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Mini Project Report on

"SMART HELMET FOR COAL MINE WORKERS"

Submitted in the partial fulfillment of the requirement for the VI semester Mini-Projectwork

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In

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

CERTIFICATE

This is to Certify that the Mini Project work report entitled **"SMART HELMET FOR COAL MINE WORKERS"** carried out by **AMRUTHA J [1VK20EC002], ANIL KUMAR [1VK20EC003], NIKITHA S [1VK20EC017], SUNIL B K [1VK20EC023]** who are the bonafide students of Vivekananda Institute of Technology, Bengaluru, in partial fulfillment of the requirements for the award of the degree Bachelor of Engineering in Electronics and Communication Engineering of Visveswaraya Technology University, Belagavi, Karnataka during the academic year 2022-2023. It is certified that the corrections/suggestions indicated for the Internal Assessment have been incorporated in the Mini Project Report deposited in the department library. The Mini Project report has been approved as it satisfies the academic requirement with respect to the Mini Project work prescribed for the said degree.

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2.	

ABSTRACT

A traditional model of the smart helmet has been produced to assist miners operating in the mining industry. Many risky incidents commonly occur in the mining sector, many of which result in life threatening injuries or death. IoT has been recently expanded across different applications which brought a huge attention to the implementation of this project for the mining field, where a noisy industrial environment can take place in. The main objective of this project is to design and develop a smart helmet for mining industry application. The system will provide Realtime monitoring of the hazardous events such as increase in temperature and humidity, release of gasses like Methane and Carbon Monoxide, conscious and unconscious state of the miner, removal of helmet of the miner and obstacle damage to the helmet. The programming and troubleshooting will be conducted on mainly two sections, helmet section and control room section that means the system will have a transmitter to transmit necessary data to the control room or nearest manager and a receiver that can be used by the control room or the managers to grab the data and alerts from the transmitter. On the other side the system also syncs the data to the Webserver. The above systems include the use of several sensors like IR sensor, Proximity sensor, Humidity Sensor, Gas sensor, and several other modules and microprocessors like node MCU. On the major side it will take an attempt to keep Realtime data over the cloud to the database along with email alert.

ACKNOWLEDGEMENT

An engineer with only theoretical knowledge is not a complete engineer. Practical knowledge is very important to develop and apply engineering skills.

It is our pleasure to be indebted to various people, who directly or indirectly contributed to the development of this work and who influenced our thinking, behaviour and acts during the course of study.

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Chapter 1

INTRODUCTION

In the 21st century, the mining industry has become one of the most dominant sectors of the economy because of the increasing need for metals and other geological materials. Among all the minerals available, coal is used extensively in electricity production due to its high availability. It can be mined both by surface mining and underground mining. Thus, the safety of underground miners becomes paramount for the concerned authorities. Coal mines involve dangers like falling objects and the presence of dangerous gases like CH4 LPG, which could cause serious cardiovascular complications. Removal of helmets while operating in mines is additionally dangerous. If any bulky object falls on a mineworker's head even after putting on a helmet, the individual may become injured and could die if immediate treatment isn't provided. So, this smart helmet is built in such a way that it will notice all types of dangerous events with the assistance of devices that are mounted on it.

Multiple sensors are mounted on the smart helmet that will help to detect any change in environmental parameters and is also capable of tracking the miners' location incessantly. Industrial hazards consist of four principal hazards this is because industries employ many different processes involving a wide range of different raw materials, intermediates, waste products and final products. The hazards encountered are fire, explosion, toxic release and environmental damage. an industry that incorporates complexity activities carried out within tunnels, underground etc. involves a variety of harmful substances that affect the health of workers.

The Chasnala mines disaster strikes nearby Dhanbad in the Indian state of Jharkhand killed at least 372 people miners. This is considered as one of the worst disastrous mining industries. Workers may not notice the exterior conditions such as rising or falling temperature, pressure etc. Sometimes workers collide with complex objects such as mines objects, a solid rock that endangers their lives. Another factor is that it affects workers to inhale harmful gases that put them in danger. In this case the miners could not contact with the outside world.

The smart and protective helmet becomes an important and useful measure to protect workers from various dangers. This project aims in designing a smart helmet for the detection of dangerous events, to monitor the surrounding environmental conditions as well as updates information in central console. The project is developed by using an esp32 board, sensors, Panic switch, and an LCD display to develop a safety helmet that can monitor and alert workers about dangerous conditions in coal mines. The rapid development and advancement in technology have transformed various aspects of human life and industry, leading to more efficient and safer work environments. One such technology that has gained widespread attention is the Internet of Things (IoT), which enables the interconnection of devices and systems for im-proved data communication and management.

The mining industry is an essential sector that contributes significantly to the global economy. However, the work environment within mines is often hazardous and challenging, posing significant risks to the health and safety of miners. The advent of the Internet of Things (IoT) has opened new opportunities for enhancing safety standards and monitoring conditions in a mine. By leveraging the IoT's capabilities, it is possible to develop smart helmet and clothing system that can monitor hazardous events in real-time, paving the way for a safer and more efficient mining industry. Mining has been an essential economic activity for centuries, and despite the advancements in technology, the risks and challenges faced by miners remain significant.

The working conditions in mines are often characterized by high temperatures, high humidity levels, the release of harmful gases, and potential flooding. The project will also focus on addressing other critical challenges faced by the mining industry, such as water rise leading to flooding. The smart helmet system will include a dedicated alert mechanism for monitoring water rise levels, ensuring that appropriate safety measures are implemented in a timely manner. By incorporating various sensors, such as IR sensors, proximity sensors, humidity sensors, and gas sensors, the system can effectively detect multiple risk factors within the mine and provide real-time updates to managers and other relevant parties.

Chapter 2

LITERATURE SURVEY

The mining industry is plagued by numerous hazards, including high temperatures, humidity, gas emissions, and flooding. The safety and well-being of miners remain a critical concern, necessitating innovative solutions for real-time monitoring and hazard prevention. This literature review focuses on the development of a smart helmet and clothing system for mining industry applications, aiming to provide real-time monitoring of hazardous events and promote overall worker safety.

T Porselvi, et al., (2021),[1] The process of Underground mining operation through human laborers is a highly unsafe scenario where the risks 1 increase with the increase in distance from the ground. The mining operations with unsafe manners are due to different methodologies utilized by the miners for extricating diverse minerals. The longer the mine, the more prominent is the hazard. The safety measures execution is very poor, especially in the coal mine industries. Coal is an essential resource to every nation as it has many commercial applications. The most integral employments of coal are in the production of thermal power, cement, and steel production and as a fuel for numerous applications. The coal mines have numerous risky stipulations that include high temperature and humidity, discharge of destructive gases that make unsafe surroundings for specialists working there. Many employees are taking off their occupations in coal mines or no longer at all inclined to pick such employments as mining. This creates a lot of challenges in the accessibility of employees for the coal mining industry. The security of laborers working in coal mine industries is increasing day by day through technologies.

Behr, et al., (2016),[2] focuses on development of a smart helmet for air quality and hazardous event detection for the mining industry and proposed a smart helmet design for air quality and hazardous event detection in the mining industry. The helmet is equipped with various sensors to monitor air quality, detect hazardous events such as gas leaks, communicate the information to a central control room using wireless technology. The study highlights the significance of real-time monitoring for improving mine safety, emphasizing the potential of IoT devices in enhancing the working conditions for miners.

Eldemerdash, et al., (2020),[3] focuses on a system that provides real-time monitoring of hazardous events such as temperature and humidity increase, gas release, and conscious and unconscious state of the miner discussed in article" IoT based smart helmet for mining industry application" discusses the design and development of a smart helmet and clothing system for the mining industry. The article proposes a system consisting of several sensors like IR sensor, Proximity sensor, Humidity Sensor, Gas sensor, and several other modules and microprocessors like node MCU and Arduino. The system's programming and troubleshooting are conducted on mainly two sections: helmet section and control room section, where the transmitter transmits necessary data and alerts to the control room or nearest manager, and the receiver can be used to grab the data and alerts from the transmitter. The system also syncs the data to the Google Firebase database. The article discusses how the proposed system aims to increase safety and health for miners, which may attract more workers to this field. The article provides an in-depth review of existing IoT based solutions for the mining industry and identifies their limitations. The article concludes that the proposed system can solve several hazards and increase the level of safety and health for miners. The proposed system's use of several sensors and modules ensures that the system can detect and respond to hazardous events quickly. The use of Google Firebase database ensures that the data is securely stored and can be accessed by authorized personnel.

Punam S. Tajane, et al., (2020) [4], Are concerned. These risks are due in case of coal industries. Thus, safety of workers should always be of major consideration in any form of Underground mining operations proves to be a risky venture as far as the safety and health of workers are concerned. These risks are due to different techniques used for extracting different minerals. The deeper the mine, the greater is the risk. These safety issues are of grave concern especially in case of coal industries. Thus, safety of workers should always be of major consideration in any form of mining, whether it is coal or any other minerals. Underground coal mining involves a higher risk than open pit mining due to the problems of ventilation and potential for collapse. However, the utilization of heavy machinery and the methods performed during excavations result into safety risks in all types of mining. Modern mines often implement several safety procedures, education and training for workers, health and safety standards, which lead to substantial changes and improvements and safety level both in opencast and underground mining.

Kartik, et al., (2023),[5] proposes a smart helmet system for hazard detection in the mining industry in the article" IoT based Smart Helmet for Hazard Detection in mining industry". The system aims to provide real-time monitoring of hazardous events such as gas leakage, temperature and humidity increase, and helmet removal. The article proposes a system consisting of several sensors like gas sensors, humidity sensors, temperature sensors, and IR sensors that can detect hazardous events in the mining environment. The proposed system also includes a microcontroller and a transmitter to transmit the data to a central location, where it can be analyzed to detect hazardous events. The article discusses how the proposed system aims to improve safety and reduce the number of accidents in the mining industry. The article provides an in-depth review of existing solutions for detecting hazardous events in the mining industry and identifies their limitations. The article concludes that the proposed system can significantly improve safety and reduce the number of accidents in the mining industry. The use of multiple sensors ensures that the system can detect different types of hazardous events, increasing the system's effectiveness. The use of a microcontroller and a transmitter ensures that the data is transmitted in real-time, enabling timely responses to hazardous events.

Kim, et al., (2021),[6] discusses the design and development of a smart helmet-based personnel proximity warning system for the mining industry in the article" Smart helmet-based personnel proximity warning system for improving underground mine safety". The system aims to improve safety in underground mines by warning miners of the presence of other miners in their vicinity. The system uses a combination of ultrasonic sensors, infrared sensors, and RFID tags to detect the presence of other miners. The article proposes a system that uses an IoT platform to transmit the data from the sensors to a central location, where it can be analyzed to warn miners of the presence of other miners. The article provides an in-depth review of existing solutions for improving safety in underground mines and identifies their limitations.

