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A SMART HELMET FOR COAL MINERS

V. Sai Prasanna Kumar, M. Shiva Rama Krishna, Dr K. Shambavi
Department of Electronics and Communication Engineering,
School of Electronics Engineering (SENSE),
Vellore Institute of Technology, Tamil Nadu, India.

ABSTRACT

Smart helmet is a device which can be used for coal miners safety. The device can be used to monitor the safety standards of the working conditions for coal miners. This device detects the temperature, humidity, harmful gas concentration, vibration. The data is analyzed and sent to the control room and the control room decides which action to take based on the parameters sent. This paper uses LoRa communication technology and GSM to send and receive information, Arduino to process the information. sensors such as MQ02, DHT11, IR sensor, vibration sensor to get the parameters. The main objective of using LoRa communication is to make sure the communication is strong even in the longer ranges where Zigbee runs out of range. The range provided by Zigbee is up to 300 meters whereas the range for LoRa can be up to 5 kms depending on the traffic in that area. The Arduino microcontroller processes the information received from the sensors and sends the information via LoRa and GSM. proper action can be taken by the control room and the workers can be evacuated or the conditions can be improved

Key words: LoRa communication, Coal Miners safety, Arduino, GSM, Sensors

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1. INTRODUCTION

In earlier days, people used to work in the underground coal mines using helmets with very less protection and they used to contain a light to see the path. Due to the increase in accidents in coal mines, for example on April 5 2010 Upper Big Branch Mine disaster has occurred in the united states of America, the Safety and Health Administration (MSHA) released its statement concluding that violation of safety protocol led to a major accident. It also declared that due to harmful gases many people lost their lives. The problem would have been minimized if they had detected it at an earlier stage. Due to advancements in technologies living in the modern era, we can eradicate all such problems with ease. Considering this problem we implemented a smart helmet which can be very effective with minimal weight also with inflated security.[1] C. J. Behr, A. Kumar and G. P. Hancke, A Smart Helmet for Air Quality and Hazardous Event Detection for the Industry", IEEE, PP. 2028-2031, 2016.In this paper there are air quality for

harmful gas detection, helmet removal sensor, collision sensor and zigbee for communication. [2] Prof. Deepali Shinkar1, Saili S Garad2, Manali S Joshi3, Komal A Nimbhorkar4, Amir R Patel5“iot Based Smart Helmet for Coal Mining Tracking” Volume: 06 Issue: 12 (IRJET) in this paper they implemented helmet using temperature humidity sensor, light sensor, air quality sensor, WIFI module and GSM . In the earlier papers on the smart helmet for coal miners used zigbee technology based on IOT and WIFI module which is not very effective at medium to long ranges. This smart device consists of 4 sensors and an alert will be sent as soon as a threat is detected. All the input data will be fed into the Arduino. The Arduino then evaluates all the data given by input and compares with the setup range, if any input data exceeds then it turns on the buzzer, sends a message to an authorized person, and also displays status on the computer screen at the control room. This setup is appropriate for the control room as it will be very helpful to monitor all the workers who were working in the coal mines. DHT 01 sensor to is used to detect and determine temperature, humidity ranges in the mines. The obstacle sensor is used to detect unwanted obstacles throughout the path. The vibration sensor is used to detect the falling rocks, objects beforehand and that helps in awarding the worker to save his life. To detect harmful gases such as SO2, CO2, NO2, NH3 MQ2 sensor has been used. After analyzing the data it will be transferred through LoRa communication. LoRa communication is a wireless communication that transfers data in a very efficient way. The whole circuit uses less power consumption.

