IOT WORKSHOP
EIECC19

Smart Workers Helmet

Mini Project Documentation

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1 Acknowledgement

We would like to express our sincere gratitude towards Professor Dhananjay V. Gadre for his remarkable guidance, monitoring, and constant encouragement throughout the project.

We would also like to thank our friends who supported us greatly and were always willing to help us.

2 Introduction

Introduction: This documentation presents an IoT project focusing on worker safety and work efficiency. It integrates gas, temperature, and IR sensors with an ESP32 microcontroller for wireless data transmission to the Blynk IoT platform. Through the Blynk app, supervisors can remotely monitor real-time sensor data and receive critical threshold notifications. The project aims to create a safer and more efficient work environment through proactive safety measures and optimized processes.

Design and Implementation: The project employs an ESP32 microcontroller with gas, temperature, and IR sensors for real-time monitoring. The ESP32 establishes a secure Wi-Fi connection to the Blynk IoT platform, enabling remote access to sensor readings. Supervisors can monitor gas levels, temperature, and helmet usage through the Blynk app, with notifications set up for threshold breaches.

Promoting Safety and Efficiency: By promptly detecting harmful gases and monitoring temperature, supervisors can proactively address hazards and implement climate control measures. The IR sensor ensures compliance with safety protocols for helmet usage. Real-time data and remote monitoring enable supervisors to optimize safety and work processes, fostering a safer and more efficient work environment.

Conclusion: In conclusion, this IoT project integrates gas, temperature, and IR sensors with an ESP32 microcontroller, allowing wireless data transmission to the Blynk IoT platform. Supervisors can remotely monitor sensor data, receive notifications, and take proactive safety measures. The project's focus on worker safety and work efficiency promotes a safer and more productive work environment.

3 Six-Box Model

Let us first list down the requirements of the proposed project as follows:

- Sensors to detect changes in the worker's environment.
- A Microcontroller to analyze the sensory data.
- A cloud platform to display the analyzed data to the supervisor.
- Buzzer to alert the workers.
- A communication channel between the Microcontroller and cloud platform.
- A supply to power up the whole circuit.

Now we will try to place the above requirements in the six-box model:

3.1 Sensors

1. IR SENSOR

The IR sensor in the project is used to detect whether the worker is wearing a helmet or not.

Figure 1: IR sensor

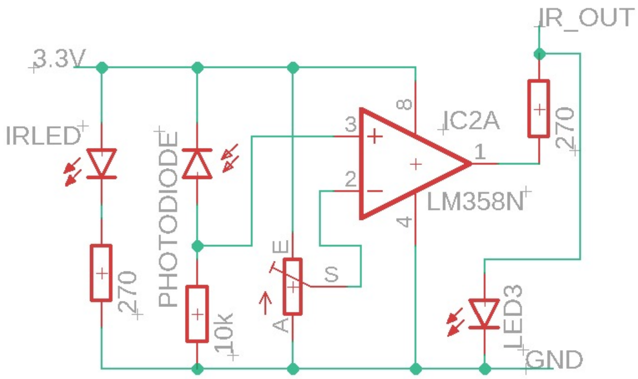


Figure 2: IR sensor

2. Gas Sensor
The gas sensor used in the project is MQ9. MQ9 Gas sensor detects LPG, Carbon Monoxide, and Methane in the environment.

Figure 3: Gas Sensor

3. Temperature Sensor
The temperature sensor used is BMP280 which can also measure pressure.

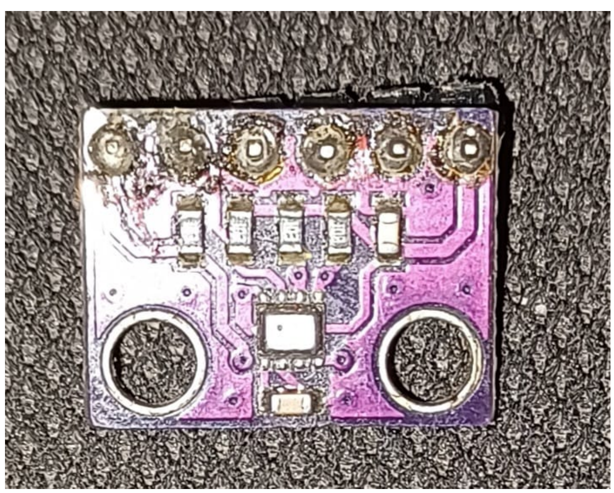


Figure 4: Temperature Sensor

3.2 Output

1. Buzzer

The buzzer is used for the output on the helmet. If a harmful gas is detected by the gas sensor the buzzer will alert the worker.