Shruthi P. Borkar (2018) [7], The world is having an extensive and diverse mineral resources and large mining industry. The proper supervision and proper communication is very important requirement of a mining industry. Supervisors are held responsible for all injuries sustained under their supervision, and should therefore be aware of potentially risky situations. The problem addressed is the improvement of a equipment, being aware of one's surroundings can sometimes be challenging

However, miners generally do not remove their helmets. Presently mining safety helmets only have the purpose of protecting the miner's head against potential hazardous bumps. The safety helmets do not have any technology added to it to let miners know when a fellow miner has encountered a hazardous event. Therefore, the purpose of the project is to modify an existing mining safety helmet to make the helmet even safer by adding a wireless sensor node network. The task was extended to designing the system small enough to fit into the safety helmet and last long enough while running on battery power. A further challenge was to modify the helmet without changing its physical structure. The added weight had to be kept to a minimum. A mining helmet needs to be modified to improve miner safety by adding intelligence to the helmet. When a miner removes his helmet, he needs to be warned. If an object falls on a miner even when wearing his helmet, he can become unconscious or immobile. The system must determine whether or not a miner has sustained a life-threatening injury. These two events are defined as hazardous events. Thirdly, dangerous gases need to be detected and announced.

Rathod, et al., (2021), [8] discusses the design and development of a smart helmet for the mining industry the article" Smart Helmet for Detection of Unsafe Events in Mining Industry Based on IoT". The helmet is equipped with several sensors like a gas sensor, humidity sensor, and temperature sensor that can detect unsafe events in the mining environment. The article proposes a system that uses an IoT platform to transmit the data from the sensors to a central location, where it can be analyzed to detect unsafe events. The article discusses how the proposed system aims to improve safety and reduce the number of accidents in the mining industry. The article provides an in-depth review of existing solutions for detecting unsafe events in the mining industry and identifies their limitations. The article concludes that the proposed system can improve safety and reduce the number of accidents in the mining industry. The use of an IoT platform ensures that the data is transmitted in real-time, enabling timely responses to unsafe events.

Chapter 3

PROJECT OVERVIEW

3.1PROBLEM STATEMENT

The mining industry is known worldwide for its highly risky and hazardous working environment. Mining workers are affected by many hazards: -

- From ventilation problems, mine flooding, gas explosions, ceiling collapsing, mine haulage, sudden in rushes and mine inundation, spontaneous combustion, to un-optimized evacuation routes.
- There is no exact solution that can forecast these risks and avoid them even before they occur.
- Mine operators have been working for decades to ensure no fatal accident results in death, injury, or poor health of miners.
- Our Objective is to give a solution to design smart helmet that has sensors embedded in it.
- Securely transmit data to managers about hazardous conditions and the worker's physical conditions, improving safety overall.

3.2 OBJECTIVE

The primary motivation behind the "SMART HELMET FOR COAL MINE WORKERS" project is to improve the safety and well-being of coal mine workers. The project aims to reduce the number of accidents and fatalities in coal mines by providing real-time monitoring and alerts for dangerous conditions. The project also aims to provide workers with a user-friendly interface for monitoring and analysing the conditions inside the coal mine, which can help them to make informed decisions about their safety. By improving the safety and well-being of coal mine workers, the project can also increase productivity and reduce costs associated with accidents and health problems. Overall, the "SMART HELMET FOR COAL MINE WORKERS" project has the potential to significantly improve the safety and well-being of coal mine workers, making their work environment safer and more productive.

Chapter 4

METHODOLOGY

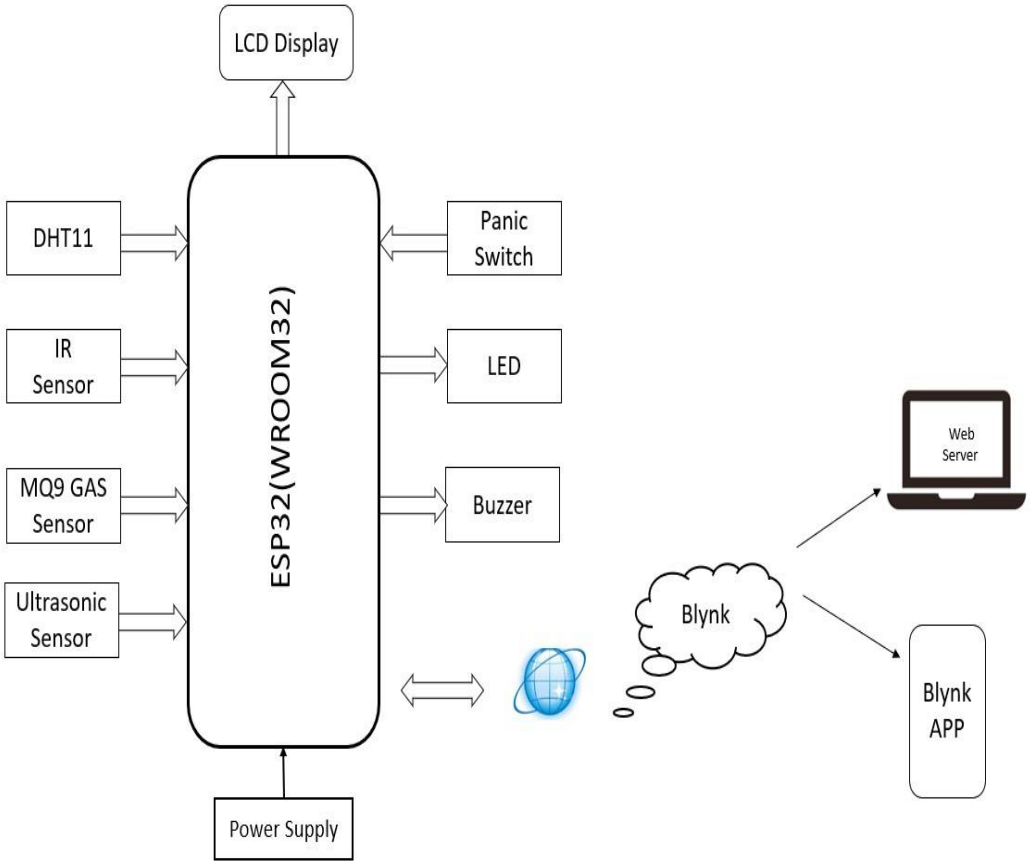

Fig 4.1 Block Diagram

The smart helmet consists of various sensors connected to ESP-32 board. The system gets activated when the following conditions are triggered: Sensors like Humidity Sensor, Temperature sensor, Gas Sensor, IR Proximity, Ultrasonic Sensor, Panic Button, etc. gets triggered when they undergo certain constrains according to the IDE program. The Sensors Readings are Displayed in the LCD Display Attached to the Helmet. If the sensors values exceed more than the threshold, Alerts are showed in LCD Display and the Buzzer makes Sound. Sensor readings are obtained for the infrared sensor, DHT11 temperature and humidity sensor, MQ9 gas sensor, and ultrasonic sensor (for measuring distance). Blynk.run () is called to handle Blynk-related tasks. Sensor readings are sent to the Blynk app using Blynk.virtualWrite().

To gather vital information about the environment, the SMART HELMET incorporates an array of sensors. These include temperature, humidity, gas, and smoke sensors, which continually monitor the conditions within the coal mine. The data collected by these sensors serves as the foundation for assessing potential hazards and risks. For immediate response during emergencies, the helmet features a Panic Switch that workers can activate when faced with imminent danger. This switch triggers an instant alert mechanism, ensuring that assistance can be provided swiftly and efficiently. To effectively communicate hazardous conditions to workers, the SMART HELMET employs a Buzzer and an LCD display. The Buzzer is programmed to emit audible alarms when dangerous situations are detected. This serves as an unmistakable warning signal, capturing the attention of workers in the vicinity. Simultaneously, the LCD display presents real-time feedback on the environment, providing workers with crucial information such as temperature, humidity, gas levels, and any pertinent alerts.

Programming and Connectivity:

The programming of the SMART HELMET's ESP32 Board is facilitated by the widely used Arduino Integrated Development Environment (IDE). This IDE, coupled with the ESP32 Board Support Package, provides developers with a familiar and accessible platform to code and configure the microcontroller. Through this programming, the ESP32 board reads data from the sensors, processes it, and triggers alerts when hazardous conditions are identified. Crucially, the SMART HELMET incorporates Wi-Fi connectivity to enable seamless communication with a webserver. Using standard protocols such as HTTP or MQTT, the helmet transmits the collected data to the webserver for further analysis and storage. By leveraging this web connectivity, the SMART HELMET contributes to a comprehensive safety ecosystem, enabling the accumulation of valuable data and facilitating continuous monitoring and historical record-keeping.

Chapter 5

REQUIREMENT ANALYSIS

5.1Hardware Requirements

- ESP32 (WROOM32)
- DHT11 Sensor
- MQ9 GAS SENSOR
- IR PROXIMITY SENSOR
- HC-SR04 ULTRASONIC SENSOR
- 20x4 LCD Display
- Panic Switch
- Buzzer

5.2 Software Requirements

- ARDUINO IDE
- BLYNK IOT
- Programming language C++

Component Description

5.3.1 ESP32-WROOM-32

ESP32-WROOM-32 is a powerful, generic Wi-Fi+BT+BLE MCU module that targets a wide variety of applications, ranging from low-power sensor networks to the most demanding tasks, such as voice encoding, music streaming and MP3 decoding. At the core of this module is the ESP32-D0WDQ6 chip. The chip embedded is designed to be scalable and adaptive. There are two CPU cores that can be individually controlled, and the CPU clock frequency is adjustable from 80 MHz to 240 MHz the user may also power off the CPU and make use of the low-power co-processor to constantly monitor the peripherals for changes or crossing of thresholds. ESP32 integrates a rich set of peripherals, ranging from capacitive touch sensors, Hall sensors, SD card interface, Ethernet, high-speed SPI, UART, I2S and 12C.

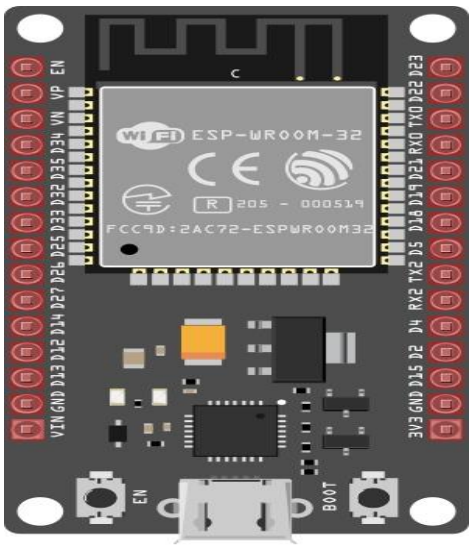

Fig 5.3.1a ESP32-WROOM-32 Board

The integration of Bluetooth, Bluetooth LE and Wi-Fi ensures that a wide range of applications can be targeted, and that the module is future proof: using Wi-Fi allows a large physical range and direct connection to the internet through a Wi-Fi router, while using Bluetooth allows the user to conveniently connect to the phone or broadcast low energy beacons for its detection. The sleep current of the ESP32 chip is less than 5 µA, making it suitable for battery powered and wearable electronics applications.

ESP32 supports a data rate of up to 150 Mbps, and 20.5 dBm output power at the antenna to ensure the widest physical range. As such the chip does offer industry-leading specifications and the best performance for electronic integration, range, power consumption, and connectivity. The operating system chosen for ESP32 is free RTOS with LwIP; TLS 1.2 with hardware acceleration is built in as well. Secure (encrypted) over the air (OTA) upgrade is also supported, so that developers can continually upgrade their product even after their release. The module also has a built-in web server which can be accessed through any web browser using is IP address. It serves as a controller to the rest of the components.