2. SMART SYSTEM ARCHITECTURE

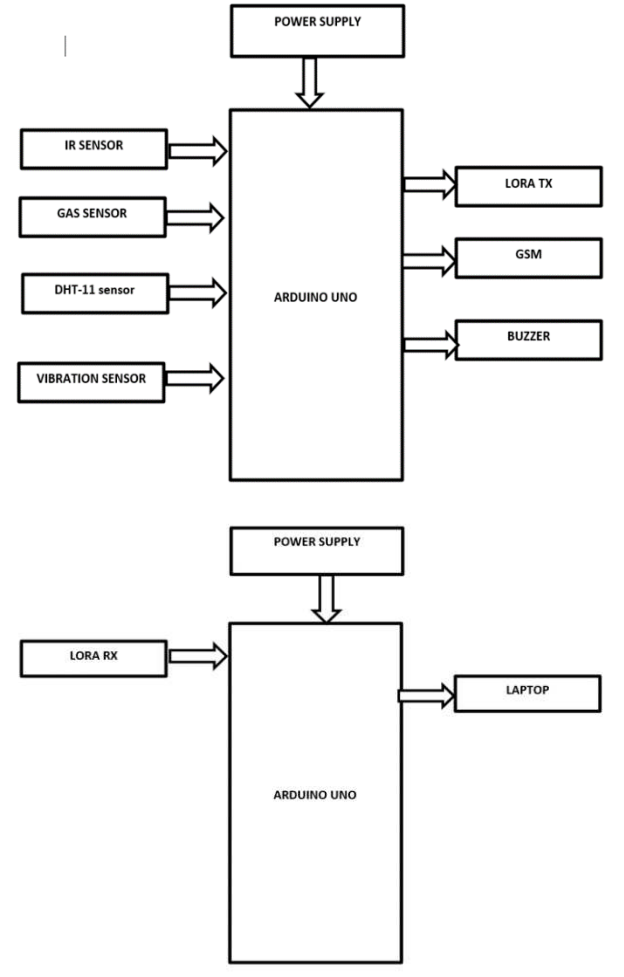


Figure 1 Smart System Architecture

Smart system architecture is divided into two parts transmitter part and receiver part transmitter part consists of 4 sensors- MQ 2 sensor, DHT 11 sensor, IR sensor and Vibration sensor. Arduino Uno, Power supply, LoRa communication transmission part, GSM and Buzzer. Receiver part consists of Arduino, LoRa communication receiver part, power supply, laptop.

2.1. Sensors

Figure (a)

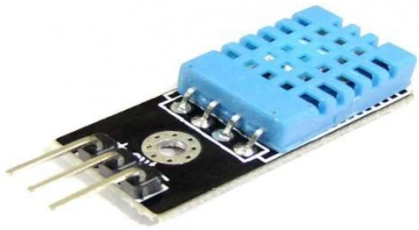


Figure (b)

Figure (c)

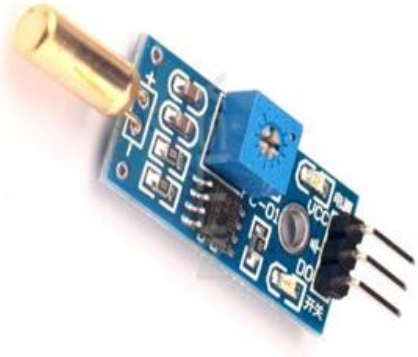


Figure (d)

Figure 2 Smart System Sensors: (a)-MQ02 Gas Sensor, (b)-DHT11 Sensor, (c) IR Sensor, (d) Vibration Sensor

(a) MQ02 GAS SENSOR

This sensor can be used to identify all the dangerous gases such as alcohol, NH3, liquified petroleum gas, carbon monoxide inside the coal mines. It will be very helpful for all dangerous gas leakages inside the mines. The required operating voltage for the MQ2 sensor is 5v.The response time it takes to detect gas is 20 seconds at maximum so, it detects a bit early.it is also cost-efficient.

(b) DHT11 SENSOR

The temperature and humidity values at any given time can be measured with DHT 11 Sensor. We can monitor all the readings in a digital way.it is small in size and this module has four pins one measures temperature another measures humidity other two for Vcc & ground. The response time for measuring temperature and humidity is 6 seconds. The power supply required is 3.3v to 5v. Temperature range will be 0 to 50 c whereas humidity ranges from 15% to 85% with 5% accuracy.