Figure 5: Buzzer

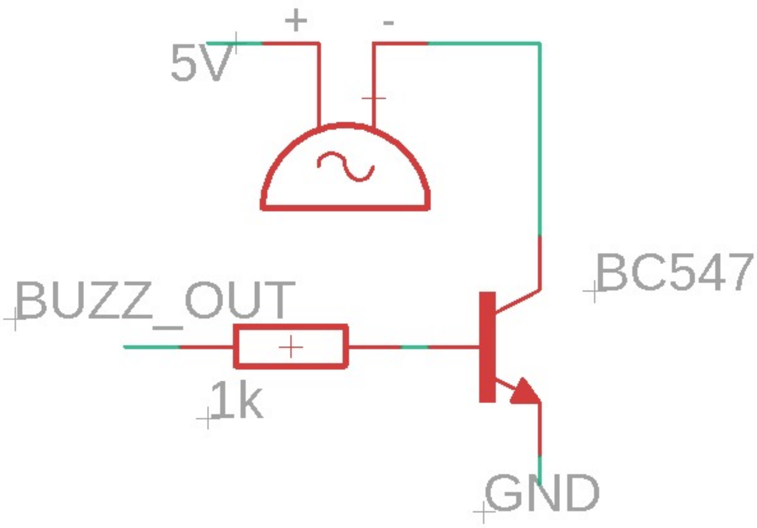


Figure 6: Buzzer Circuit

2. LED

There is a main LED that indicates the battery level by blinking when the battery is below a certain level.

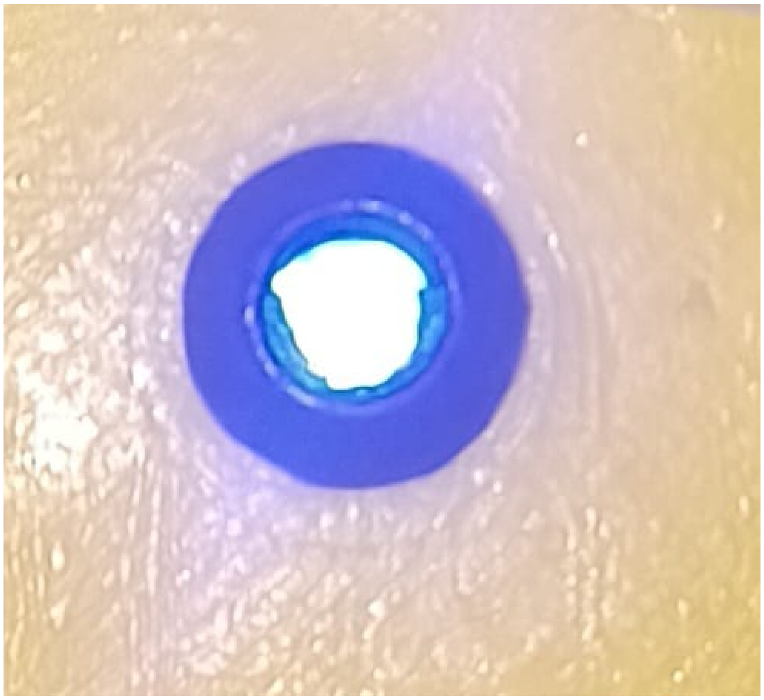


Figure 7: LED

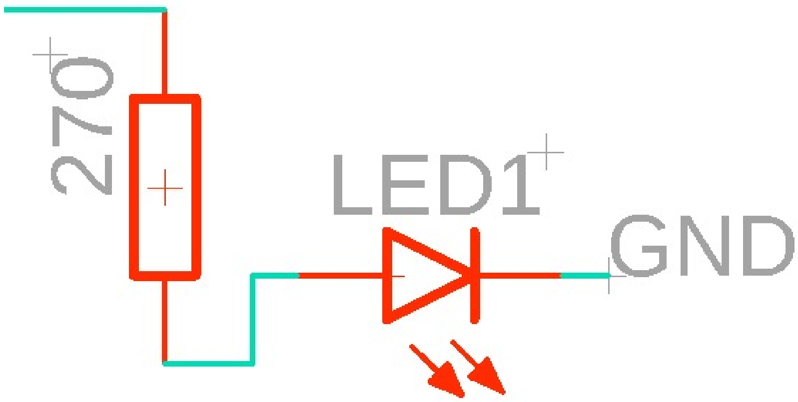
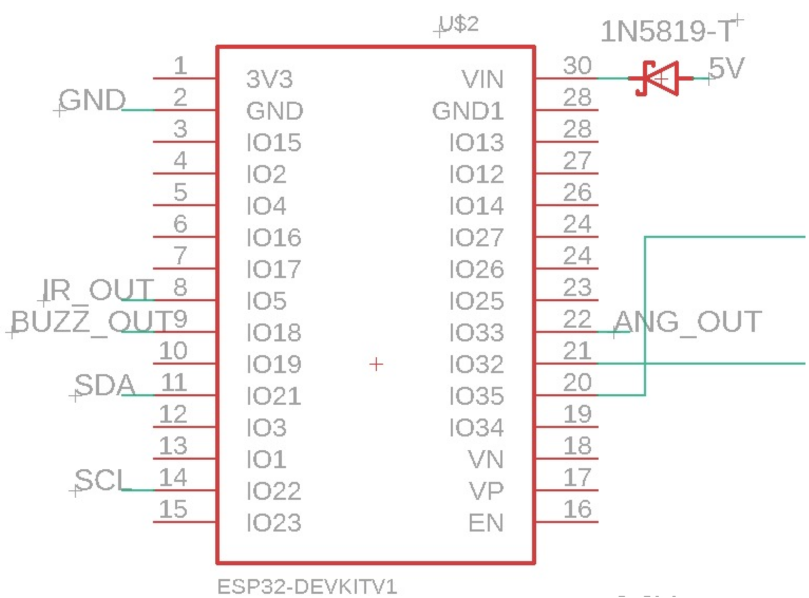


Figure 8: LED schematic

3.3 Micro Controller

The project utilizes the ESP32 microcontroller as the central component for data processing and wireless communication. The ESP32 is chosen for its powerful capabilities, including built-in Wi-Fi connectivity and ample processing power. It serves as the brain of the system, coordinating the operations of the gas, temperature, and IR sensors, as well as facilitating communication with the Blynk IoT platform. To protect the ESP32 and other components from potential damage caused by the back current, a Schottky diode (IN5819) is incorporated into the circuit.

