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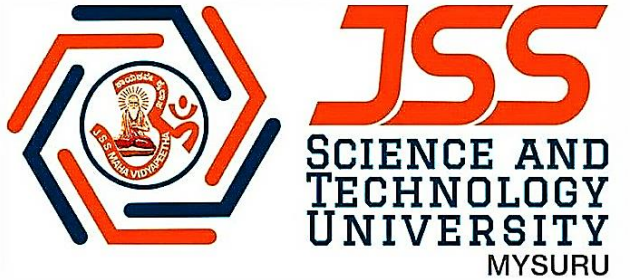

Report on

"SMART HELMET FOR COAL MINERS"

Carried out on

"EC67L – Design and Implementation Lab"

Submitted by

NAME	USN	Marks-E1
MD ZAID SALMAN	01JST19EC045	
P SUDARSHAN YADAV	01JST19EC057	
RISHITHA R GOWDA	01JST19EC070	

Under the guidance of

Prof. Shashidhar R & Prof. N Shiva Prasad

Assistant Professor

Department of E&CE

JSS S&TU, Mysuru

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

JSS SCIENCE AND TECHNOLOGY UNIVERSITY

JSS TECHNICAL INSTITUTIONS CAMPUS

MYSORE-570006

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Abstract

In recent days Coal mining has been dangerous activity for workers in mine during operation dangerous gases. gases like Sulphur, Methane might release into the air causes suffocation, gas explosions
this mini project is a continuous, real-time monitoring and surveillance system based on wireless communication (nRF module) to increase safety by monitoring various parameters such as temperature, humidity, dangerous gases (Methane), helmet wearing. Alongside alarming the control room operator, the worker will also be informed of the sort of danger considering the predicted protocols. As a result, the proposed system will increase the workers' safety and efficiency of the mining operation. They have chance to rescue his life from hazards occurs in coal miners.

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Chapter 1

INTRODUCTION:

1.1 OVERVIEW:

Extracting the coal from the ground is termed as coal mining. The coal is widely used to generate electricity since decades. During the early days, coal mining was done through manual digging and extracting. Those days, the miners used to employ conveyers, trucks, carts and hydraulic jacks etc. Now days, mining explosives and automatic equipment are widely used. Coal mining industry is one of the most dangerous industries in terms of number of deaths of its labor. There are number of reasons of mining disasters including leakage of poisonous gases, lack of oxygen (suffocation), explosions, roof collapses, malfunctioning of equipment etc. However, the number of deaths has been minimized worldwide by employing latest equipment and smart gadgets. It is still the area that needs serious actions to safeguard the lives of the miners. Every year, a large number of miners die in the developing countries like India, and Chile

The surveillance of the mining environment and the worker's health are considered essential parameters in mining. On the other hand, the workers tend to avoid bringing some safety equipment due to its weight, heat, etc. The current safety helmets are utilized to protect the worker's head against the impacts caused by objects drop off or colliding with protuberances inside the tunnel. In mining complexes, monitoring and appropriate communications are fundamental requirements for correctly managing human and machinery resources. Administrators should be aware of situations with hazard potentials. Therefore, it is crucial to have a monitoring and surveillance system to acquire the evaluated data, transmit it to the control center, and make the most appropriate decision at the earliest possible moment.

There are two types of communication networks for underground places: wired and wireless networks.

The wired networks have the following drawbacks:

- High installation and commissioning costs
- Being damaged during accidents
- High maintenance costs
- Time-consuming installation and repairing
- Difficult and time-consuming diagnoses

Regarding the mentioned disadvantages, implementing a wired network doesn't have technical and economic justifications. On the other hand, wireless networks do not have the weaknesses of the wired networks. Still, they are also technically and economically defensible, acquiring features such as high speed, high safety, self-diagnosis, remarkable reliability. To Address this Problem, we have developed a prototype model - Smart Helmet to assure extra safety among Mineworkers. This Will Help to Identify any Dangerous Changes in the Surroundings by Continuously Monitoring the Mining Environment through the Smart Helmet. The Sensor placed in the Helmet will help us to detect any Hazardous Changes and Alert the miners through Various Alerting Mechanism.