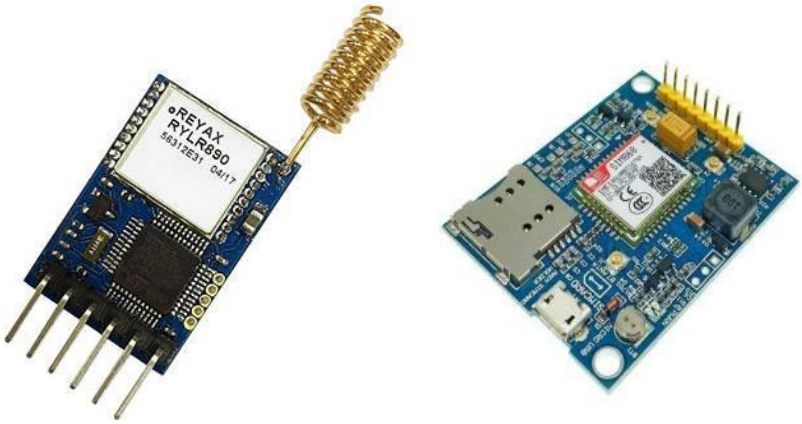
(c) Infrared Sensor

Infrared sensor module contains mainly an infrared transmitter and an infrared receiver. Obstacles inside the coal mine will be detected using an infrared sensor. The receiver collects the input from the surroundings and will transmit data to the transmitter then it detects the object. The object should be ranging from 20 to 60 from the input end from a few centimeters to certain feet.it required input voltage for operating around 5v.

(d) Vibration Sensor

Vibration sensor generally detects vibrations if it goes beyond the threshold. If any kind of hard substances such as rocks fall near this module it generally detects. It can easily vary the range depending upon the requirement by adjusting the threshold value. The operating voltage of the Vibration sensor is 5v.

2.2. Communication Module



(a) (b)

Figure 3(a) Lora Communication, (b) Global System For Mobile communication (GSM) 800

(a) Lora Communication

LoRa communication's transmitter and receiver are easy to use. It is used to transfer wireless data to a large distance with ease. It is also very power efficient. Transmitting setoff at around 910MHz-915MHz and sensitivity of a receiver around -146dbm whereas for transmitters it vary up to 18.5dBm at low power consumption.it can cover up to 15km within the range. The operating voltage around 2.0v to 3.5v. It provides a long data transmission.

(b) Global System for Mobile Communication (GSM) 800

GSM is very compact and can be easily injected into various electronics projects in which transmission of message signals is vital. It has 14 pins with a micro USB slot for transmission and receiving signals. GSM800 operates under a quad-band. It only works for frequencies starting from 800MHz to 1800MHz.It can be used to give alerts in the form of messages and phone calls. With the help of AT commands gsm800 can be controlled. Inputs can be sent through Arduino through the UART interface. GSM has only one Universal Asynchronous Receiver/Transmitter port. GSM 800 operates at 3.3v.

2.3. Processing Module

Figure 4 Arduino Uno

2.4. Arduino Uno

Arduino Uno is a type of microcontroller with various in-built sensors and electronics. For using multiple sensors in a protocol with many input interfaces Arduino will be used. Generally, Arduino boards are open-source hardware and software. Anyone can design them in various sizes and functions. We can select based on our needs and functionality. Arduino Uno can be easily programmable and consumes very little power. It is more power-efficient, so it makes it cost-effective. The Arduino Uno has a total of 25 pins in which there are 14 Digital input/ output pins in which 6 provide Pulse Width Modulation output, 8 are Analog input pins, one DC current per input/output pin with 40 mA, Flash memory of 32 KB, Sram of 2KB. Arduino helps to create projects without any connection issues as Arduino itself provides an open-source free IDE to program the Arduino. It makes the work easy.

3. METHODOLOGY

The smart system divided into two parts. The transmitter part consists of Arduino, DHT11 sensor, MQ 02 gas sensor, LoRa communication, GSM sim800a, Vibration sensor, IR sensor, power supply, The receiver part consists of LoRa communication, Arduino, power supply, laptop.

