SMART MOTOCYCLE HELMET

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Project report submitted in partial fulfilment of the requirements for the degree of

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BRANCH: ELECTRONICS AND COMMUNICATION ENGINEERING

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

PSG COLLEGE OF TECHNOLOGY
(Autonomous Institution)

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Bona fide record of work done by

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SYNOPSIS

The Smart Helmet project is designed to enhance road safety and reduce motorcycle-related accidents by integrating intelligent systems, mobile monitoring, and wireless communication. The system consists of two helmets that work together using Arduino microcontrollers and sensor technologies to detect, communicate, and respond to critical rider conditions in real time.

Each helmet is equipped with an alcohol sensor, fall detection module, temperature regulation using a Peltier device, and Bluetooth communication modules. These components work together to monitor the rider's condition and environment. For example, if alcohol is detected, the helmet disables the ignition, preventing the rider from operating the vehicle under the influence.

The helmets communicate with each other via peer-to-peer wireless connectivity, allowing real-time sharing of critical data such as alcohol detection, fall alerts etc. This seamless communication ensures that necessary actions, such as alerting emergency contacts or activating buzzers for rider awareness, can be carried out promptly.

Additionally, the Peltier module provides thermal regulation, ensuring the rider's comfort across various weather conditions. The system also integrates with the Blynk open-source mobile application, allowing riders to monitor important metrics like temperature, alcohol detection status, and accident alerts directly on their smartphones. The Blynk app serves as a user-friendly interface, providing remote visibility and control over helmet functions for enhanced convenience and safety.

Overall, the Smart Helmet project represents a forward-thinking approach to rider safety, blending embedded systems, sensor integration, mobile app interfaces, and peer-to-peer wireless communication to set a new benchmark in intelligent safety gear for motorcyclists. By addressing major causes of road accidents such as drunk driving, delayed response, and rider discomfort, the system offers an innovative solution to improve motorcycle safety.

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LIST OF FIGURES

CHAPTER 1
INTRODUCTION

The Smart Helmet is an innovative project aimed at improving road safety for two-wheeler riders through the integration of intelligent technologies. This project focuses on the development of a dual-helmet system that communicates wirelessly and responds to real-time situations such as alcohol detection, accidents, and thermal discomfort. The helmets are equipped with sensors and modules that assist in rider safety, accident alerts, and comfort management, all controlled by an Arduino microcontroller.

The key features are:

- **Alcohol Sensor:** Prevents vehicle ignition if alcohol is detected.
- **Fall Detection Sensor:** Detects accidents and sends alert messages with location to emergency contacts.
- **Temperature Control:** Uses a Peltier module to regulate helmet interior temperature.
- **GSM Module & Bluetooth:** Sends alerts and allows wireless communication.
- **Blynk App Integration:** A user-friendly open-source mobile app that displays real-time sensor data such as alcohol levels, temperature, and fall detection alerts. It offers convenient remote monitoring and enhances user interactivity.

The benefits from using such a helmet system are:

- **Enhanced Rider Safety:** Through real-time monitoring of alcohol levels and crash detection, ensuring immediate action in critical situations.
- **Comfort and Usability:** Temperature regulation using the Peltier module ensures a pleasant riding experience in various weather conditions.
- **Emergency Responsiveness:** The fall detection system combined with GSM communication ensures timely help during accidents.
- **Remote Monitoring:** The Blynk app offers visibility and ease of control via smartphone, improving awareness and convenience.

Overall, the Smart Helmet represents a significant step toward intelligent mobility solutions, providing a safe, smart, and connected riding experience for users.

1.1 NEED FOR THE PROJECT :

With two-wheeler accidents accounting for over 44% of road fatalities in India (MoRTH, 2022), there is an urgent need for innovative safety solutions. Many accidents are caused by drunk driving, lack of helmet use, and delayed emergency response. Traditional helmets offer only passive protection, while the Smart Helmet proactively enhances rider safety. By integrating alcohol detection, fall sensors, and comfort features like a cooling system, the project not only prevents unsafe riding but also ensures rapid assistance in emergencies. Additionally, the use of the Blynk app enables remote monitoring, making the system both smart and user-friendly.