1.2 MOTIVATION:

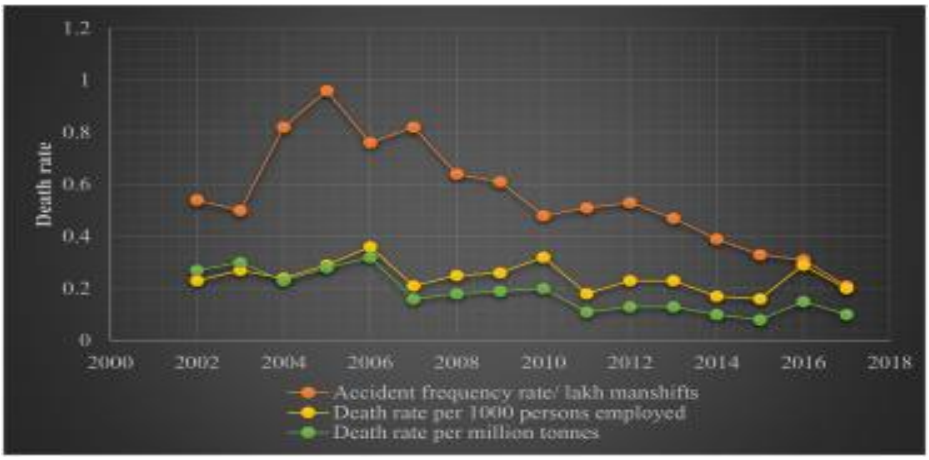

Fig.1.1: Accident data in mining area.

Mining is very important for the economy of any country as it generates various opportunities for many sectors. As a society, we are blessed to appreciate the benefits that this sector manufactures by processing these materials and products that supply us. As a result, we must provide security for the men and women who are now employed in coal mining. The goal of this study is to provide a solution to mining through communication and security monitoring. Coal mining has a unique function in the modern world; it has the potential to save the lives of coal miners by creating particular gadgets that can be extremely beneficial to the industry's workers. People working in underground coal mines must utilize several characteristics such as smart helmets with sensors such as removers, collision detectors, gas detectors, and the helmet.

1.3 PROBLEM STATEMENT:

The person who are working in the coal mining has to free various environmental parameters in their mining.so to overcome that problem we are using "Smart Helmet for Coal Miners". the Smart Helmet indication takes the required precautions to avoid any potentially dangerous situations and sends out a warning/alerts through lights and inform the base station.

1.4 OBJECTIVES:

The main purpose of this project is to provide safety for coal miners who work under ground for long time.

1. To design a device known as smart helmet which must be able to detect 3 types of hazardous situations such as harmful gases, high temperatures, humidity.
2. To send alert messages to workers working in the mine and report to the base station so they take necessary protocols in hazardous situations.

Chapter 2

LITERATURE SURVEY:

Abid et al. [1] and Mustafa Abro et al. They introduced an IoT-based jacket that can be worn. It is made for the safety of people or labour who work in coal mines and are regularly exposed to risks. This prototype is made in a way that senses many things, such as the occurrence of dangerous gases, the heartbeat of a worker in coal, underground environmental conditions, and pinpoints the location of the miner through GPS. These parameters will probably be transmitted via a WiFi protected channel to a dynamic internet protocol.Formalized paraphrase This group of students developed a device that pinpoints the exact location of the coal miner. The exact location of the person is obtained, which will save the precious life of any worker during any calamity. This system uses RFID for tracking and locating. As soon as an incident is reported, the pinpoint location will help them in the rescue.

D. Kock et al. [2] formed automation which serves coal miners in a very productive way. It was developed for the miners of South Africa. They conjointly researched the (CID) coal port detection. To do so, they employed two popular methods, like natural gamma radiation vibration and analysis

. Gaidhane et al. [3] suggested a system of safety for workers in mines, and it is based on Zig Bee technology. It also monitors gas levels, which are dangerous because most of the deaths that occur in mines are due to the deposition of hazardous gases in mines. As soon as the value crosses the threshold, the alarm is routed through ZigBee by blowing the alarm and lighting up different LEDs.

Cheng Qiang et al. [4] suggested a wireless communication system for coal miners that works on the IoT; it senses humidity, CH4 (Methane), and temperature levels for coal miners. The man who's tracking in the floor channel alarms the miner via voice communication regarding the incident that happened. Guo Feng and Yongping Wu et al. These researchers developed a device that is very useful for risk mitigation in areas where there is mineral exploration activity, such as coal, gold, etc. This system is best for finding the exact location of the coal worker. With this device, tracking is easy, and any help in an emergency can be delivered very quickly. The primary drawback of the system is that Bluetooth is a shortspace wireless technology, and the usage of cabling is tough

Al-Suwaidi & Zemerl (2009) [5]. They have suggested a system that has a remedy for various issues with the help of GPS. This application will search for a pinpoint location, and any missing coal worker can be traced easily with the help of GPS. In this system, the client-server architecture approach is utilized. The server allows the mobile phone of the client to register and login, and it saves its password and credentials in the database of the server. Pranjal Hazarika and colleagues [8]Designed for coal workers, this helmet is very suitable for underground coal exploration where there is a risk of dangerous gases such as methane and carbon, etc. This helmet contains sensors for the aforementioned harmful gases, and information is sent to the control room wirelessly, via a wireless module named ZigBee, linked with the helmet.