1. MQ 02 the Gas sensor is used to detect the levels of poisonous gas in the mine. If the value is greater than 990 ppm it sends a message saying “gas alert”.

2. DHt11 detects the temperature and humidity. If the value of temperature is greater than 36 it sends a message saying “temperature alert”. If the value of humidity is greater than 94 it sends a message saying “humidity alert”.

3. Vibration sensor detects sudden changes in movements. If c==0 it sends a message saying “vibration alert”.

4. IR sensor detects the obstacles and these sensors are interfaced with Arduino. If b==1 it sends a message saying “obstacle alert”.

5. The threshold for each of the readings of these sensors is set and if any value crosses the threshold, a buzzer is activated and alerts are sent to the receiver module and the mobile phone.

6. The receiver part receives the alerts along with mobile phone and specific action will be taken.

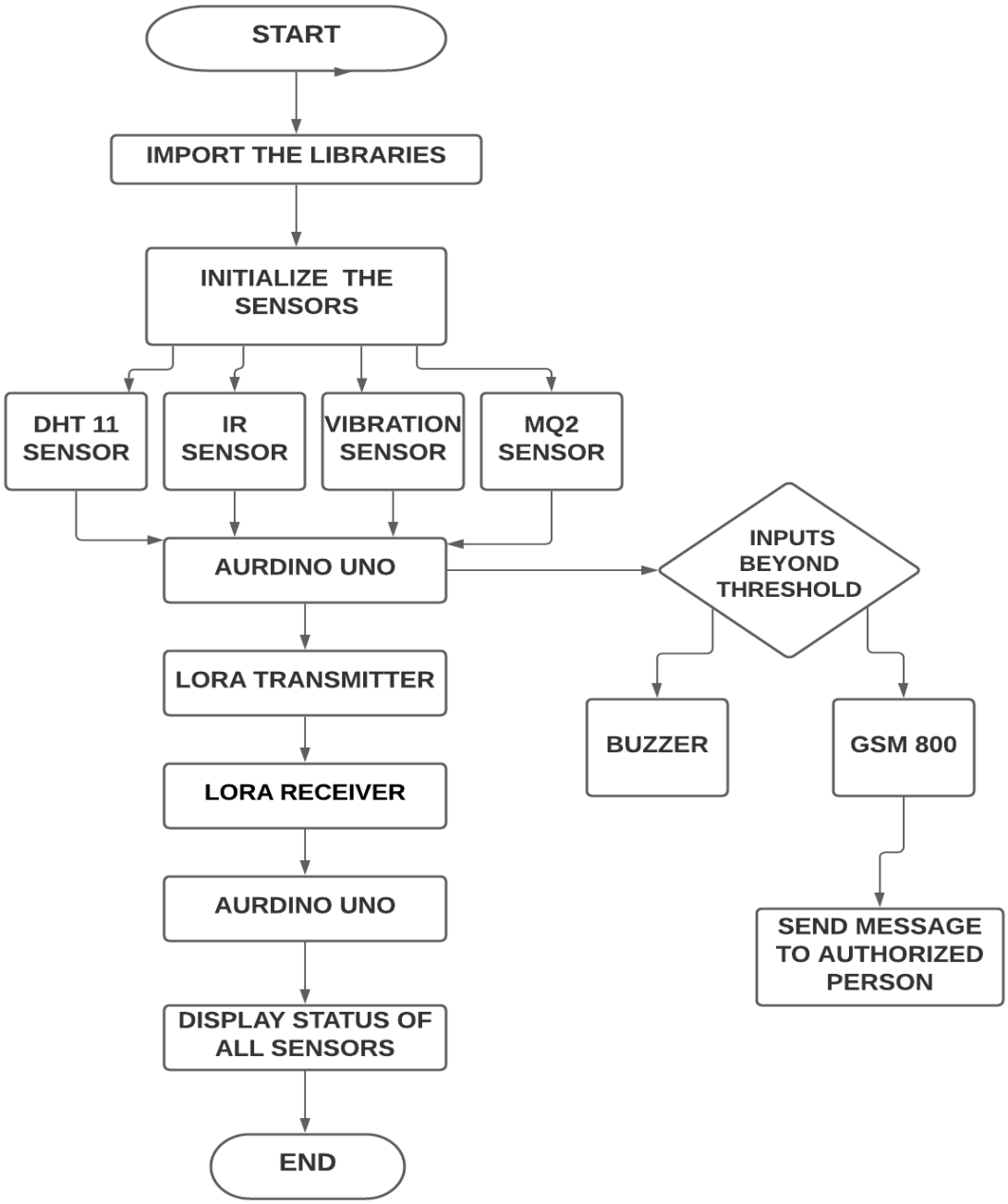


Figure 5. Flowchart of Smart System

4. RESULTS AND DISCUSSION

The proposed Smart Helmet System is shown in figure 6.1, 6.2

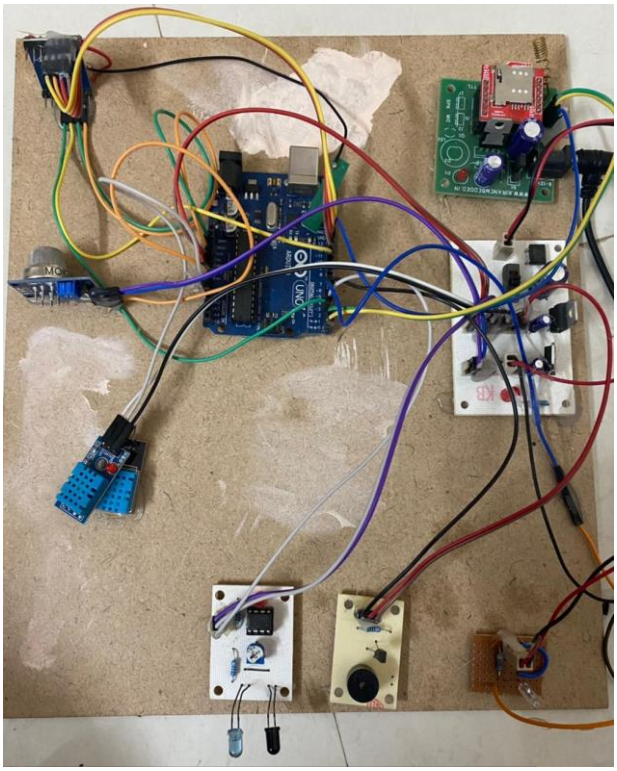


Figure 6.1 Smart Helmet

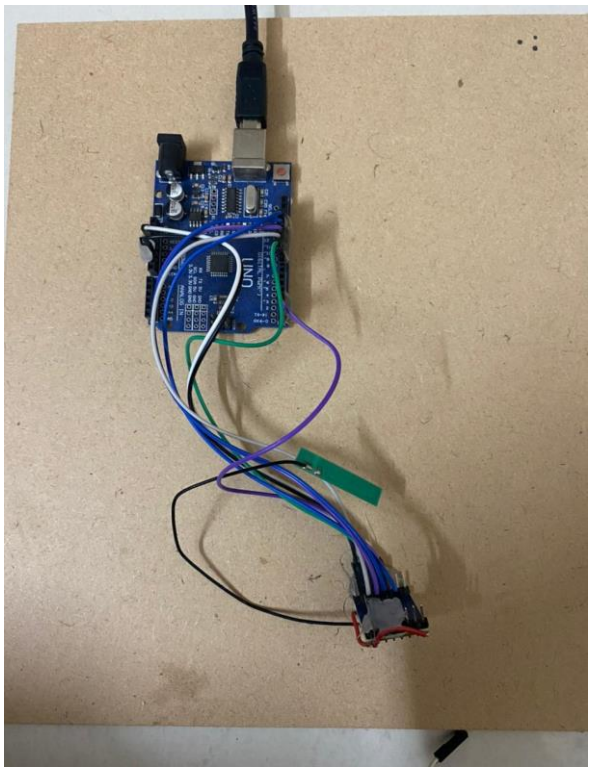


Figure 6.2 Receiver part

If the parameters for safety exceed the human threshold limit then alerts will be sent via GSM to the authorized personnel. Figure 6.3 depicts the message.