(a)



(b) Schematic

Figure 9: ESP32

3.4 Blynk IOT

The Blynk IoT platform plays a crucial role in analyzing and monitoring the sensory data collected by the project. It provides a user-friendly interface for supervisors to visualize and control the system's operations. Through the Blynk app or web dashboard, supervisors can access real-time data and receive notifications from the integrated sensors.

To enhance visibility and indicate the system's status, an LED is incorporated to indicate the main power status. When the system is powered on, the LED illuminates, providing a clear indication that the project is operational. This visual cue helps supervisors easily determine the system's power status at a glance.

Additionally, the LED connected to the IR sensor serves as an indicator for helmet usage. When the IR sensor detects that a worker is wearing a helmet, the LED corresponding to the IR sensor illuminates. This provides a convenient visual confirmation to supervisors that the safety protocol is being followed.

In the event that the gas sensor detects a harmful gas in the working environment, a cautionary measure is implemented. The CAUTION LED is triggered, indicating the presence of hazardous gas. This warning LED will remain illuminated until the supervisor takes action to acknowledge the alert and reset the system. The supervisor can accomplish this by using the RESET switch on the Blynk app or web dashboard, effectively turning off the CAUTION LED and resetting the system.

By incorporating these LED indicators and implementing the functionality to control and reset the system through the Blynk platform, supervisors have a clear visual representation of the system's status and can take immediate action in response to potential safety risks. The seamless integration of LED indicators and the flexibility of the Blynk platform contribute to creating a more user-friendly and efficient monitoring system.

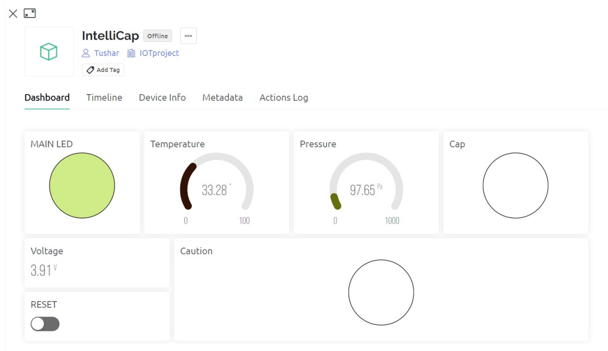


Figure 10: Blynk IOT Dashboard

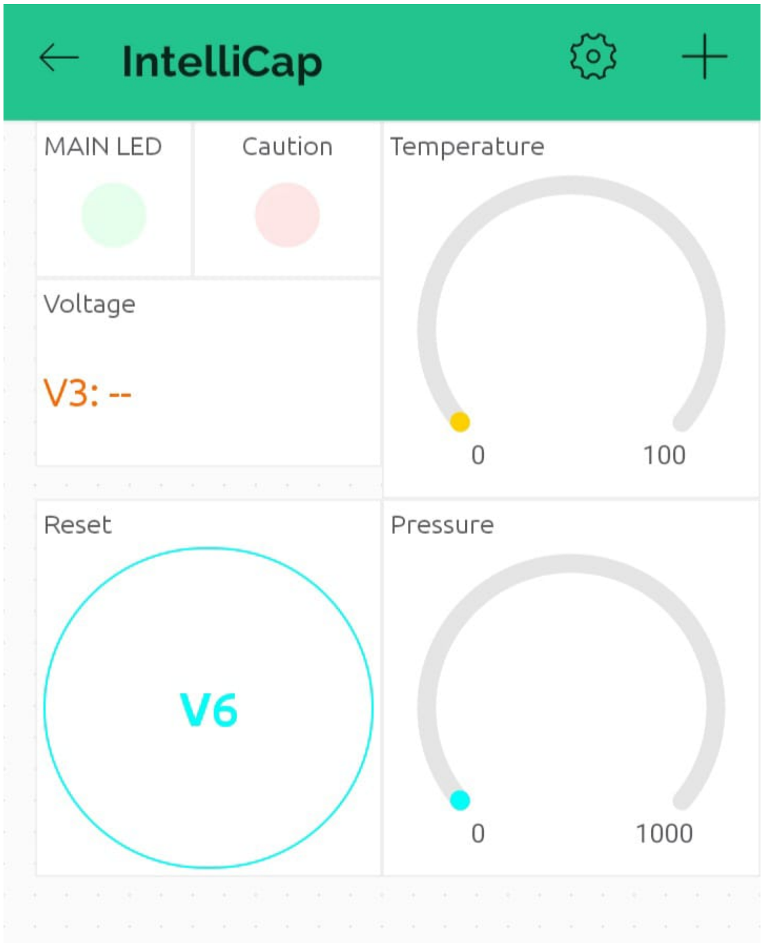


Figure 11: Blynk IOT App

3.5 Power Supply

The power supply for the project is a Samsung INR18650 Li-ion battery, providing a reliable and rechargeable energy source. This high-quality battery ensures extended operation and offers the advantage of being easily rechargeable for prolonged usage.