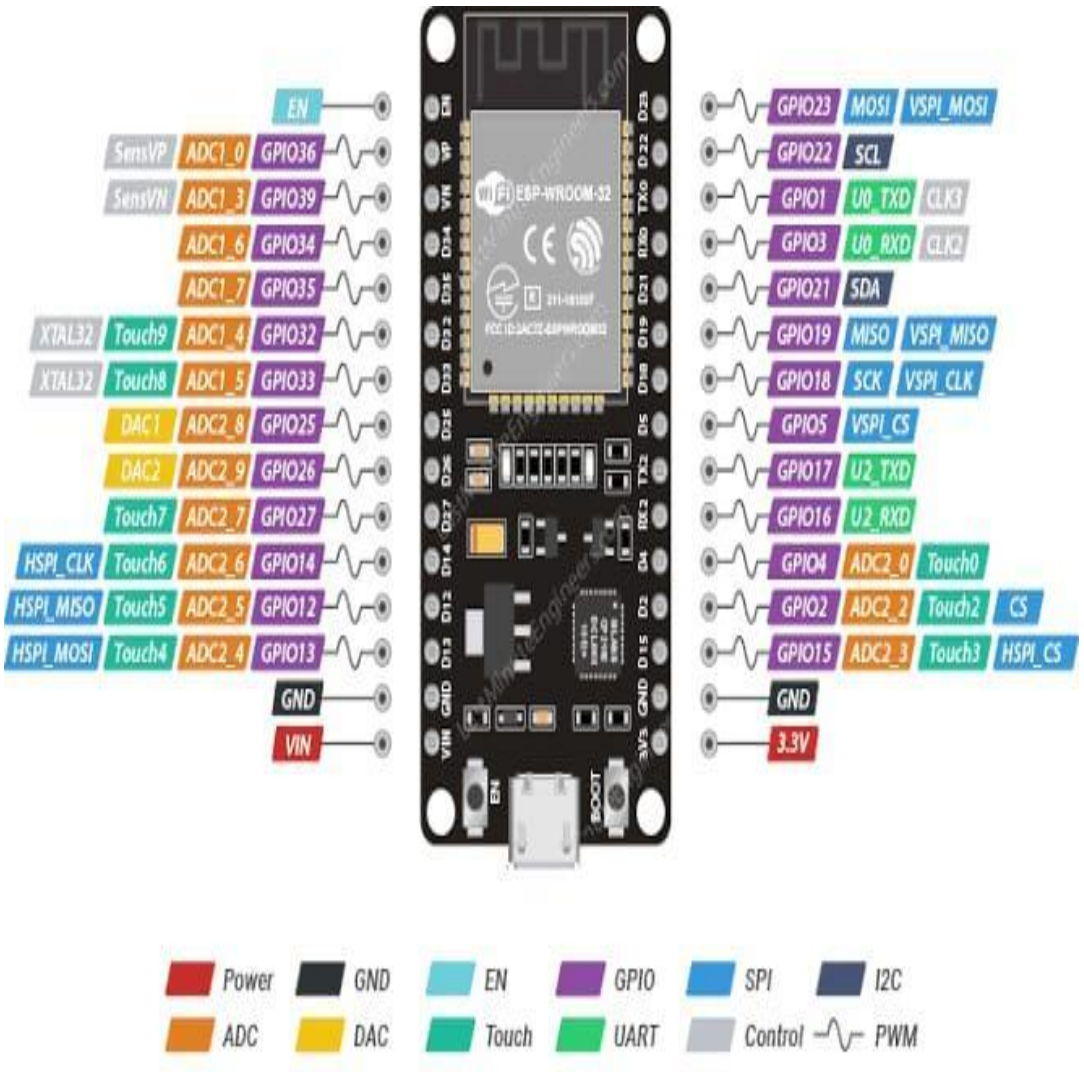

Fig 5.3.1b ESP32-WROOM-32 Board Pin out

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The module is powered by the ESP32 dual-core Tensilica LX6 microcontroller, which operates at a clock frequency of up to 240 MHz's It is based on the Xtensa architecture and provides ample processing power for various applications. The ESP32-WROOM-32 supports both Wi-Fi 802.11b/g/n and Bluetooth 4.2. It offers robust Wi-Fi connectivity for wireless communication and can act as both a station (client) and an access point (AP). The integrated Bluetooth functionality enables easy integration with other Bluetooth devices. It has 4MB of flash memory for program storage and data storage. Additionally, it has 520KB of SRAM for general-purpose usage. It provides a number of GPIO (General-Purpose Input/Output) pins, which can be configured for various purposes such as digital input/output, PWM (Pulse Width Modulation), I2C (Inter-Integrated Circuit), SPI (Serial Peripheral Interface), and UART (Universal Asynchronous Receiver-Transmitter) communication. It features several peripherals, including touch sensors, temperature sensors, hall effect sensors, and capacitive sensing interfaces. These allow you to interface with a wide range of external sensors and devices. The module has a power management unit that supports various power modes, allowing efficient power consumption and battery operation for low-power applications.

5.3.2 DHT11 SENSOR

DHT11 is a low-cost digital sensor for sensing temperature and humidity. This sensor can be easily interfaced with any micro-controller such as Arduino, Raspberry Pi etc.… to measure humidity and temperature instantaneously. DHT11 humidity and temperature sensor is available as a sensor and as a module. The difference between this sensor and module is the pull-up resistor and a power-on LED. DHT11 is a relative humidity sensor. DHT11 sensor consists of a capacitive humidity sensing element and a thermistor for sensing temperature. The humidity sensing capacitor has two electrodes with a moisture holding substrate as a dielectric between them. Change in the capacitance value occurs with the change in humidity levels.

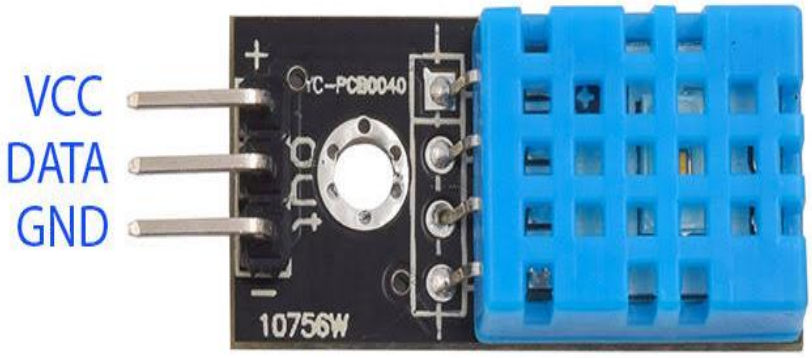

Fig 5.3.2 DHT11 Sensor

The IC measure, process this changed resistance values and change them into digital form. For measuring temperature this sensor uses a Negative Temperature coefficient thermistor, which causes a decrease in its resistance value with increase in temperature. To get larger resistance value even for the smallest change in temperature, this sensor is usually made up of semiconductor ceramics or polymer. The temperature range of DHT11 is from 0 to 50 degree Celsius with a 2-degree accuracy. Humidity range of this sensor is from 20 to 80% with 5% accuracy. The sampling rate of this sensor is 1Hz.i.e., it gives one reading for every second. DHT11 is small in size with operating voltage from 3 to 5 volts. The maximum current used while measuring is 2. 5mA.DHT11 sensor has four pins- VCC, GND, Data Pin and a not connected pin. A pull-up resistor of 5k to 10k ohms is provided for communication between sensor and micro-controller. This sensor is used in various applications such as measuring humidity and temperature values in heating, ventilation and air conditioning systems.

5.3.3 IR PROXIMITY SENSOR

An infrared sensor is an electronic device that emits infrared light in order to detect certain features of the environment. An infrared sensor can detect motion as well as measure the heat of an item. The term "passive IR sensor" refers to a sensor that just measures infrared radiation rather than emitting it. These are radiations that are invisible to the naked eye but can be detected by an infrared sensor.

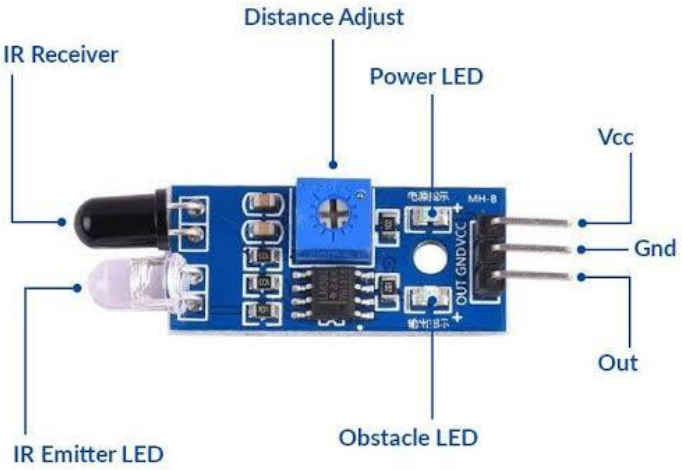

Fig 5.3.3 IR proximity sensor

The emitter is a simple IR LED (Infrared Light Emitting Diode), and the detector is a simple IR photodiode that detects IR light of the same wavelength as the IR LED. The resistances and output voltages fluctuate in accordance to the magnitude of the IR light received as it falls on the photodiode. An IR sensor is made comprised of an IR LED and an IR Photodiode, which are referred to as a Photo–Coupler or Opto–Coupler when used together. As previously stated, the Infrared Obstacle Sensor includes an IR transmitter and receiver. A light emitting diode (LED) that produces infrared radiation is known as an infrared transmitter. As a result, they are referred to as IR LEDs.

Although an IR LED appears to be a regular LED, the radiation it emits is invisible to the naked eye. Because they detect the radiation from an IR transmitter, infrared receivers are also known as infrared sensors. Photodiodes and phototransistors are two types of infrared receivers. Infrared Photodiodes differ from regular photodiodes in that they only sense infrared energy. When the IR transmitter sends out radiation, some of it reaches the object and is reflected back to the IR receiver. The sensor's output is determined by the intensity of the IR receiver's reception.

5.3.4 MQ9 Sensor

Fig 5.3.4 MQ9 Sensor

The MQ9 is a methane, carbon monoxide gas detection sensor. The sensor includes tin dioxide as its sensing element. The SnO2 (tin dioxide) has lower conductivity in pure air. When the air has carbon Monoxide, Coal, Liquefied, flammable gases, the conductivity of the sensor gets higher. A simple device makes measuring this change in conductivity and turning it into obvious data. However, the sensor requires some calibration. Before using the module, one must have to calibrate this sensor. This sensor estimates the flammable gas concentration using a resistance ratio. This ratio includes Maximum sensor resistance in 1000ppm R0 and internal resistance Rs. In pure air, after preheating, you need to upload the calibration code and wait for fifteen minutes until R0 reaches a fixed value.

Applications of MQ9 Sensor

- **Domestic Gas Leakage:**

The goal of detecting a gas leak is to prevent the worst potential causes of the gas leak, using the above type of MQ sensor. The choice of the MQ9 sensor is because of MQ9 which is suitable for detecting natural gas.