1.2 PROBLEM DEFINITION:

Motorcycle safety is a major concern, with factors like alcohol-impaired riding, delayed emergency responses, and rider discomfort often contributing to accidents. Traditional helmets only offer basic protection but fail to address these critical issues in real-time. The growing need for smarter safety solutions in the two-wheeler industry calls for a new approach that combines technology, safety, and convenience.

The Smart Helmet project aims to solve these problems by integrating advanced sensors, wireless communication, and embedded systems into the helmets. The goal is to create a system that continuously monitors the rider’s condition, detects potential risks like alcohol consumption or accidents, and responds instantly. By combining these technologies, the Smart Helmet will not only make riding safer but also more comfortable, ensuring riders are protected in various conditions. With features like alcohol detection, fall detection, temperature control, air bag deployment and seamless communication between helmets, this system could set a new standard for motorcycle safety, making the ride safer and more convenient.

1.3 PROJECT OBJECTIVE:

The Smart Helmet project aims to create a pair of helmets that improve rider safety and comfort by using a mix of sensors, real-time monitoring, and communication features. The key objectives include:

- **Alcohol Detection:** If the rider is detected to be under the influence, the helmet will automatically disable the vehicle’s ignition, preventing drunk driving.
- **Accident Detection & Emergency Response:** If a fall or accident is detected, the system will send the rider's GPS location to emergency contacts so help can arrive quickly.
- **Temperature Control:** Using a Peltier device, the helmet will regulate temperature, keeping the rider comfortable in both hot and cold conditions.
- **Airbag Deployment**: The helmet is equipped with a small airbag system that inflates upon detecting a fall or crash, using a gas canister. The airbag deploys within milliseconds of the fall detection, minimizing the risk of injury.
- **Peer-to-Peer Communication:** The two helmets will communicate with each other wirelessly, sharing critical data like accident alerts and environmental conditions to ensure the rider’s safety.
- **Mobile App Integration:** Through the Blynk app, the rider can monitor key metrics like temperature, alcohol detection status, and accident alerts right from their smartphone.

By integrating these features, the Smart Helmet will create a safer, more comfortable riding experience, responding instantly to situations that could otherwise be dangerous or uncomfortable for the rider.

CHAPTER 2
LITERATURE SURVEY

- Rahul Kamdi et al. (2023) - "An IoT Based Intelligent and Smart Helmet"
  - ➢ Uses IoT technology for accident detection and emergency notifications.
  - ➢ Includes an alcohol detection mechanism to prevent drunk driving.
- Vibhutesh Kumar Singh et al. (2022) - "SmartPPM: An IoT-Based Smart Helmet Design"
  - ➢ Integrates Bluetooth and wireless communication for emergency response.
  - ➢ Utilizes impact sensors to detect head injuries and send alerts.
- Felix Wilhelm Siebert et al. (2021) - "Detecting Motorcycle Helmet Use with Deep Learning"
  - ➢ AI-powered detection of helmet usage to enforce road safety compliance.
  - ➢ Uses YOLO deep learning models for real-time helmet detection.
- M. Patel et al. (2022) - "Smart Helmet with Accident Detection and Safety Features"
  - ➢ Implements a helmet-based airbag system for head protection.
  - ➢ Uses GPS and GSM modules for real-time tracking and emergency alerts.
- J. Wang et al. (2023) - "Wearable Safety Systems for Motorcyclists: A Review"
  - ➢ Reviews various wearable safety technologies for riders.
  - ➢ Highlights the effectiveness of smart helmets in reducing accident fatalities.
- P. Gupta et al. (2021) - "Helmet-Based Airbag System for Road Safety"
  - ➢ Develops an airbag system integrated into helmets for crash protection.
  - ➢ Utilizes pressure and impact sensors to trigger deployment.