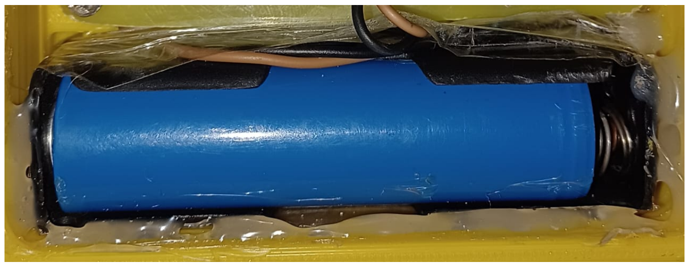


Figure 12: Samsung INR18650

1. 5V Booster Circuit

A booster circuit using the SX1308 module was implemented to convert the input voltage from 3.7V to a stable 5V. This boosted 5V output is essential for powering the ESP32 microcontroller, buzzer, and MQ9 gas sensor. The SX1308 module efficiently regulates and steps up the voltage, ensuring a reliable power supply for these components. This booster circuit enables the seamless operation of the ESP32, facilitates audible alerts through the buzzer, and powers the MQ9 gas sensor for accurate gas detection in the system.

Figure 13: SX1308

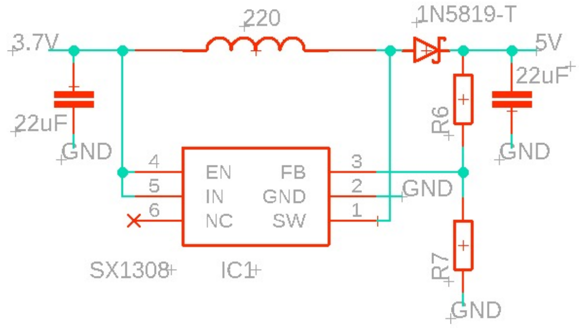


Figure 14: SX1308 Schematic

2. 3.3V Voltage Regulator

A 3.3V voltage regulator is employed in the project to provide a stable and regulated power supply for specific components that require a lower voltage level. The voltage regulator ensures that the voltage output is precisely maintained at 3.3V, regardless of any fluctuations in the input voltage.

This 3.3V power supply is crucial for powering sensitive components such as the ESP32 microcontroller, which operates at this voltage level. The voltage regulator acts as a reliable intermediary between the power source and the components, providing a consistent and accurate voltage level for their operation.

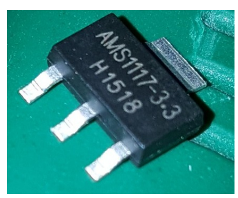


Figure 15: AMS1117 3.3V

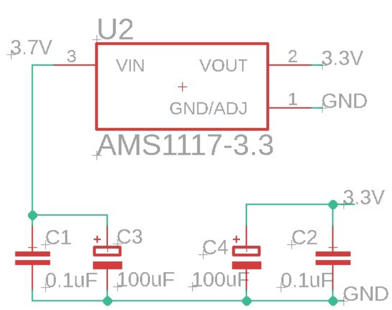


Figure 16: AMS1117 Schematic

3. Charging Circuit
To facilitate the charging of the battery used in the project, a TP4056 charging module is implemented. The TP4056 is a dedicated lithium-ion battery charging module that provides a convenient and efficient solution for recharging the battery. It is designed to handle the specific charging requirements of lithium-ion batteries and offers several built-in features for safe and reliable charging. The charging module is equipped with voltage protection circuitry, which ensures that the battery is charged within safe voltage limits. This protection circuitry prevents overcharging, over-discharging, and excessive voltage fluctuations that could potentially damage the battery or pose a safety risk. By incorporating this circuitry, the module provides a safeguard against potential battery-related issues, promoting the longevity and stability of the battery. Furthermore, the charging module utilizes a C-type USB connector for easy and convenient charging. The C-type connector is known for its versatility, allowing for faster charging and data transfer compared to traditional USB connectors.