- **Industrial Gas Detector:**

The environmental, industrial gas detector can provide a suitable monitoring method that uses an MQ9 sensor. This is a lightweight, customer-friendly, and low-cost air monitoring device that can measure Methane gas we can use for safety purposes in industries.

5.3.5 HC-SR04 Ultrasonic sensor

HC-SR04 is a type of ultrasonic sensor which uses sonar to find out the distance of the object from the sensor. It provides an outstanding range of non-contact detection with high accuracy & the stable readings. It includes two modules like ultrasonic transmitter & receiver. This sensor is used in a variety of applications like measurement of direction and speed, burglar alarms, medical, sonar, humidifiers, wireless charging, non-destructive testing, and ultrasonography. The HC-SR04 ultrasonic sensor includes a transmitter & a receiver. This sensor is used to find out the distance from the objective. Here the amount of time taken to transmit and receive the waves will decide the distance between the sensor and an object. The range of this sensor available between 2cms to 400cms.

The HC-SR04 Ultrasonic sensor comes with four pins namely Vcc pin, Trigger pin, Echo pin, & Ground pin. This sensor is used to measure the accurate distance between the target and the sensor. This sensor mostly works on the sound waves. When the power supply is given to this module, it generates the sound waves to travel throughout the air to hit the necessary object. These waves strike and come back from the object, then collects by the receiver module. Here both the distance as well as time has taken is directly proportional because the time taken for more distance is high. If the trigger pin is kept high for 10 µs, then the ultrasonic waves will be generated which will travel at the sound speed. So, it creates eight cycles of sonic burst that will be gathered within the Echo pin. This ultrasonic sensor is interfaced with Arduino to gauge the necessary distance between sensor & object.

Fig 5.3.5 HC-SR04 Ultrasonic Sensor

5.3.6 16×2 LCD

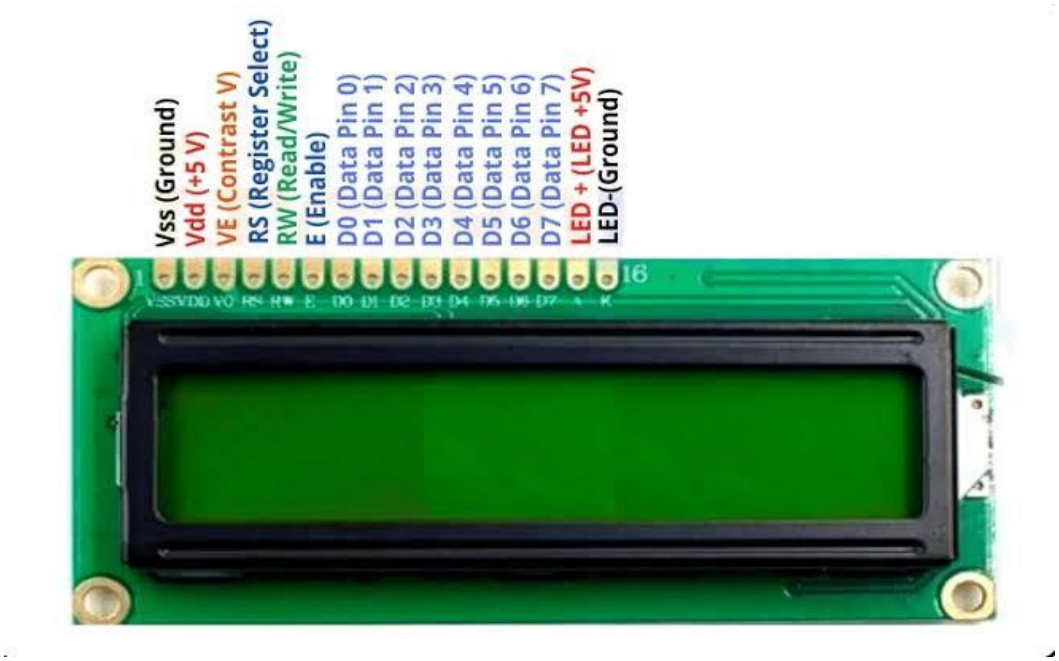

Fig 5.3.6 16×2 LCD

16×2 LCD is one kind of electronic device used to display the message and data. The term LCD full form is Liquid Crystal Display. The display is named 16×2 LCD because it has 16 Columns and 2 Rows. it can be displayed (16×2=32) 32 characters in total and each character will be made of 5×8 Pixel Dots. These displays are mainly based on multi-segment light-emitting diodes. 16 x 2 LCD display modules are constant of 16 Columns and 2 Rows. The 1st row of this module has a total of 16 columns 0 to 15 and the position of the first row is 0. Also, the 2nd row has a total of 16 columns 0 to 15 and the position of the second row is position is 1. So, the total numbers of the column are 16 x 2 = 32. Its means 16 x 2 LCD module can display 32 characters at the same time.

Each column will be made of 5×8 Pixel Dots. So, every character will be made of 5×8 = 40 Pixel Dots. It means total display has (32×40) 1280 Pixels. It will be a very complicated task to handle everything with the help of a microcontroller. So, an Interface IC like HD44780 is used, which is mounted on the backside of the LCD Module. The function of this IC is to get the Commands and Data from the microcontroller and process them to display meaningful information onto the LCD Screen.

5.3.7 I2C

Fig 5.3.7 I2C

Due to limited pin resources in a microcontroller/microprocessor, controlling an LCD panel could be tedious. Serial to Parallel adapters such as the I2C serial interface adapter module with PCF8574 chip makes the work easy with just two pins. The serial interface adapter can be connected to a 16x2 LCD and provides two signal output pins (SDA and SCL) which can be used to communicate with an MCU/MPU. I2C Module has an inbuilt PCF8574 I2C chip that converts I2C serial data to parallel data for the LCD display. These modules are currently supplied with a default I2C address of either 0x27 or 0x3F. To determine which version, you have checked the black I2C adaptor board on the underside of the module. If there 3 sets of pads labelled A0, A1, & A2 then the default address will be 0x3F. If there are no pads the default address will be 0x27. The module has a contrast adjustment pot on the underside of the display. This may require adjusting for the screen to display text correctly.

I2C (Inter-Integrated Circuit) is a widely used serial communication protocol that enables devices to communicate with each other using a two-wire bus. The bus consists of a data line (SDA) and a clock line (SCL). In the I2C protocol, devices are classified as either masters or slaves. The master device initiates communication by generating the clock signal and addressing specific slave devices through their unique addresses. Slaves respond to the master's requests by sending or receiving data. Multiple devices can be connected to the same I2C bus, each with its own unique address. The protocol supports different data transfer speeds, including standard, fast, and high-speed modes, with the slowest device determining the overall speed. I2C also includes features such as clock stretching, which allows a slave to pause the clock line if it needs more time to process data.

5.3.8 7805 Voltage Regulator IC

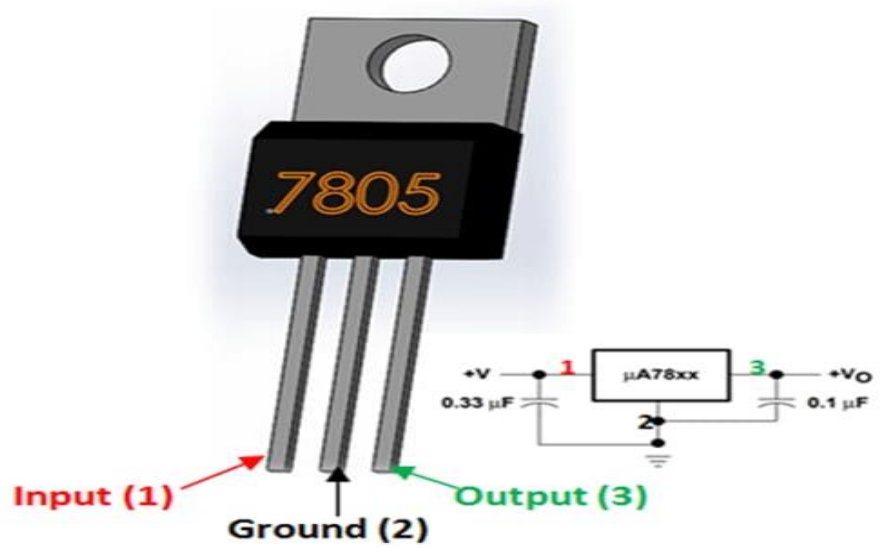

Fig 5.3.8 7805 voltage regulator IC

The 7805-voltage regulator is a popular integrated circuit (IC) that belongs to the 78xx series of fixed linear voltage regulators. It is specifically designed to provide a constant, regulated output voltage of +5 volts. The "78" in the part number indicates that it is a positive voltage regulator, while the "05" indicates the output voltage of 5 volts.

The 7805 typically operates with an input voltage ranging from 7 volts to 35 volts (although it can handle higher voltages up to 40 volts in some cases). The input voltage must be at least a few volts higher than the desired regulated output voltage. The output voltage of the 7805 is fixed at +5 volts. It provides a stable and regulated DC voltage, which can be used to power various electronic circuits and devices. It is a linear voltage regulator, which means it regulates the output voltage by dissipating excess energy as heat. It has built-in circuitry to maintain a constant output voltage even when the input voltage or load current varies within specified limits. 7805 is available in different variants with varying current-handling capabilities, such as 1A, 1.5A, and 2A. The specific variant you use will depend on your application's power requirements. Pin Configuration: The 7805 IC typically has three pins: Input (Vin), Ground (GND), and Output (Vout). The input pin is connected to the unregulated DC voltage source, the ground pin is connected to the circuit's common reference point, and the output pin provides the regulated +5V output.

5.3.9 Buzzer

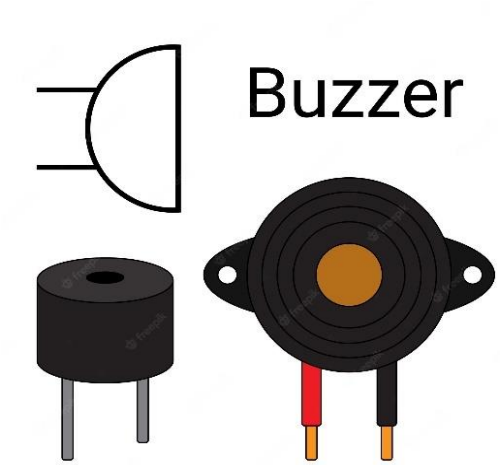

Fig 5.3.9 Buzzer

A buzzer is an electronic component that produces audible sound signals in the form of beeps, tones, or alarms. It is widely used in various applications where audio feedback, alerts, or notification sounds are required. When an electrical signal is applied to the buzzer, the transducer inside the buzzer converts the electrical energy into mechanical vibrations. These vibrations produce sound waves, resulting in the audible sound emitted by the buzzer. The specific sound output, such as the tone, frequency, and volume, is determined by the internal construction and design of the buzzer. The electrical signal applied to the buzzer can be controlled to produce different sound patterns, durations, or intensities.