Srivastava (2015)[6] studied toxic gasses in critical areas and their effects on miners. He implemented a real-time monitoring system using a network of wireless sensors. This system controls environmental parameters like temperature, humidity, and several poisonous gasses. Furthermore, it possesses an alarm section in the helmet that informs the workers and the people around of the dangerous circumstance according to the type of the threatening danger and can confront the issue at the earliest possible moment. The system uses ZigBee technology to generate a wireless sensor

network. This network conforms to the IEEE 802.15.4 standard that is suitable to work under rough working conditions.

Kesavan, Balaji, Sivashankaran and Yogeshwaran (2013)[7] designed a smart safety helmet using ZigBee technology to monitor hazardous gasses, helmet removal from the head, and alert protocol. The analyzed gasses are Carbon monoxide, Sulfur dioxide, and Nitrogen dioxide.

Kumar and Reddy (2018)[8] designed a smart safety helmet to monitor dangerous gasses based on ZigBee. In addition, a stick is implemented on the safety helmets to identify the workers using Infra-Red (IR) sensors and to ensure the helmet wearing. Then they evaluated the blow to the head using micro-electromechanical switch (MEMS) sensors

. Behr, Kumar and Hancke (2016)[9] proposed a smart helmet to reduce mine dangers by analyzing three parameters of air quality, blow to head, and helmet wearing detection. The air quality factor includes the evaluation of the density of dangerous gasses.

Borkar and Baru (2018)[10] suggested generating a safe network using smart helmets to analyze the environmental conditions around the workers and real-time data transmission. Chi et al. (2014) described the relation for reconfigurable smart sensors for WSN industries on the Internet of Things (IoT) platform to gather all sensor data thoroughly. This system is designed based on the IEEE 1451 protocol. This system is totally convenient and fast to acquire real-time data quickly for the Internet of Things environment.

Maity, Das and Mukherjee (2012)[11] exhibited mineral parameters like unusual gasses, temperature, and humidity on a system to prevent the presence of dangerous gasses and high environmental temperature to workers.

Hermanus (2007)[12] investigated the performance of Occupational Health and Safety (OHS) against variations in the compositions of different sections in the mineral division of South Africa. They resulted that mining in South African suffers from a shortage of mutual interactions between workers and engineers, risk management education, and other things like these.

Misra, Kanhere, Ostry and Jha (2010)[13] described the common characteristics in a wide range of stressful environments, explained the factors that could affect communications while settling in these areas, and indicated the most challenging parameters in underground environments..

Chehri, Fortier and Tardif (2009) [14]investigated and evaluated the UWB-based WSN navigation system with high accuracy in underground mines. The objective of these systems is to detect equipment and miners under regular operation or emergency conditions in the galleries of the underground mines.

Hong Jiang and Shuangyou (2008)[15] designed a real-time monitoring and alarm system based on CAN-BUS technology for underground areas and acquired data. S3C2410 microprocessor and ZigBee are implemented in this system as the central core of the system and wireless sensor network to transmit data, respectively.

Chapter 3

METHODOLOGY:

HARDWARE & SOFTWARE REQUIREMENTS:

- Software requirements:

Arduino IDE

The Arduino IDE is an open-source software, which is used to write and upload code to the Arduino boards. The IDE application is suitable for different operating systems such as Windows, Mac OS X, and Linux. It supports the programming languages C and C++. Here, IDE stands for Integrated Development Environment. The program or code written in the Arduino IDE is often called as sketching. We need to connect the Genuine and Arduino board with the IDE to upload the sketch written in the Arduino IDE software. The sketch is saved with the extension '.ino.'