CHAPTER 3
PROPOSED METHODOLOGY

The Smart Helmet system aims to enhance rider safety by using embedded systems, sensor technologies, and wireless communication to monitor the rider's condition, detect accidents, and regulate temperature. The proposed methodology follows a systematic approach in the design and implementation of the project, ensuring real-time monitoring, accurate responses, and seamless integration with mobile applications.

3.1 PROCESS FLOW

The process flow of the Smart Helmet can be broken down into several key steps that ensure safety, communication, and comfort for the rider.

3.1.1 Monitoring the Rider's Condition:

- Alcohol Detection:
  - ✓ The MQ-135 Gas Sensor continuously checks for alcohol presence in the rider's breath.
  - ✓ If alcohol is detected at levels above the safety threshold, an alert is sent to the rider, and the ESP32 disables the ignition to prevent the rider from starting the vehicle.
  - ✓ Real-time updates on alcohol levels are sent to the Blynk mobile app, providing constant monitoring.
- Temperature Regulation:
  - ✓ The DHT Temperature Module measures the internal temperature of the helmet.
  - ✓ Based on the readings, the TEC1 12706 Peltier Module activates to either cool or heat the helmet, providing comfort under varying weather conditions.
  - ✓ Temperature data is visible on the Blynk mobile app, allowing the rider to adjust settings remotely.
  - ✓ The cooling system can be activated automatically as well as manually in the blynk app.

3.1.2 Accident Detection and Emergency Response:

- Fall Detection:
  - ✓ Using the accelerometer and gyroscope integrated into the helmet, the system detects any sudden movements, such as a fall or crash.
  - ✓ If a fall is detected, the ESP32 sends an emergency alert along with the rider's GPS coordinates to the mobile app and pre-set emergency contacts.
  - ✓ Buzzer alerts in both helmets notify nearby riders or pedestrians of the incident.
- Airbag System:

- ✓ The airbag is built into the helmet. It is equipped with a small, compact **airbag module** connected to the fall detection system.
- ✓ The system uses **compressed gas** (usually stored in a small cylinder) to deploy the airbag when triggered by a fall detection event.
- ✓ The airbag is designed to deploy within milliseconds of detecting a fall, providing a cushion to protect the rider's head and neck from impact.

- Peer-to-Peer Communication:
  - ✓ The two helmets communicate wirelessly using the ESP32, sharing critical data such as accident detection or alcohol presence.
  - ✓ In case of an emergency, both helmets activate their buzzers to draw attention, ensuring prompt assistance.

3.1.3 Mobile App Interface:

- Blynk App:
  - ✓ The Blynk app displays key data such as alcohol detection, temperature status, and emergency alerts in real-time.
  - ✓ It allows the rider to control helmet features like temperature adjustments and monitor the status of the helmet's sensors.

3.1.4 System Integration and Operation:

- The system components—sensors, controllers, and communication modules—work in unison, transmitting data to ensure the rider's safety.
- The NodeMCU-32 Development Board acts as the central controller, processing sensor data, activating necessary actions (such as alcohol detection or emergency alerts), and managing communication between the two helmets and the mobile app. responsive and user-friendly safety solution. The system is designed to provide a seamless experience for riders, offering peace of mind through real-time data tracking, emergency alerts, and the convenience of temperature regulation.

3.1.5 Audio Communication Between Helmets:

- Microphone Module:
  - ✓ Each helmet is equipped with a **microphone module** that picks up the rider's voice.
  - ✓ The audio is processed by the **ESP32** and transmitted wirelessly to the second helmet using **Bluetooth/WiFi communication**.
  - ✓ The second helmet receives the audio signal and plays it through a **speaker module**, enabling real-time communication between the two riders.
- Two-Way Communication**:**

Both riders can speak and listen to each other seamlessly, without the need to stop or remove their helmets.
This audio communication ensures safety by allowing the riders to discuss any important issues, such as road conditions or potential hazards, while keeping their focus on the road.