Buzzers are often driven by an external control circuit, microcontroller, or other electronic devices. By controlling the electrical signal applied to the buzzer, the sound output can be controlled and used for various purposes, such as signaling an event, providing audio feedback, generating alarms, or indicating a warning condition. Buzzers are widely utilized in applications such as alarms, timers, notification systems, electronic devices, and many other areas where audible alerts or sound signals are needed. They provide a simple and effective means of generating sound in electronic projects and systems. Piezo Buzzer 5V (Wire type) is a loud continues type Piezo Buzzer. It has two wires for connection and can work on 3 to 7 V DC. Just connect with power supply and it will give loud sound. The piezo buzzer produces sound based on reverse of the piezoelectric effect.

5.3.10 ARDUINO IDE

The Arduino Integrated Development Environment (IDE) is a cross-platform application written in C and C++. It runs on Windows, Mac OS X, and Linux. It's used to write and upload program to Arduino-compatible boards, as well as other vendor development boards with the support of third-party cores. The GNU General Public License, version 2 is used to license the IDE's source code. The Arduino IDE has specific code structuring guidelines to support the languages C and C++. The Wiring project is a software library that is included with the Arduino IDE and provides numerous common input and output processes. User-written code simply needs two basic functions: one to start the sketch and another to run it. The GNU toolchain, which is also included with the IDE release, was used to compile and link a program stub main () into an executable cyclic executive program.

The Arduino IDE uses the Arduino software to transform executable code into a text file in hexadecimal encoding, which is then loaded into the Arduino board's firmware via a loader program. Arduino is the uploader by default. Other vendors began to add bespoke open-source compilers and tools (cores) that can produce and upload sketches to MCUs that are not supported by Arduino's official range of MCUs as the popularity of Arduino as a software platform grew. The Arduino organization started offering early access to a new Arduino Pro IDE with debugging and other sophisticated features in October 2019.

- The Arduino IDE is a free and open source programmed for developing and compiling code for the Arduino Module.
- It is official Arduino software that makes code compilation so simple that even a nontechnical person may get their feet wet with the learning process.
- It runs on the Java Platform and is compatible with operating systems such as MAC, Windows, and Linux. It includes built-in functions and commands that are useful for debugging, modifying, and compiling

code in the environment.

- Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro, and many other Arduino modules are available.
- On the board of each of them is a microcontroller that has been programmed and accepts data in the form of code. Which will be transmitted and uploaded to the board's controller.

• The IDE environment is made up of two primary components: an editor and a compiler. The editor is

used to write the appropriate code, while the compiler is used to compile and upload the code to the Arduino.

• The core code, also known as a sketch, written on the IDE platform will eventually generate a Hex File, which will be transmitted and uploaded to the board's controller.

• The IDE environment is made up of two primary components: an editor and a compiler. The editor is

used to write the appropriate code, while the compiler is used to compile and upload the code to the Arduino.

Fig 5.3.10 7805 Arduino IDE

Why Arduino?

Arduino is an open-source electronics platform that uses simple hardware and software to make it easy to use. Arduino boards can take inputs such as light from a sensor, a finger on a button, or a Twitter message and convert them to outputs such as turning on an LED, triggering a motor, or publishing anything online. By providing a set of instructions to the board's microcontroller, you may tell it what to do. The Arduino programming language (based on Wiring) and the Arduino Software (IDE) (based on Processing) are used to accomplish this. Thousands of projects have used Arduino throughout the years, ranging from simple household items to complicated scientific apparatus. This open-source platform has united a global community of makers students, amateurs, artists, programmers, and professionals whose contributions have added up to an enormous quantity of accessible knowledge that may be of tremendous benefit to novices and specialists alike.

Arduino was created at the Ivrea Interaction Design Institute as a simple tool for rapid prototyping intended for students with no previous experience with electronics or programming. As soon as it gained a larger following, the Arduino board began to evolve in order to meet new needs and problems, evolving from simple 8-bit boards to solutions for IoT, wearables, 3D printing, and embedded settings. All Arduino boards are open-source, allowing users to create them on their own and customize them to meet their own needs. The software is also open-source, and it is evolving thanks to contributions from users all over the world. Arduino is a computer hardware and software startup, project, and user community that creates microcontroller kits for creating digital devices and interactive things that can sense and control real items. The project's products are offered as open-source hardware and software under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL) allowing anybody to make Arduino boards and share software. Commercially available preassembled Arduino boards as well as DIY kits are available A variety of microprocessors and controllers are used in the project's board designs. These systems include a set of digital and analogue input/output (I/O) pins that can be used to connect to other expansion boards ("shields") and other circuits. For loading applications from personal computers, the boards provide serial communications ports, including Universal Serial Bus (USB) on some variants. The microcontrollers are mostly programmed with features from the C and C++ programming languages.

The Arduino project includes an integrated development environment (IDE) based on the Processing language project, in addition to standard compiler toolchains. The Arduino project began in 2005 as a student project at the Interaction Design Institute Ivrea in Ivrea, Italy with the goal of providing a low-cost and simple means for novices and professionals to design devices that interact with their surroundings using sensors and actuators. Simple robots, thermostats, and motion detectors are common examples of such gadgets aimed at beginning enthusiasts. The Arduino Uno microcontroller board is based on the gadgets aimed at beginning enthusiasts. The Arduino Uno microcontroller board is based on the ATmega328P microcontroller (datasheet). There are 14 digital input/output pins (six of which can be used as PWM outputs), six analogue inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header, and a reset button on the board. It comes with everything you'll need to get started with the microcontroller; simply plug it into a computer with a USB cable or power it with an AC-to-DC adapter or battery. You can tamper with your UNO without fear of making a mistake; if something goes wrong, you can replace the chip for a few dollars and start over. In Italian, the word "uno" means "one," and it was chosen to commemorate the release of Arduino Software (IDE) 1.0. The Uno board and Arduino Software (IDE) version 1.0 were the reference versions of Arduino, which have since been superseded by newer releases. The Arduino Uno board is the first of a series of USB Arduino boards and the platform's reference model; see the Arduino index of boards for a comprehensive list of current, historical, and obsolete boards. Arduino is a free and open-source hardware platform.

How can I get the Arduino IDE?

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The software is available for popular operating systems including as Linux, Windows, and MAX, so make sure you're downloading the relevant software version for your operating system.

- If you want to download the Windows app version, make sure you have Windows 8.1 or Windows 10, as the app version is not compatible with Windows 7 or earlier versions of Windows.
- You must have Windows 8.1 or Windows 10 to download the Windows app version, as it is not compatible with Windows 7 or earlier versions of the operating system.

The Ide environment is divided into 3 sections

1. Menu bar
2. Text Editor
3. Output pane

As you download and open the IDE software, it will appear like an image below.

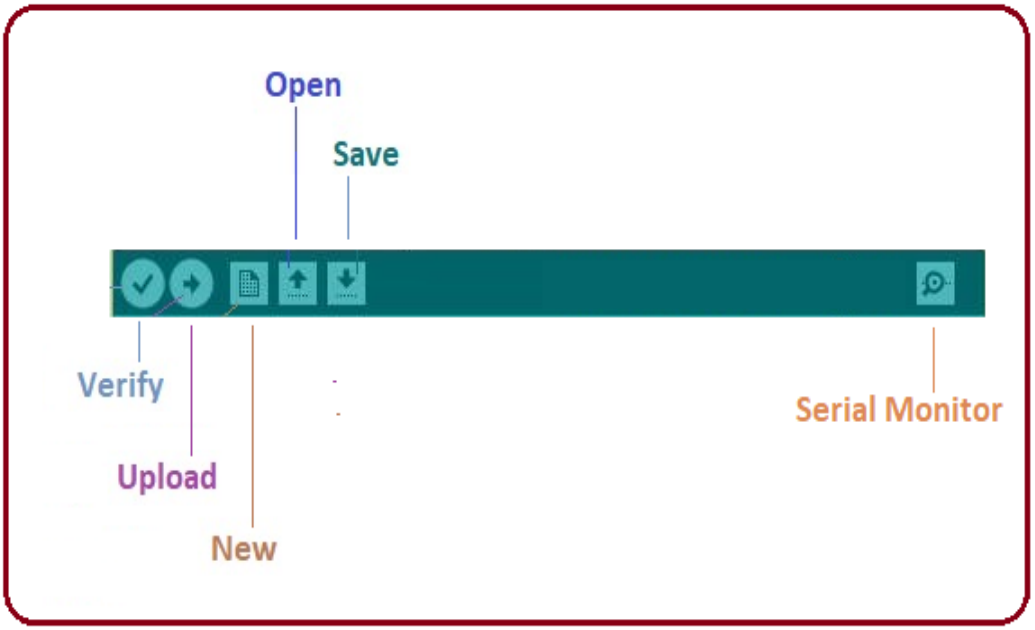
The bar appearing on the top is called Menu Bar that comes with five different options as follow

- **File** - You can open a new window for writing the code or open an existing one. Following table shows the number of further subdivisions the file option is categorized into

And when it's through compiling, it'll display you the hex file for the most recent sketch that will be sent to the Arduino Board for the exact task you want to accomplish.

- **Edit** - Used for copying and pasting the code and making changes to the font.
- **Sketch** - for compiling and scripting
- **Tools** - primarily for project testing This panel's Programmer portion is used to burn a boot loader to a new microcontroller.
- **Help** - If you're unsure about software, there's plenty of assistance available, from getting started to troubleshooting.

The **Six Buttons** appearing under the Menu tab are connected with the running program as follow.



- The code is verified with the check mark in the circular button. Once you've finished writing your code, click here.
- The arrow key is used to upload and transmit the A new file is created using the dotted paper.
- necessary code to the Arduino board.
- The upward arrow is used to open a previously saved Arduino project.

The downward arrow is used to save the code that is now running. A **Serial Monitor** is a distinct pop-up window that operates as an independent terminal and is used to send and receive Serial Data. It is located in the upper right corner. You can also open it by going to the Tools panel and selecting Serial Monitor, or by pressing Ctrl+Shift+M all at once. The Serial Monitor will actually assist you in debugging your created Sketches by allowing you to see how your application is running. To use the Serial Monitor, your Arduino Module must be linked to your computer via USB connection

5.3.11 BLYNK IOT

Fig 5.3.11 Blynk IOT

Blynk is a suite of tools for all makers, innovators, designers, teachers, nerds, and geeks who want to use you can quickly put together a great interface using the widgets we provide, upload the example code to your hardware their smartphones to control electronics like as Arduino, Raspberry pi, and others. We've completed all the difficult tasks, such as setting up an internet connection, developing an app, and writing hardware code. With Blynk, and start seeing results in under 5 minutes! It's ideal for inexperienced creators and saves a tone of time for diabolical geniuses. All popular boards and shields will work with Blynk. We wanted to provide you complete control over how you integrate Blynk into your current or future projects.

The convenience of Blynk Cloud is another something you'll appreciate. It's free and open source, by the way. Consider a smartphone prototyping board where you can drag and drop buttons, sliders, displays, graphs, and other useful widgets. And these widgets can operate Arduino and retrieve data from it in a matter of minutes. Blynk isn't a one-trick pony that only works with a specific shield. Instead, it was created to work with the boards and shields you already have. It’s also compatible with iOS and Android. UPD: Blynk can also be used through USB. This means you may play around with the software while waiting for some internet protection to arrive by connecting it to your laptop or desktop. Blynk works over the Internet. So, the only condition is that your device be able to communicate with the Internet. Blynk libraries and sample sketches will get you online, connect to Blynk Server, and link up with your smartphone regardless of the type of connection you choose —Ethernet, Wi-Fi, or maybe this new ESP8266 everyone is talking about.