Fig .3.1: Arduino IDE Software

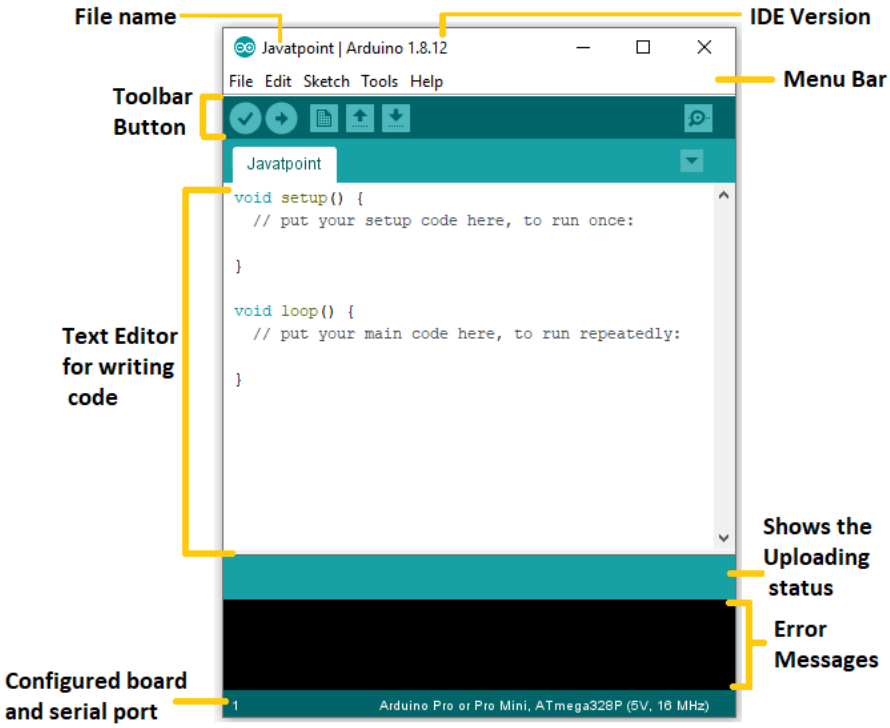

Fig. 3.2: IDE Environment

- Hardware requirements

1.Arduino Uno

is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

The word "uno" means "one" in Italian and was chosen to mark the initial release of Arduino Software. The Uno board is the first in a series of USB-based Arduino boards; it and version 1.0 of the Arduino IDE were the reference versions of Arduino, which have now evolved to newer releases. The ATmega328 on the board comes pre-programmed with a bootloader that allows uploading new code to it without the use of an external hardware programmer.

While the Uno communicates using the original STK500 protocol, it differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

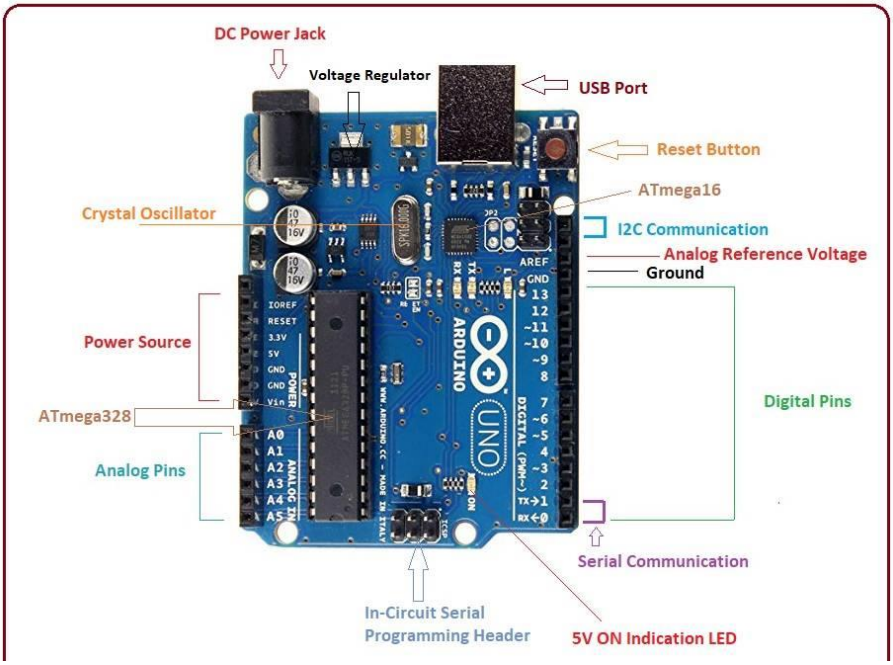

Fig 3.3: Arduino UNO

2.MQ 4 sensor

Sensitive material of MQ-4 gas sensor is SnO2, which with lower conductivity in clean air. When the target combustible gas exist the sensors conductivity increases higher along with the gas concentration rising.MQ-4 gas sensor has high sensitivity to Natural gas, Methane and could be used to detect both Methane and Propane. The sensor could be used to detect different combustible gas especially Methane, it's low cost and suitable for different application.

1. Detecting range: 300~10000ppm
2. Signal output indicator.
3. Dual Signal output (analog output and TTL output).
4. The TTL output signal is low level, allows us to connect with SCM directly.
5. Analog output 0~5V voltage.
6. Quick response and recovery.

Fig.3.4: MQ-4 Sensor

3.DHT11 Specifications

1. Operating Voltage: 3.5V to 5.5V
2. Operating current: 0.3mA (measuring) 60uA (standby)
3. Output: Serial data
4. Temperature Range: 0°C to 50°C
5. Humidity Range: 20% to 90%
6. Resolution: Temperature and Humidity both are 16-bit
7. Accuracy: ±1°C and ±1%

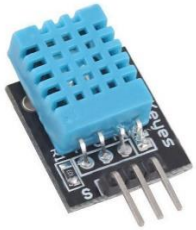

Fig. 3.5:DHT11 Sensor

4.IR Sensor

The main specifications and features of the IR sensor module include the following.