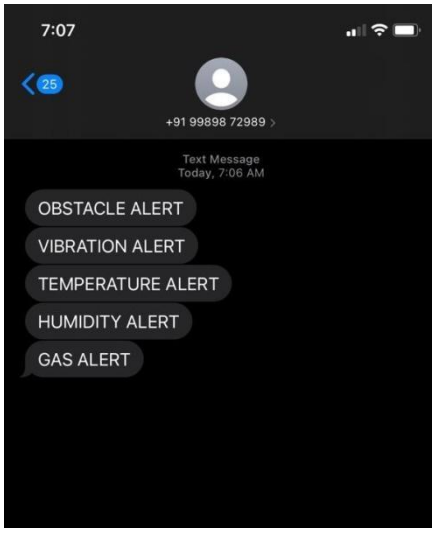


Figure 6.3

All the above mentioned parameters in fig 6.3 can be monitored on the laptop even if they don't exceed the threshold as shown in fig 6.4.

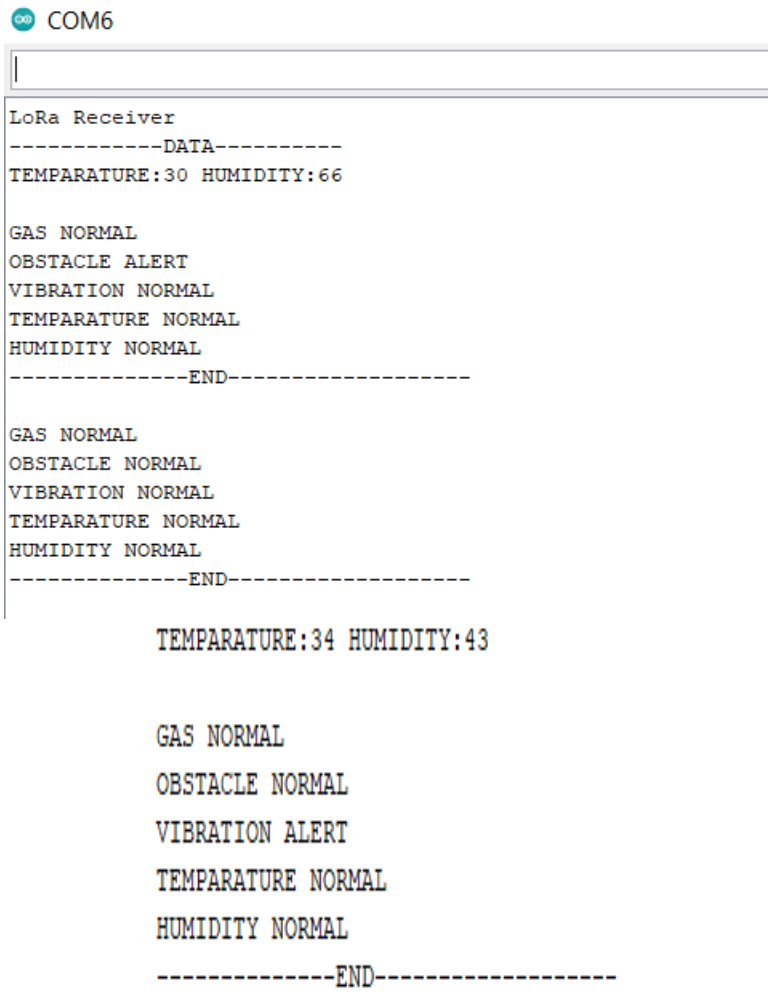


Figure 6.4 Output In Monitor

5. CONCLUSION

A device known as smart helmet was designed which was able to detect 5 types of hazardous situations such as harmful gases, high temperatures, humidity, obstacles and collisions. LoRa communication was used in order to communicate in the longer ranges within the mines within the span of 5 kilometers and reporting to control center. Therefore, monitoring the whole situation and evacuating miners in times of distress.

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