Currently, Blynk libraries work with:

- USB
- Ethernet shield
- WIFI shield
- Arduino with Ethernet
- Arduino YÚN (testing in progress).

A larger number of Arduino-compatible shields and boards (this list will be updated as we test the compatibility). We developed a Blynk server because it's not easy to get Arduino out of your home network. It takes care of all authentication and communication, as well as keeping a watch on your board while your smartphone is turned off. The Blynk server is open-source and runs on Java. If you truly need to, you'll be able to run it locally. The communication between mobile apps, Blynk Server, and Arduino is based on a basic, lightweight protocol.

Blynk is designed to simplify the process of building IoT applications by providing a comprehensive platform with easy-to-use tools and services.

Here's a breakdown of its key components and functionalities:

Mobile App: The Blynk mobile app is available for iOS and Android devices. It serves as the primary user interface for controlling and monitoring IoT devices. Users can create custom dashboards within the app by adding widgets such as buttons, sliders, graphs, and notifications. These widgets can be linked to specific functions or data points of the connected devices.

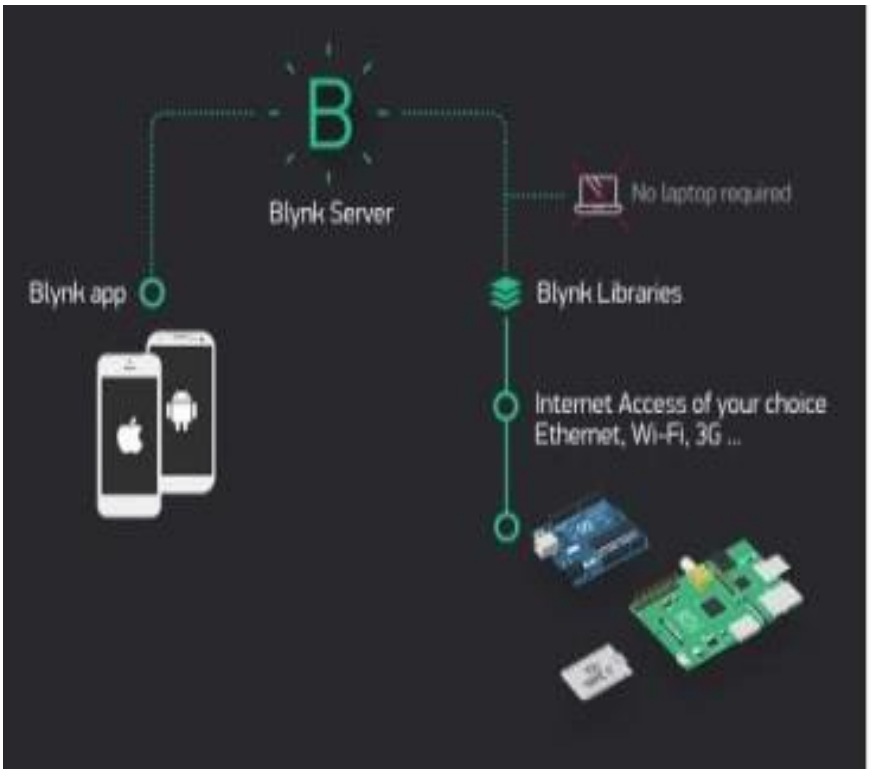
Cloud Server: The Blynk cloud server acts as the bridge between the mobile app and the connected devices. It manages the communication and data exchange between them. The server ensures secure connectivity, encrypting the data transmitted between the app and the devices.

Hardware and Libraries: Blynk supports a wide range of hardware platforms, including popular ones like Arduino, Raspberry Pi, ESP8266, and more. To connect a device to the Blynk platform, developers need to use compatible software libraries. These libraries provide the necessary functions and protocols to establish a connection with the Blynk server and define how the devices interact with the app.

Widget Library: Blynk offers an extensive library of widgets that can be added to the mobile app's dashboards. These widgets allow users to control and monitor their connected devices. For example, a button widget can trigger an action on the device when pressed, while a graph widget can display sensor readings in real-time.

Cloud Storage and Analytics: Blynk provides cloud storage for collecting and analyzing data from IoT devices. Developers can leverage this feature to monitor device performance, track sensor readings, and generate analytics reports. This data can be visualized within the Blynk app or exported for further analysis.

Overall, Blynk simplifies the development of IoT applications by offering a user-friendly platform with pre-built widgets, secure connectivity, and seamless integrations. Whether you're a beginner or an experienced developer, Blynk empowers you to create interactive and innovative IoT solutions without the need for complex coding or hardware configurations.



All data you send from Hardware to Blynk is saved by default. But you can access it only via application (we don't have any other interface at the moment). If you need more than that have to install local Blynk server and you'll be able to get all your in-csv files.

Blynk Features

- API.
- Access Controls/Permissions.
- Activity Dashboard.
- Activity Tracking.
- Asset Tracking.
- Configuration Management.
- Connectivity Management.
- Data Import/Export.

One of the key features of Blynk IoT is its compatibility with a wide range of hardware devices, including popular platforms like Arduino, Raspberry Pi, ESP8266, and more. This allows users to easily connect their devices to the Blynk cloud and control them remotely from anywhere in the world. The platform provides a drag-and-drop interface for creating custom dashboards, which can be designed to display real-time data, such as sensor readings, analytics, and device statuses. Users can add widgets like buttons, sliders, graphs, and gauges to their dashboards, making it simple to interact with and visualize IoT data.

Blynk IoT also supports push notifications, allowing users to receive alerts and updates on their mobile devices when specific events occur. This feature is especially useful for monitoring critical parameters or triggering actions based on predefined conditions. Furthermore, Blynk IoT offers built-in integration with various cloud services and APIs, enabling seamless connectivity with popular platforms such as Google Sheets, Twitter, and Amazon Web Services. This integration expands the possibilities for data storage, analysis, and interaction with other web services.

Overall, Blynk IoT provides an accessible and versatile platform for developing and managing IoT projects. Its features empower users to create innovative solutions, monitor devices remotely, and build customized dashboards for effective visualization of IoT data.

5.3.12 Programming language C++

C++ is an object-oriented programming language which gives a clear structure to programs and allows code to be reused, lowering development. i.e., viewed by many as the best language for creating large-scale application. C++ is a super set of C language. A related programming language, Java, is based on C++ but optimized for the distribution of program object in a network such as internet.

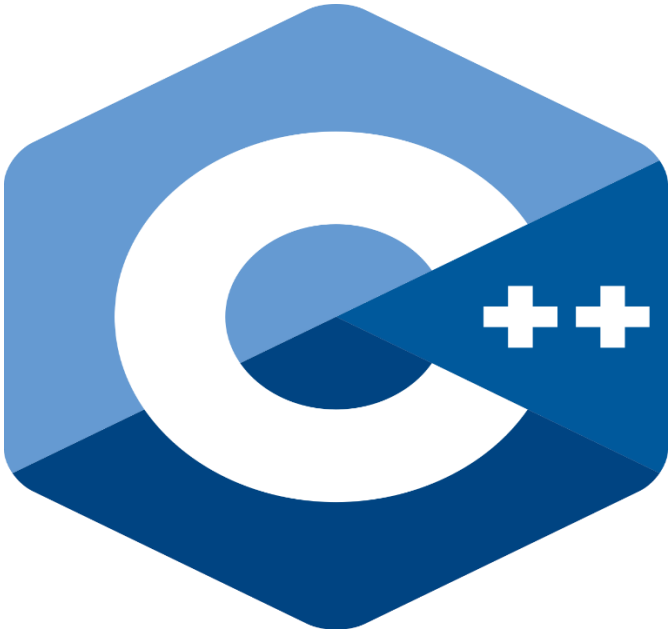


Fig 5.3.12 C++ Programing

C++ is one of the world's most popular programming language. C++ can be found in today's operating system, GUI and embedded system. C++ is portable and can be used to develop applications that can be adopted to multiple platforms. C++ is a powerful and widely used programming language that was developed as an extension of the C programming language. It was designed with the goal of providing both high-level and low-level programming capabilities, making it suitable for a wide range of applications++ is known for its efficiency, performance, and flexibility. It allows programmers to write code that can directly interact with hardware, making it suitable for systems programming, embedded systems, and resource-constrained environments. At the same time, it also supports high-level abstractions and object-oriented programming paradigms, enabling the development of complex and scalable software systems.

One of the key features of C++ is its support for object-oriented programming (OOP). It provides classes, objects, inheritance, and polymorphism, allowing programmers to organize their code into modular and reusable components. This promotes code reusability, maintainability, and the creation of robust software architectures. C++ also supports generic programming through the use of templates. Templates allow the creation of generic functions and classes that can work with different data types. This powerful feature enables code to be written once and reused with different data types, providing a high level of code abstraction and flexibility. Memory management in C++ is primarily done manually, giving programmers fine-grained control over resource allocation and deallocation. This control can be advantageous but also requires careful management to avoid memory leaks and other memory-related errors. To help with memory management, C++ provides features such as constructors, destructors, and smart pointers.

C++ has a rich standard library that provides a wide range of functions and classes for various tasks, including input/output operations, string manipulation, containers (e.g., vectors, lists, maps), algorithms, and more. Additionally, C++ supports interoperability with the C programming language, allowing C++ code to call C functions and vice versa. Over the years, C++ has evolved through different versions, with the latest being C++17 and C++20. These newer standards introduced several language features and improvements, such as enhanced support for concurrency, lambda expressions, range-based for loops, modules, and concepts.

Overall, C++ is a versatile programming language that combines low-level control with high-level abstractions, making it suitable for a wide range of applications, from systems programming to desktop applications, game development, scientific simulations, and more. Its combination of performance, flexibility, and extensive community support has contributed to its popularity among programmers worldwide.