- The operating voltage is 5VDC
- I/O pins – 3.3V & 5V
- Mounting hole
- The range is up to 20 cm
- The supply current is 20mA
- The range of sensing is adjustable
- Fixed ambient light sensor

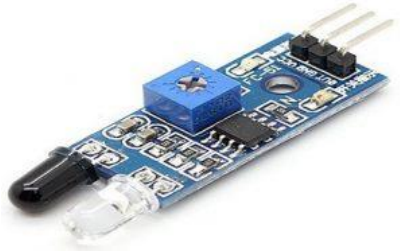

Fig. 3.6: IR Sensor

5.nRF Module

1. 2.4GHz RF transceiver Module
2. Operating Voltage: 3.3V
3. Nominal current: 50mA
4. Range: 50 – 200 feet
5. Operating current: 250mA (maximum)
6. Communication Protocol: SPI
7. Baud Rate: 250 kbps - 2 Mbps.
8. Channel Range: 125
9. Maximum Pipelines/node: 6
10. Low-cost wireless solution

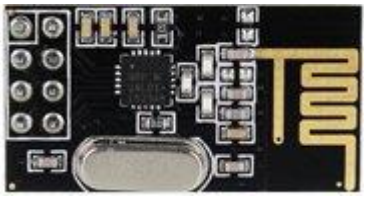

Fig .3.7 :nRF Transceiver

- BLOCK DIAGRAM

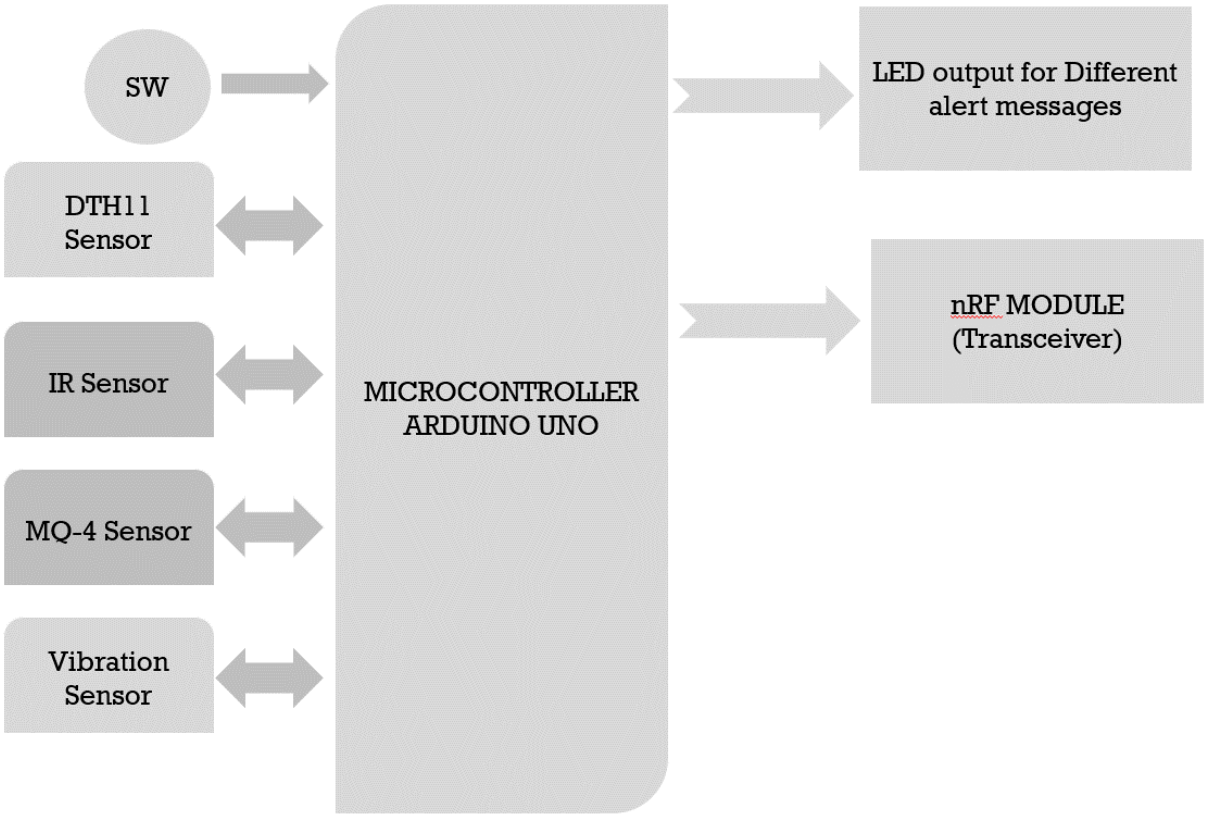

Fig.3.8:block diagram of transmitter part of our project.