Figure 17: TP4056

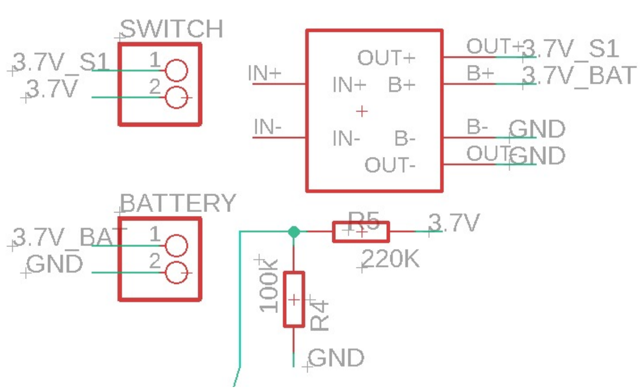


Figure 18: TP4056 Schematic

4 Project Description

4.1 Block Diagram

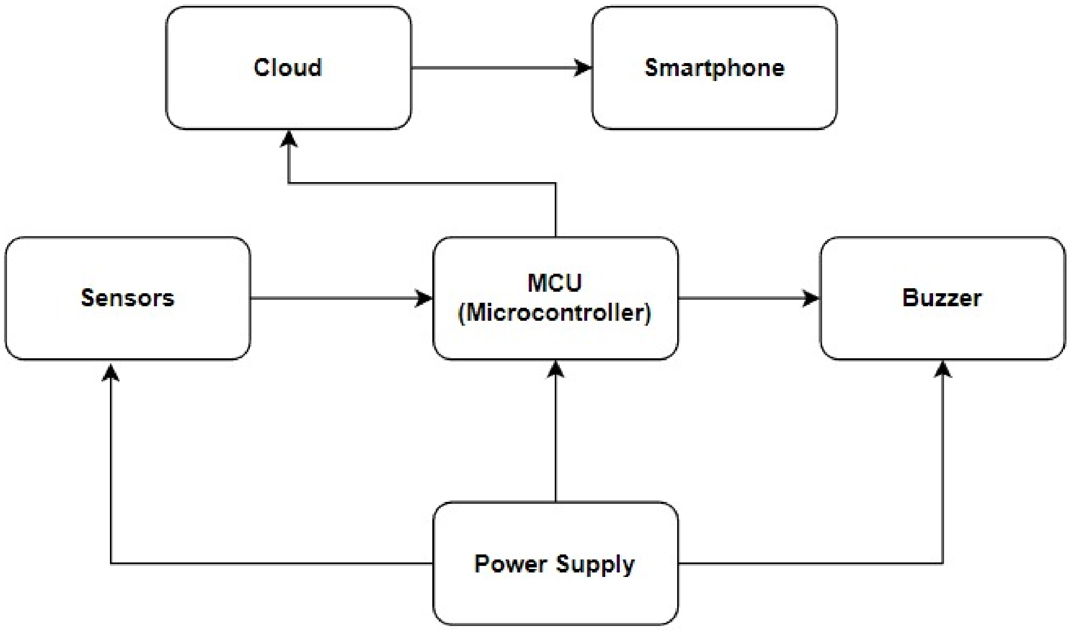


Figure 19: Smart Workers Helmet Block Diagram

4.2 Hardware Description

The system comprises various elements, including the ESP32 microcontroller, gas sensor, temperature sensor, IR sensor, voltage booster circuit, 3.3V voltage regulator, TP4056 charging module, and Samsung INR18650 Li-ion battery. Each component plays a critical role in achieving the project's objectives of worker safety and work efficiency.

The ESP32 microcontroller serves as the central processing unit and wireless communication interface for the system. With its built-in Wi-Fi capabilities and powerful processing power, it efficiently handles data transmission to the Blynk IoT platform. The gas sensor is employed to detect harmful gases in the working environment, providing real-time monitoring for prompt safety measures. The temperature sensor offers insights into the ambient temperature, allowing supervisors to implement climate control measures to prevent heat-related illnesses.

The IR sensor is utilized to monitor helmet usage, ensuring adherence to safety protocols and minimizing head injuries. The voltage booster circuit, utilizing the SX1308 module, converts the 3.7V input voltage from the Li-ion battery to a stable 5V, providing sufficient power to the ESP32, buzzer, and MQ9 gas sensor. The 3.3V voltage regulator ensures a regulated power supply for components requiring a lower voltage level, such as the ESP32.

The TP4056 charging module plays a vital role in recharging the Samsung INR18650 Li-ion battery, which serves as the power supply for the system. This rechargeable battery provides a reliable and portable energy source, enabling uninterrupted operation of the IoT project.

In the hardware setup, a transistor and a resistor are employed in the buzzer circuit to control the activation and deactivation of the buzzer.The purpose of using the transistor is to provide electrical isolation between the microcontroller and the buzzer. The microcontroller's GPIO pins have limited current-sourcing capabilities, and directly driving the buzzer may exceed those limits, potentially damaging the microcontroller. By using a transistor, the current required to activate the buzzer is drawn from an external power source, rather than directly from the microcontroller.

Another important component used in the hardware setup is the voltage divider circuit, which is employed in conjunction with the ESP32 microcontroller.The purpose of the voltage divider circuit is to ensure compatibility between the higher voltage source and the ESP32's input range. The ESP32's analog pins typically have a voltage range of 0 to 3.3V, which may not be compatible with the voltage level provided by certain sensors or external devices. By using the voltage divider, the higher voltage can be scaled down to a suitable range for accurate and safe measurement by the microcontroller.

These hardware components work in synergy to create a robust IoT system that prioritizes worker safety and enhances work efficiency. Through careful selection and integration, the hardware components form a cohesive and reliable solution that meets the project's objectives. The combination of advanced microcontroller capabilities, sensor functionalities, voltage regulation mechanisms, and a rechargeable battery ensures a well-rounded hardware foundation for the successful implementation of the project.

4.3 Software Description

The software implementation of this IoT project utilizes the Arduino IDE and the Blynk IoT platform, along with additional libraries and coding techniques, to ensure seamless functionality, remote monitoring, and intelligent control. The firmware code written in Arduino IDE incorporates ranges for the IR sensor distance and gas sensor concentration, triggering actions such as activating the buzzer and blinking the LED based on predefined thresholds. Furthermore, the software includes logic to monitor the battery percentage and blink the LED when it falls below a certain value.

