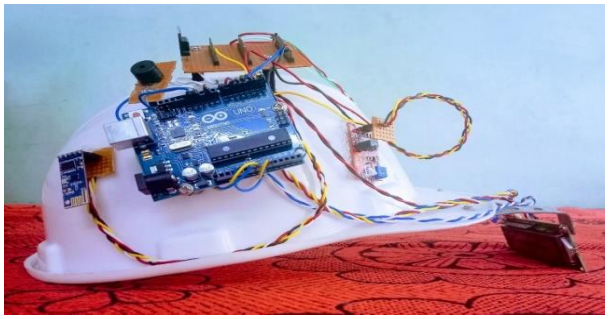

Fig-4 Hardware connection of Helmet module

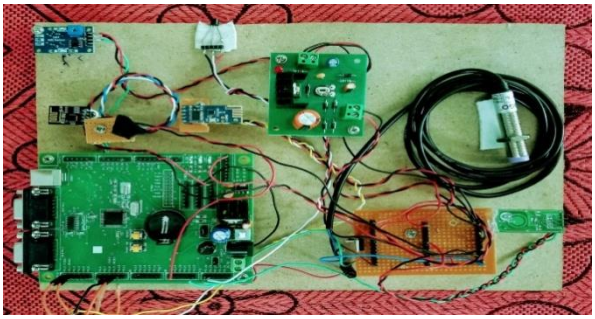

Fig-5 Hardware connection of Ground module

Hardware connection of helmet module and the ground module of the proposed system are shown in Fig-4 and Fig-5 respectively. Both modules communicate via ZigBee communication.


Fig-6 Gas detection display


Fig-7 Heart beat rate of miner


Fig-8 Metal detection display

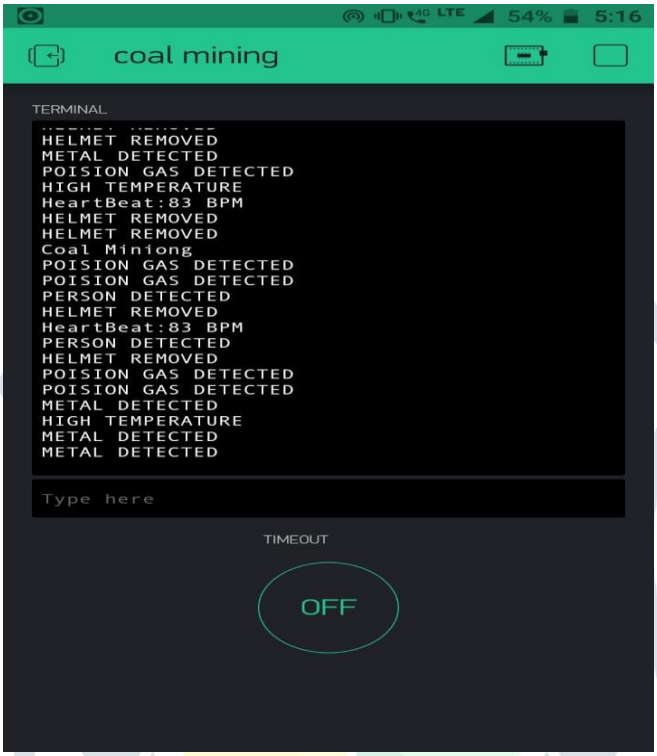


Fig-9 Output displayed in blynk app

Above figures shows the conditions of the mining area that are sensed by the sensors present in both the modules and displaying of those results in LCD present in the helmet module. In coal mines, bomb blasting is common in mining area, it discharges some toxic gases like methane (CH4), sulphur dioxide (SIO2), carbon monoxide (CO2) and some other gases causes negative response to miner health, If toxic gas is present in mining area, then it displayed on LCD shown in Fig-6.Monitoring of miner heart beat rate is shown in Fig-7, and it also displays in the blynk, Metal detecting sensor is used to detect the metal in mining area shown in Fig-8. The helmet removal of miner, temperature of mining area, PIR motion detection, All data can also be accessed in the mobile as shown aboveFig-9;and the timeout switch is used in the blynk to alert the miner by buzzer and the timeout message is also displayed on LCD and can be stored permanently using IoT.

## VI. CONCLUSION AND FUTURE SCOPES

The study on real time monitoring of toxic gases and other parameters present in underground mine has analysed using wireless sensor network. A real time monitoring system is developed to provide clearer and more point to point perspective of the mine. This system is displaying the parameters on the control Module 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. Alarm triggers when sensor value crosses the threshold level. This system also stores all the data in the IoT for future inspection. From the experiments and observations, the following conclusion can be drawn Each node in a particular framework functions as the pioneer robot when all its parameters are configured properly. Sensor nodes can reconfigure remotely over a wireless network and most of the processing done in software on computer side. The calibration equations of gas sensors may have affected the accuracy of the ppm results. This is a low cost and lifelong system. The system works according to the requirements specified, it was tested. The system can be enhanced by adding additional measuring instrument like object fall detection, water leakage, dust, vibrations etc,, and The other important data can be communicated through this system making it feasible where wired communication is a hindrance. Some new safety technology can also be adopt and canimprove the data transmission distance.

## VII. REFERENCES

[1] G.Prabhakar Reddy and M.Vijaya Lakshmi, *"IoT in Mines for Safety and Efficient Monitoring"* International Journal of Advanced Research in Computer Engineering And Technology(IJARCET) November 2015.

[2] Yongping Wu and GuoFeng, *"The study on coal mine monitoring using the Bluetooth wireless transmission system*", 2014 IEEE Workshop on Electronics, Computer and Applications, pp. 1016-1018, 2014.
[3] CHENG Qiang, SUN Ji-ping, ZHANG Zhe, ZHANG Fan *"ZigBee Based Intelligent Helmet for Coal Miners"* World Congress on Computer Science and Information Engineering 2009.
[4] Jingjiang Song ,Yingli Zhu and Fuzhou DongK, "automatic monitoring system for coal mine safety based on wireless sensor network", IEEE Radio Science and Wireless Technology Conference, pp.933-936, 201
[5] Madhu "Coalmine safety monitoring system", International journal of Mechanical Engineering and Technology (IJMET) Volume 8,Issue 12 ,December 2017
[6] Vaibhav Pandit and U.A Rane "Coal mining using ARM 7 and Zigbee" International Journal of Emerging Technology and Advanced Engineering(IJETAE)volume 3,Issue 5,May 2013.