In the proposed model we have 3 units
1.Sensing part
2.Actuating part
3.Communication

Sensing part consists of 3 major sensors like IR sensors to detect helmet is removed or not, MQ-4 gas sensor to know the level of poisonous gas level, DTH sensor to know the temperature and humidity

Actuating part consists of different colors LED for different sensors

Communication part consists of nRF24l01 trans receiver to send and receive alert messages from one system to another

Chapter 4

RESULTS & DISCUSSION:

The Figure 4.1 shows the circuit diagram implemented with integrated all sensors and attached nRF module over the helmet using Arduino UNO microcontroller with alert LEDs.

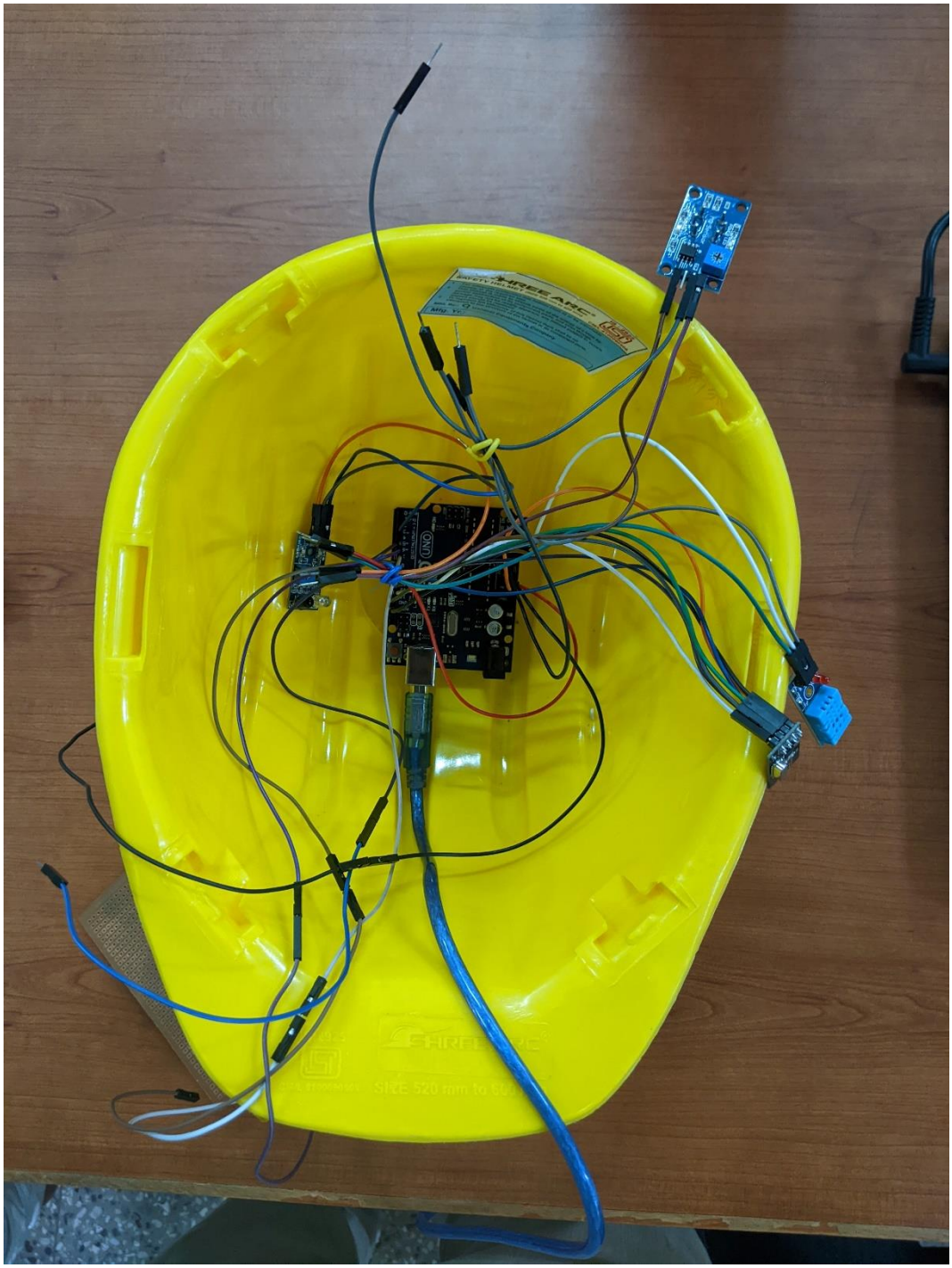

Fig.4.1: Smart helmet with transmitter module

Figure 4.2 shows the base station where the sensor data is monitered and for communication nRF module is used as reciever and different colour leds are used as warnings