Chapter 6

WORKING METHODOLOGY

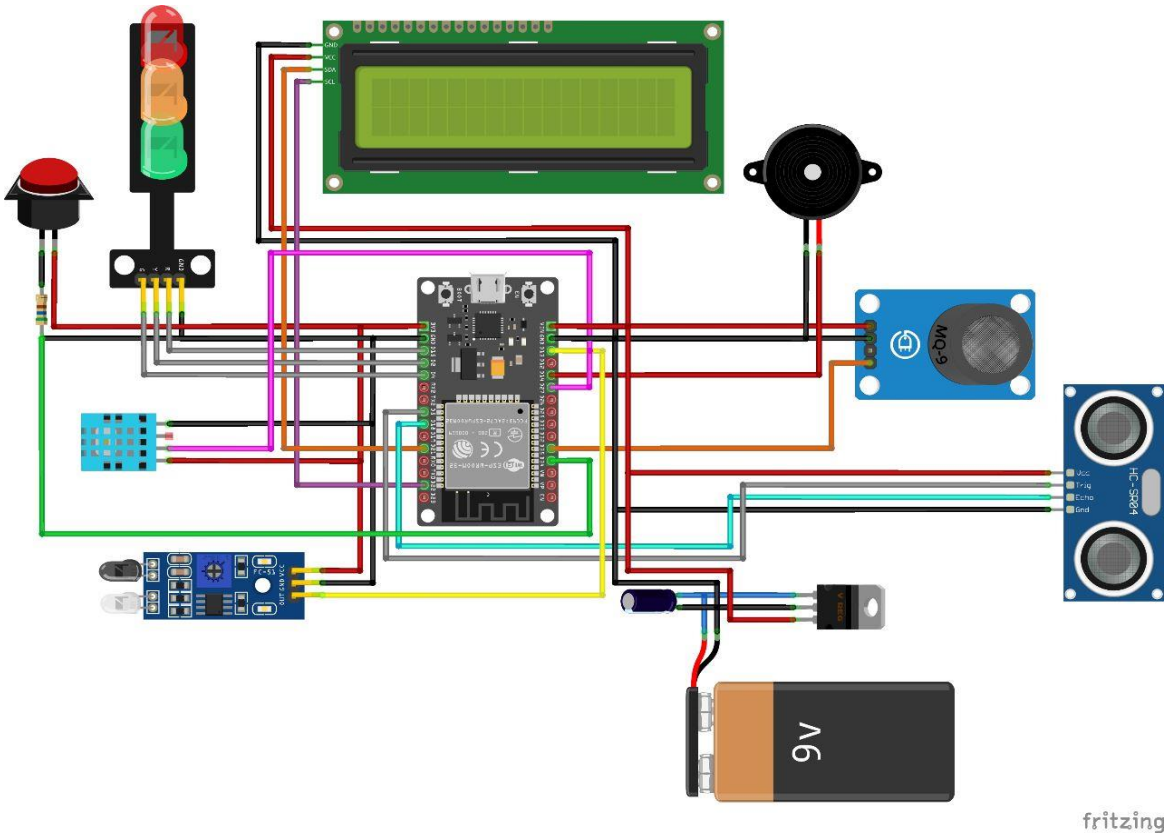


Fig 6.1.1 Circuit diagram

The architecture diagram of the smart helmet for the mining industry includes two main sections: the helmet section and the control room section. The helmet section consists of various sensors such as an IR sensor, proximity sensor, humidity sensor, and gas sensor, along with a microprocessor. These sensors will provide real-time data about the hazardous events, including temperature and humidity changes, gas releases, the conscious and unconscious state of the miner, removal of the helmet, and obstacle damage to the helmet. This data will be transmitted wirelessly using a transmitter to the control room section. The control room section consists of a receiver that can receive the transmitted data and alerts from the transmitter. The control room section also includes a system to generate email alerts based on the received data, which will help in alerting the nearest manager or the control room about the hazardous events.

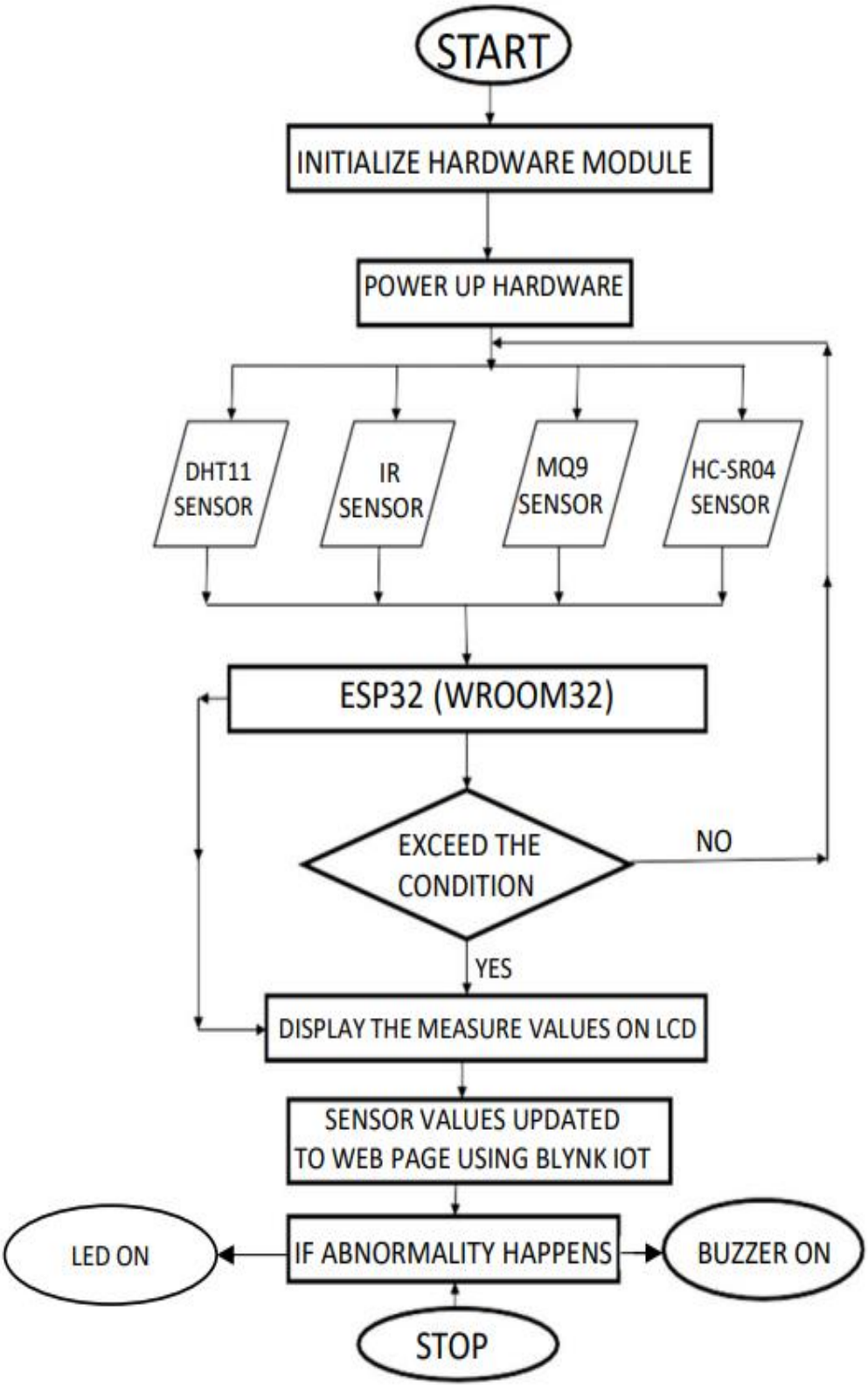


Fig 6.1.2 Flow Chart

The various actions will be done based on sensor readings:

IR SENSOR: If the infrared sensor detects that a helmet is not worn, it displays a message on the LCD and activates the buzzer.

DHT11 SENSOR: If the temperature exceeds 40 degrees Celsius, it displays a high-temperature warning on the LCD and activates an LED and the buzzer.

ULTRASONIC SENSOR: If an obstacle is detected within 30 cm, it displays a message on the LCD and activates an LED and the buzzer. If the obstacle distance is less than 2 cm for a certain duration, it detects a collision and displays a collision message on the LCD.

MQ9 GAS SENSOR: If the gas value exceeds 2000, it displays a gas detection message on the LCD and activates an LED and the buzzer.

SWITCH: When switch is pressed, it displays an alert message on the LCD. A delay of 1 second is added at the end of the loop to control the sampling rate. Same data will be Transmitted to web server through blynk IOT.

1. Data Collection: The starting point of the data flow diagram is the data collection process, which involves the use of various sensors embedded in the smart helmet and clothing as shown in Figure. These sensors include IR sensors, proximity sensors, humidity sensors, gas sensors, and others. They continuously collect data related to environmental conditions (temperature, humidity, gas levels), the miner's health (consciousness, physical state), and safety (helmet removal, obstacle damage).

2. **Data Processing**: Once the data is collected, it is sent to the microprocessors as shown in Figure integrated within the helmet and clothing system. The microprocessors process the raw data, filtering out noise and converting sensor outputs into meaningful information.

3. **Local Alert Generation**: If the microprocessors detect any hazardous events or conditions, they generate local alerts for the miner. These alerts can include audio or visual signals as shown in Figure, such as beeping sounds or flashing lights, to warn the miner about potential dangers and guide them to take appropriate action.

4. **Data Transmission**: The processed and analyzed data, along with any generated and synced alerts, are transmitted from the helmet and clothing system to the control room via a wireless communication module. This module may use Wi-Fi, Bluetooth, or other wireless communication technologies to ensure transmission as shown in Figure.

Chapter 7

RESULTS

- The helmet section of the project can be viewed in below figure**.** whether the helmet is worn or not will be displayed on the LCD and it is shown in fig 7.1.

Fig7.1 Helmet Section

- The below figure shows the breadboard implementation of the project.

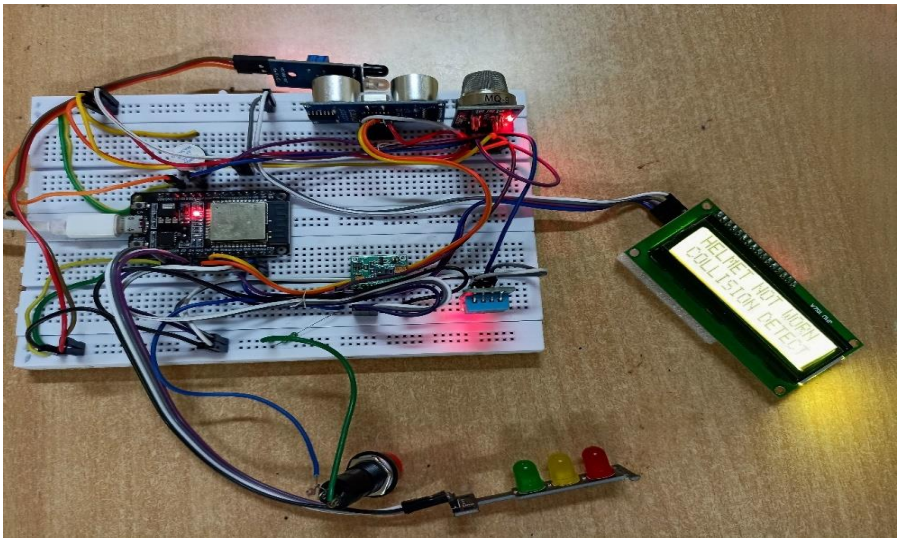


Fig 7.2 Breadboard Implementation

- The data transferred from the ESP board can be viewed in mobile application as shown below