In the Arduino firmware code, specific ranges are defined for the IR sensor distance and gas sensor concentration readings. When the IR sensor detects an object within a certain range, the code triggers the buzzer to emit a sound, indicating the presence of an object or obstruction. Similarly, when the gas sensor measures a concentration level beyond the specified range, the buzzer is activated as a warning signal to indicate the presence of harmful gases in the environment.

Additionally, the software includes logic to monitor the battery percentage using the built-in battery level measurement feature. When the battery percentage falls below a predefined threshold, the code triggers the LED to blink intermittently, providing a visual indication that the battery needs to be recharged or replaced.

The integration of the Blynk IoT platform allows supervisors to remotely monitor and control the system through the Blynk app or web dashboard. Real-time sensor data, including IR sensor distance, gas sensor readings, and battery percentage, is displayed in graphical or numerical formats. Supervisors can set threshold values and receive notifications when these thresholds are exceeded, enabling timely intervention and ensuring worker safety.

Through the combination of Arduino IDE, Blynk IoT platform, sensor libraries, and intelligent coding techniques, the software implementation enables effective monitoring, control, and alerting mechanisms for the IoT system. This ensures a responsive and proactive approach to worker safety by promptly detecting and notifying supervisors of potential hazards detected by the sensors, as well as providing a visual indication of the battery status.