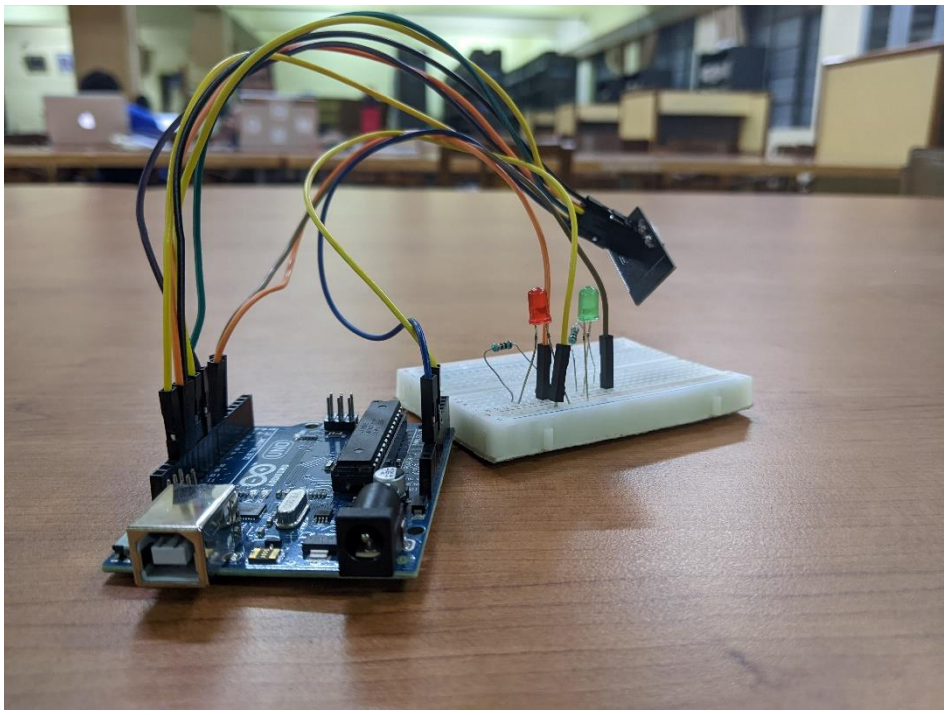

Fig.4.2: Base station Receiver module

The Fig 4.3 snippet of serial monitor displaying sensor data

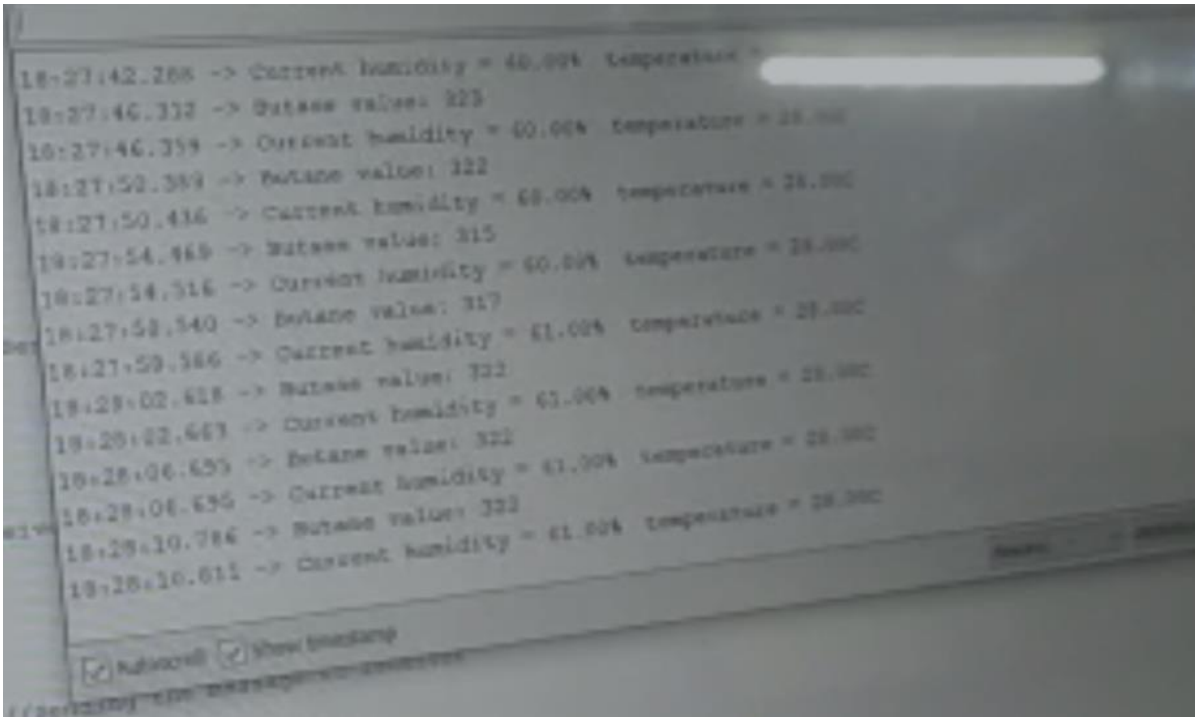

Fig.4.3 Sensor values on IDE

The Figure 4.4 Shows the Warning Levels in the Base Station at receiver end

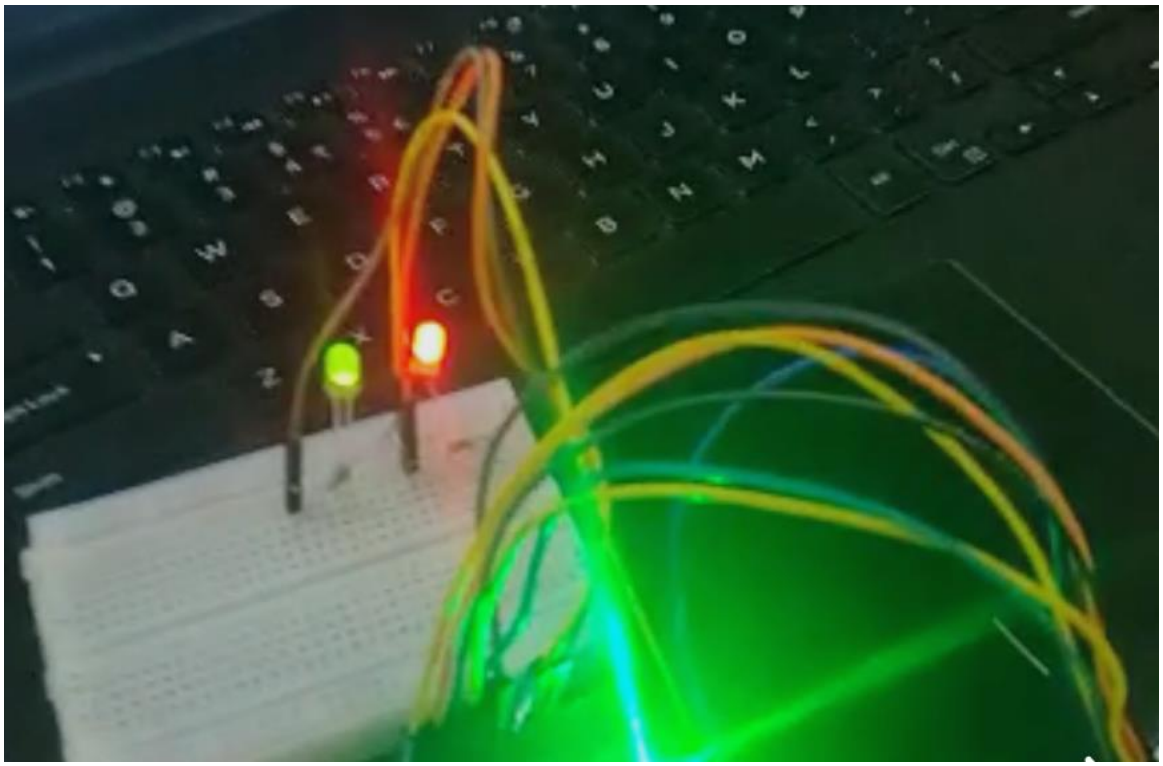

Fig.4.4. Base Station at Receiver

Chapter 5

CONCLUSIONS & FUTURE SCOPE:

5.1 CONCLUSION:

This project solves the Problem of coal miners to an extent by Alerting the Miners in Case of Any Emergency Conditions. The Sensors in the Miners Helmet Monitors all the Information in Realtime and in case of any Value Crosses the Threshold Value the Buzzer is Activated and the Emergency Rescue Protocol is followed. Through this smart helmet, the supervisor can continuously monitor the entire workers involved in mining process and can also get notification about the worker's condition and can immediately save the workers from any serious issues in case of emergency. Hence, we can reduce the death rate of the coal miners and provides increased security to them. The gadget is probably effortlessly extended. It will enhance gadget scalability and expand correct role of underground miners in future.

5.2 FUTURE SCOPE:

Further it can be improved by the integrating more sensors on the helmet such as heart rate sensor and other gas sensors in order to take safety measures over miner's health .and also Actual mine conditions with all the emergencies can be simulated and the miners can be trained in the simulated environment for better performance and intelligent responses. They must also be given proper training and licenses for the explosive handling inside the mines.

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