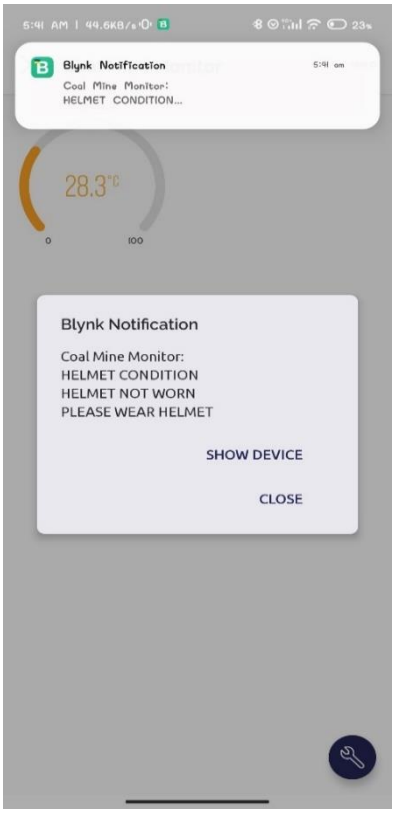


Fig 7.3 Blynk mobile application

- The collected data from ESP32 can be viewed in Blynk Web Dashboard,

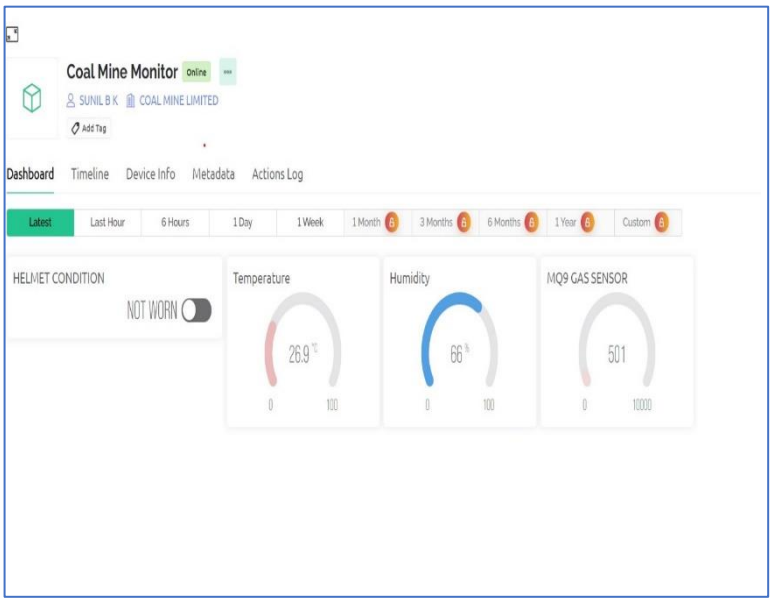


Fig 7.4 Blynk web dashboard

- The interface between ESP32 board and the smart helmet can be see in below figure

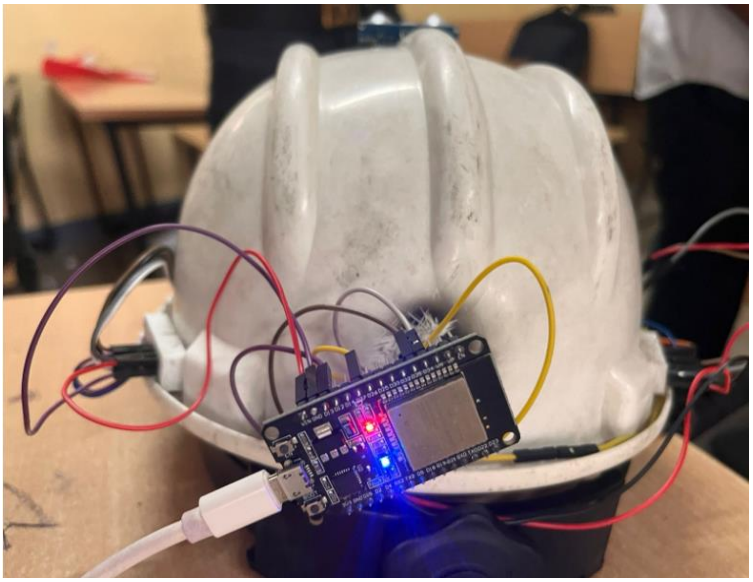


Fig 7.5 ESP32 Board

- The Helment section showing the temperature and humidity values in LCD display

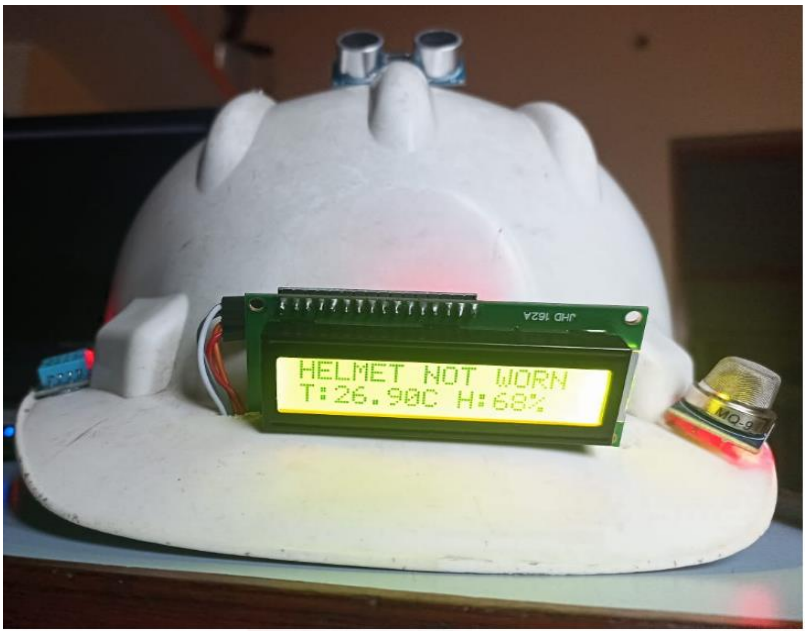


Fig 7.6: Displaying the Temperature and Humidity

- Below fig shows how the overall components of the project were implemented in helmet

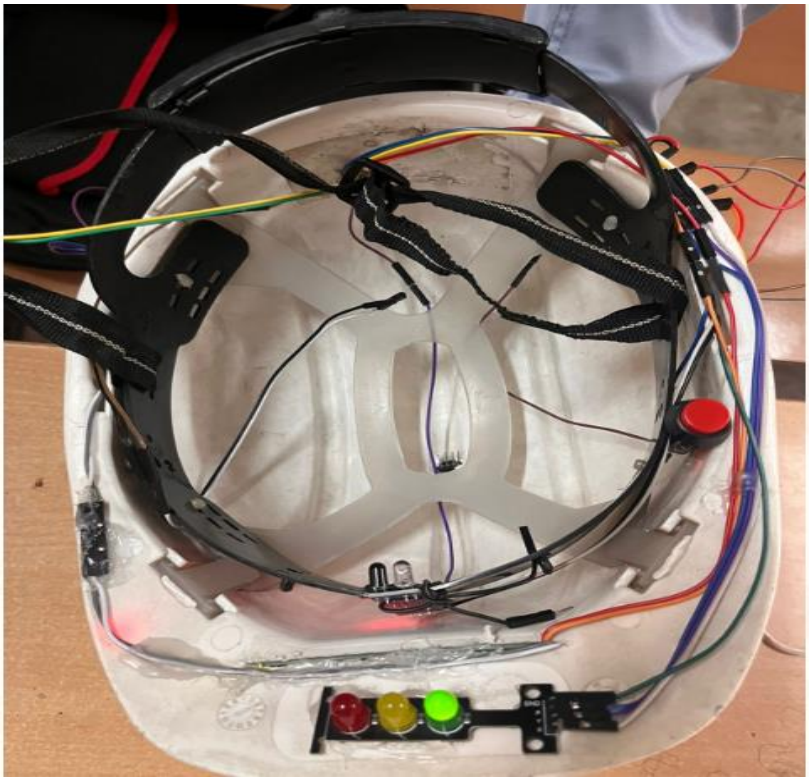


Fig 7.7: Displaying the connections of the helmet

Chapter 8

8.1 ADVANTAGES:

- Monitoring the environment safely.
- Enhanced services in the coal mining industry.
- Prevent miners from high temperature, humidity, and harmful gases.
- Sending alerts to avoid disasters.
- Minimum Human interaction required for the transfer of information and data

8.2 LIMITATIONS:

- Specialized and trained technicians required for repair and updation
- Increase in weight of the helmet
- Requires time to time diagnosis

8.3 APPLICATIONS:

- For Underground Mine system
- Can be used to detect harmful gases
- Used to monitor the Temperature and humidity of the mine

Chapter 9

CONCLUSION

The implementation of a smart helmet for the mining industry represents a groundbreaking idea with the potential to dramatically enhance miner safety. This innovative system is designed to monitor hazardous events in real-time, such as rising temperature and humidity levels, the release of dangerous gases like methane and carbon monoxide, and the conscious or unconscious state of the miner. Furthermore, the system will track the removal of a miner's helmet and any ensuing damage that may occur. The proposed system's programming and troubleshooting will be executed in two distinct sections: the helmet section and the control room section. Equipped with a transmitter, the system will relay essential data and alerts to the control room or the nearest manager, while a receiver will allow the control room or manager to access this crucial information.

In addition, the system will synchronize the collected data and disseminate email alerts when necessary. As a whole, this advanced system will significantly improve the safety of miners by facilitating real-time monitoring of their environment, mitigating the risk of accidents, and enabling prompt interventions during emergencies. By employing state-of-the-art sensors and microprocessors, the system's efficiency and reliability are markedly increased, making it an exceptionally promising solution for addressing the unique challenges faced by the mining industry. The adoption of this pioneering smart helmet will undoubtedly contribute to a more secure working environment for miners. By providing continuous monitoring and instant alerts, it equips managers and emergency responders with the necessary tools to act swiftly in critical situations.

Chapter 10

OUTCOME

The Arduino microcontroller is used to create a prototype for a mine safety system in this proposed method. This device is made from each hardware and software program factors. The hardware is made from several sensors, while the software program is made of an Android software that connects to the Arduino board and other hardware additives via the internet of things. The android-based totally programmer consists of signals and a database in which readings from sensors are presented and inserted the usage of hardware. The use of the wireless community to growth mine safety is a solution for reaching each protection and development in mining initiatives. This looks at objectives to automate the method of mining unit monitoring and handing over updates via cell networks. This gadget hardware components talk with all the sensors.

This project is used to optimize the utilization of the mining subject without the intervention of human beings with the aid of using sensors that screen the environment and a microcontroller that switches on/off the buzzer routinely in the event of unstable condition maintaining mining operation these days necessitates ensuring the protection and well-being of employees and property. The employment of Arduino, gasoline sensors, Temperature sensors, and humidity sensors inside sensors inside the improvement of coal mine security for employees maintains to screen mining protection and replace data at the IOT websites.

Chapter 11

FUTURE SCOPE

There are several future enhancements that can be considered for the smart helmet for mining industry application: Firstly, the system can be further developed to include more advanced sensors and analytics to provide deeper insights into the working conditions of the miners. For example, the addition of sensors to detect the presence of dust and other particulate matter can help monitor the air quality in the mine and prevent respiratory problems for miners. Secondly, the system can be integrated with machine learning algorithms to provide more accurate predictions and preventive measures. By analyzing the data collected by the system, the algorithms can predict potential safety hazards and recommend actions to be taken before they occur. Thirdly, the system can be enhanced with augmented reality (AR) technology to provide miners with a real-time visual display of the environment around them. This can help them navigate through the mine and avoid obstacles or hazardous areas. Lastly, the system can be integrated with communication technology to enable real-time communication between miners and the control room. This can help to improve safety and response times in emergency situations.

Chapter 12

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