5 Circuit Design

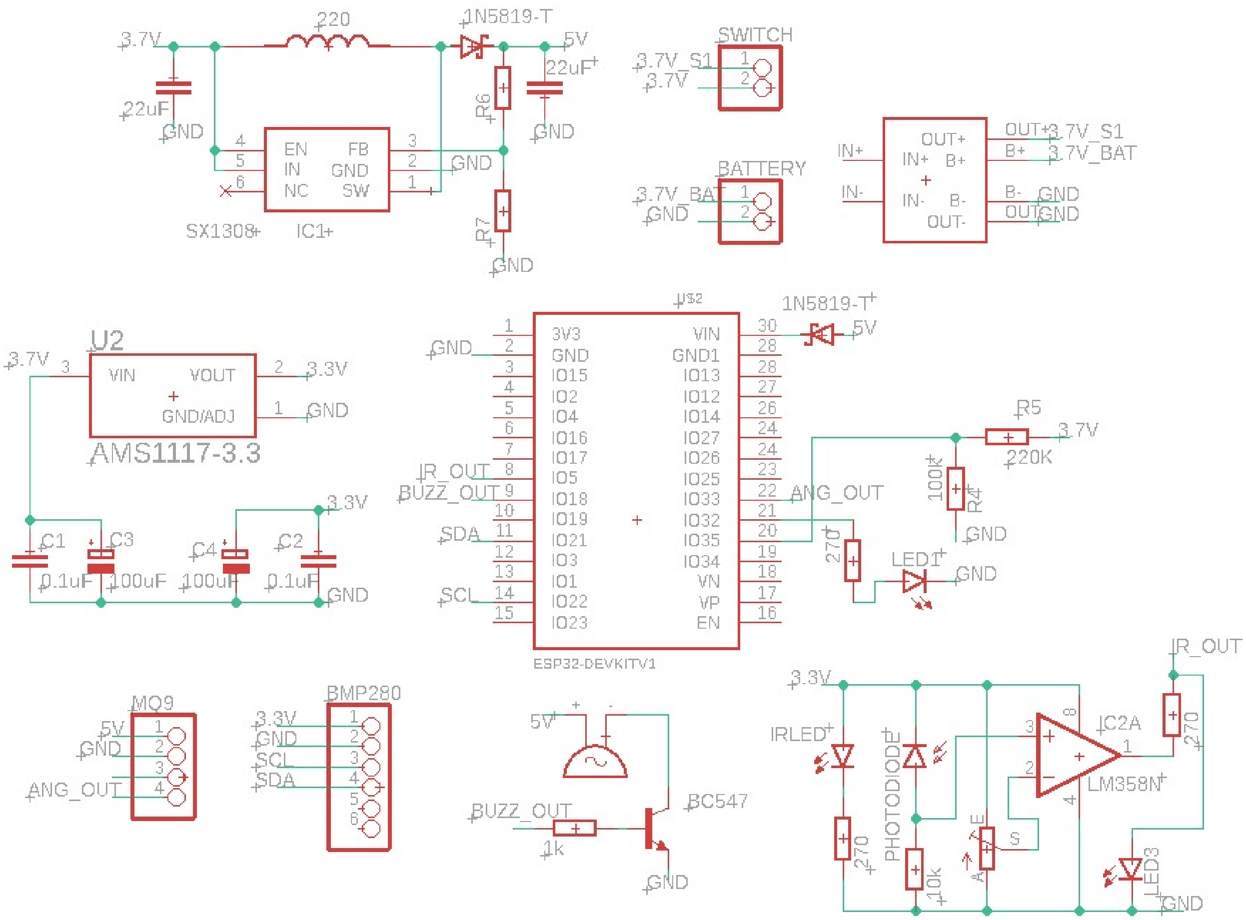


Figure 20: Schematic for Smart Workers Helmet

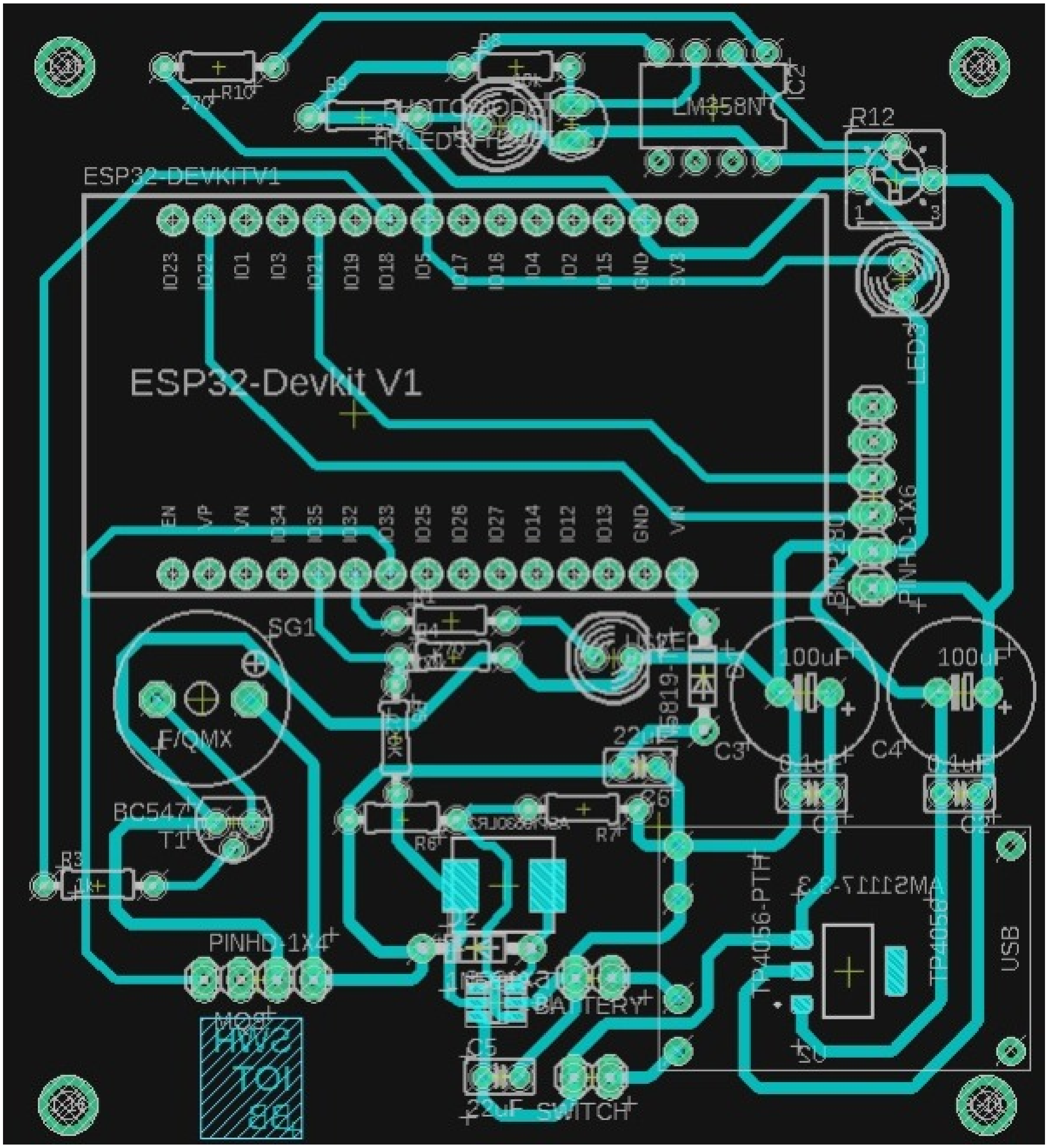


Figure 21: PCB Layout for Smart Workers Helmet

6 Code

ESP32 Code

```
#include <WiFi.h>
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>

#include <Adafruit_BMP280.h>

#define BLYNK_TEMPLATE_ID           "TMPL3HvRQ5n99"
#define BLYNK_TEMPLATE_NAME         "IntelliCap"
#define BLYNK_AUTH_TOKEN "BTkct42lPcXLysRb8JZPd35V9pBRQVMV"

char ssid[] = "Tryme";
char pass[] = "bruhhhhh";

static const int MAIN_LED = 32;
static const int VOLT_PIN = 35;
static const int SENSOR_PIN = 5;
static const int IRLED_PIN = 19;
static const int GAS_PIN = 33;
static const int BUZZ_PIN = 18;


static const float R1 = 220000.0;
static const float R2 = 100000.0;
static const float Vin = 3.7;

float temperature;
float pressure;
float sensorValue;
float VBattery;
float gas;
int state=0;
int state2=0;

int switchState = 0;


Adafruit_BMP280 bmp;

BLYNK_WRITE(V6)
```

```
{
  switchState = param.asInt();
}

void setup() {

  Serial.begin(9600);
  delay(1000);

  bmp.begin(0x76);

  pinMode(MAIN_LED,OUTPUT);
  pinMode(IRLED_PIN,OUTPUT);
  pinMode(VOLT_PIN,INPUT);
  pinMode(SENSOR_PIN, INPUT);
  pinMode(GAS_PIN, INPUT);

  ledcSetup(0, 0, 10);
  ledcAttachPin(BUZZ_PIN, 0);

  ledcSetup(1, 0, 10);
  ledcAttachPin(MAIN_LED, 1);

  Blynk.begin(BLYNK_AUTH_TOKEN,ssid, pass);
  ledcWrite(1, 1024);
  digitalWrite(IRLED_PIN ,LOW);

}

void loop() {

  Blynk.run();

  for(int i=0;i<1000;i++){
     sensorValue += analogRead(VOLT_PIN);
     gas += analogRead(GAS_PIN);
  }
  sensorValue=sensorValue/1000;
  gas = gas/1000;

  float Vout = sensorValue * Vin / 4095.0;
  VBattery = Vout * (R1 + R2) / R2;

```

```
  temperature = bmp.readTemperature();
  pressure = bmp.readPressure()/1000;

  state = digitalRead(SENSOR_PIN);
   if(state==1){
    digitalWrite(IRLED_PIN ,HIGH);
  }else{
    digitalWrite(IRLED_PIN ,LOW);
  }

  if(gas>500){
    ledcWrite(0, 512);
    state2=1;
  }

  if (switchState == 1)  // If the Switch is turned ON
  {
    ledcWrite(0, 0);
    state2=0;
  }

  if(VBattery<3.2){
    ledcWrite(1, 512);
  }else{
    ledcWrite(1, 1024);
  }

  Serial.println(temperature,2);
  Serial.println(pressure,2);
  Serial.println(VBattery,2);
  Serial.println(gas);


  Blynk.virtualWrite(V5,state2);
  Blynk.virtualWrite(V1,temperature);
  Blynk.virtualWrite(V2,pressure);
  Blynk.virtualWrite(V3,VBattery);
  Blynk.virtualWrite(V4,state);
}
```

7 3D Printed Box

As part of the project, a custom-designed box was created using Autodesk Fusion software and 3D printed using an Ender 3 V2 3D printer. The purpose of this box is to house the electronic components and ensure a compact and secure fit inside the helmet.

The box design was created in Autodesk Fusion, allowing for precise measurements and customization to accommodate the specific dimensions and layout requirements of the project. The software's design tools and features facilitated the creation of a box that perfectly fits the electronic components, providing protection and minimizing any potential movement or damage during use.

Once the design was finalized, the 3D printing process was carried out using the Ender 3 V2 3D printer. The printer's capabilities, such as its build volume and precision, ensured the accurate replication of the box design. The 3D printing material used, such as PLA (Polylactic Acid), offered durability and stability for the box.

The resulting 3D-printed box provides a tailored solution for securely housing the electronic components within the helmet. Its precise fit ensures that the components are well-protected and properly positioned, optimizing the functionality and safety of the overall system.

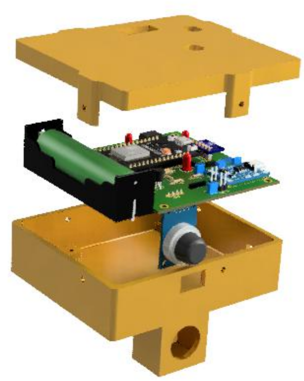


Figure 22: Fusion 360 Renders

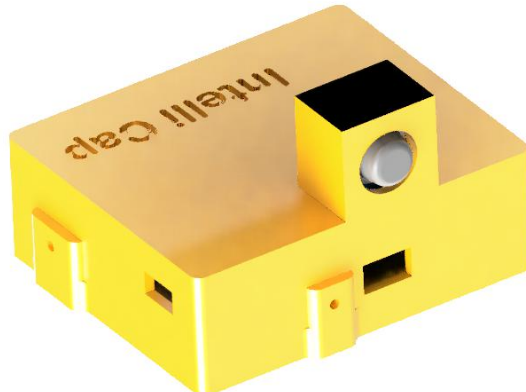


Figure 23: Fusion 360 Renders

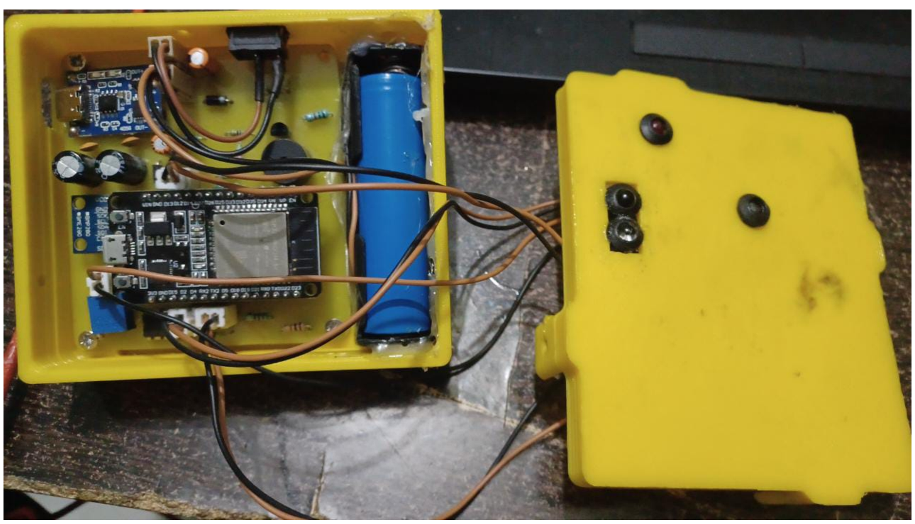


Figure 24: Fusion 360 Renders

8 References

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