3.2 BLOCK DIAGRAM

The block diagram of the entire system is given in Figure 3.2

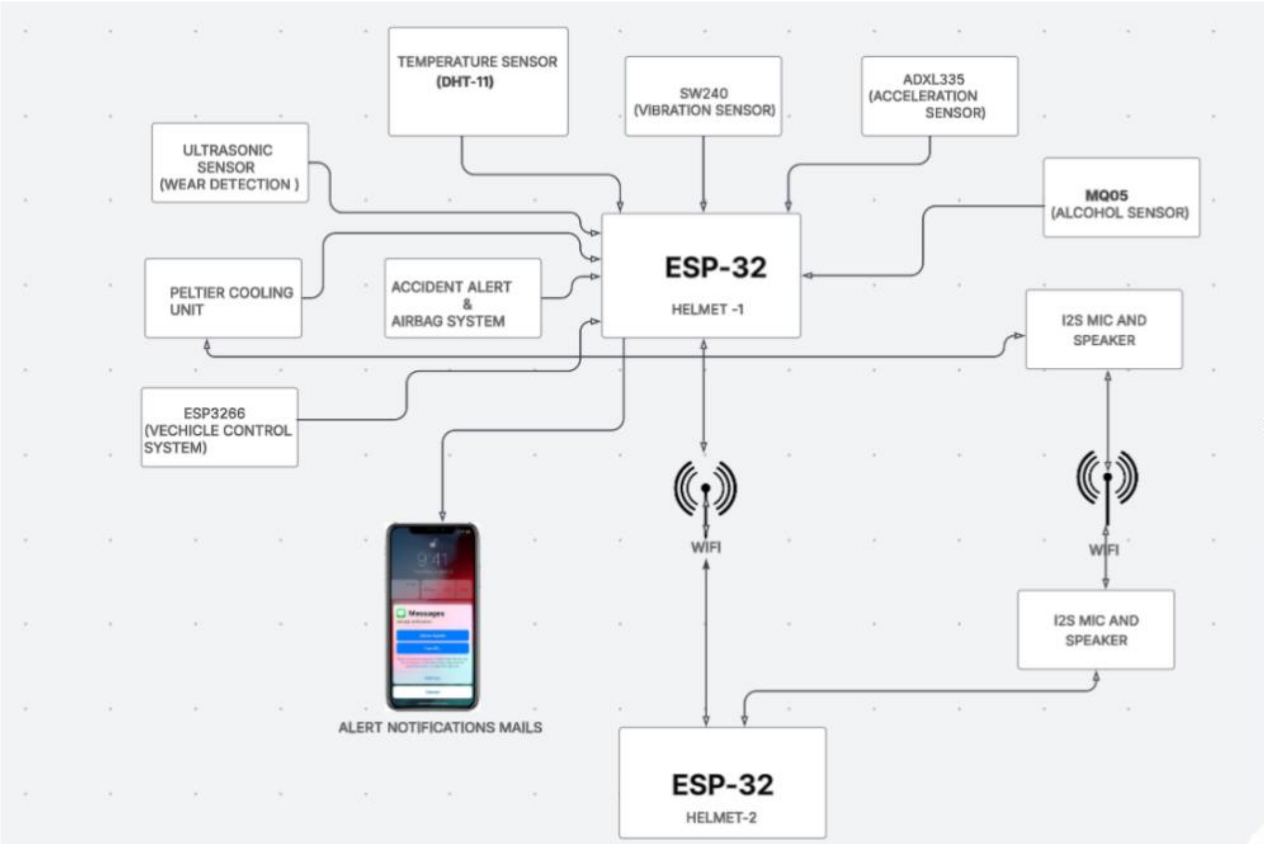


Fig. 3.2 Block Diagram

3.2.1 FLOW CHART:

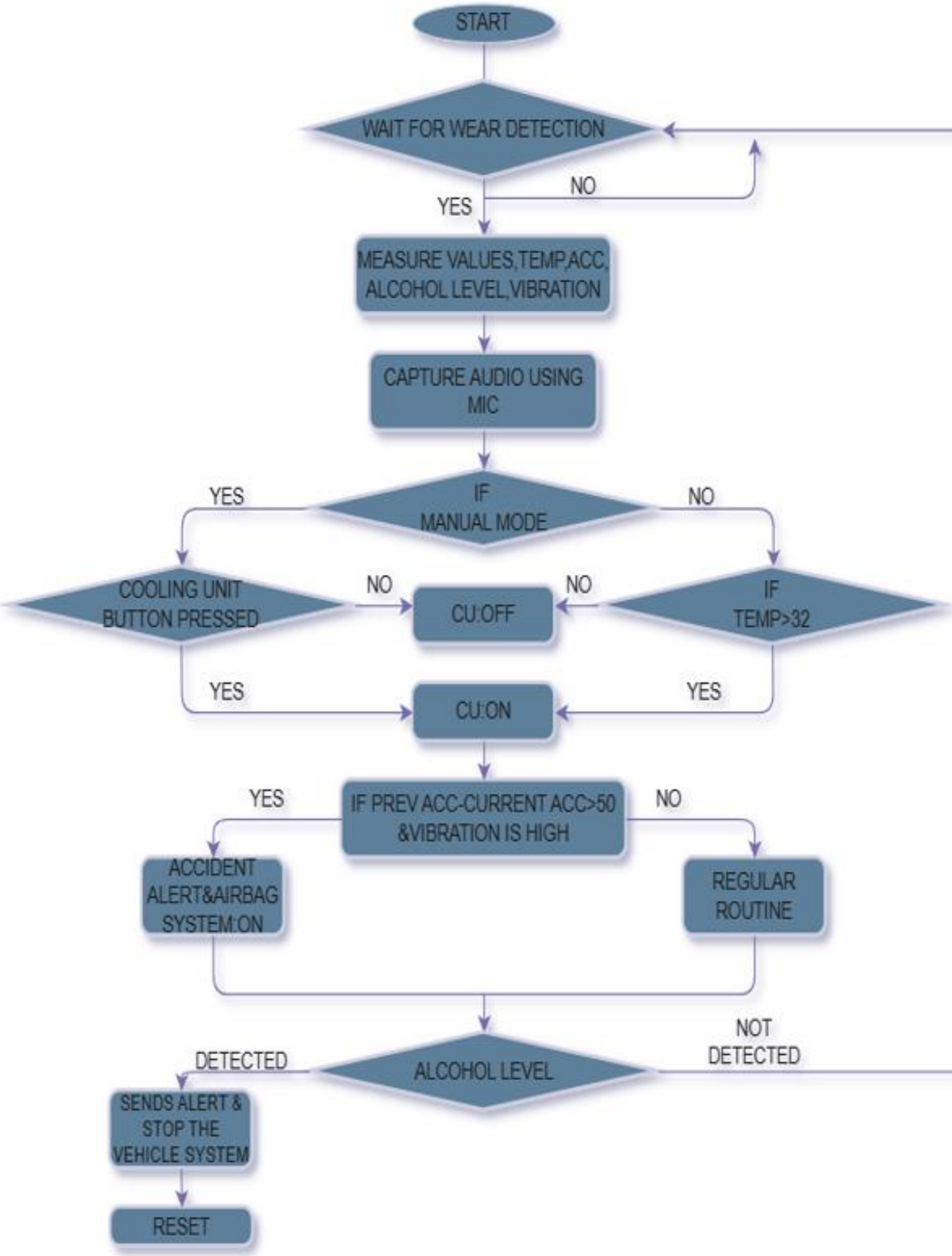


Fig: 3.2.1 Flow chart

3.3 SUB-SYSTEMS

the main subsystems that are most critical to the Smart Helmet project, highlighting their importance in ensuring rider safety, comfort, and communication:

1. Alcohol Detection Subsystem

- Importance: This subsystem prevents the rider from operating the vehicle under the influence of alcohol, which is a major cause of accidents. It ensures that the helmet can detect alcohol vapor and automatically disables the ignition system, preventing the rider from starting the vehicle.
- Components:
  - ➢ MQ-05 Gas Sensor (detects alcohol and other harmful gases)
  - ➢ Control Unit (ESP32) (processes sensor data and triggers vehicle safety features)

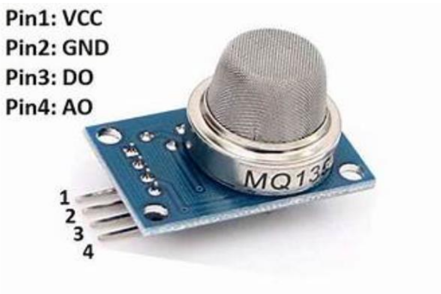


Fig: 3.3.1 MQ-05 sensor

2. Temperature Control Subsystem

- Importance: Maintaining an optimal temperature inside the helmet enhances rider comfort, especially in varying weather conditions. The Peltier module, combined with a temperature sensor, ensures that the rider stays comfortable, whether it’s too hot or cold.
- Components:
  - ➢ TEC1 12706 Peltier Module (for cooling or heating)
  - ➢ DHT Temperature Sensor (monitors environmental temperature)

Fig:3.3.2 TEC1 12706 PELTIER MODULE Fig: 3.3.3 12V DC TOOTHLESS FAN

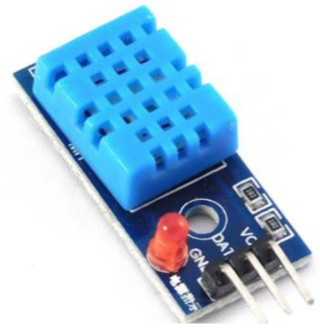


Fig: 3.3.4 DHT-11 TEMPERATURE AND HUMID SENSOR

3. Audio Communication Subsystem

- Importance: This subsystem enables two-way communication between riders, allowing them to talk without needing to remove their hands from the handlebars. This improves safety by reducing distractions while riding.
- Components:
  - ➢ Microphone Module (captures the rider's voice)
  - ➢ Speaker Module (transmits voice to the other rider)
  - ➢ ESP32 (Bluetooth/WiFi) (manages communication between helmets)

4.Fall detection subsystem:

The SW-420 Vibration Sensor Subsystem is designed to detect sudden vibrations or impacts caused by falls or crashes. It enhances the fall detection system by working with the accelerometer and gyroscope to confirm a fall. Upon detecting a fall, it triggers airbag deployment for rider protection and sends emergency alerts with the rider's GPS location via the GSM module. When the acceleration drops and vibration is high it denoted that accident has taken place. This subsystem is crucial for ensuring immediate safety responses, improving rider protection in case of accidents

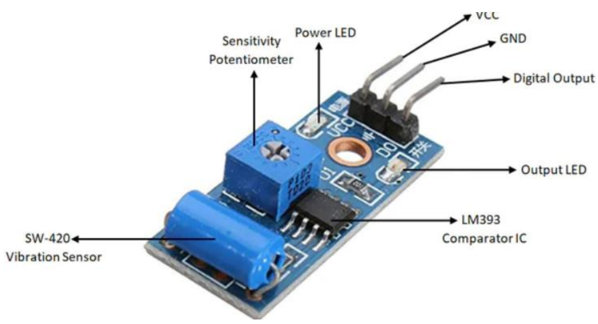
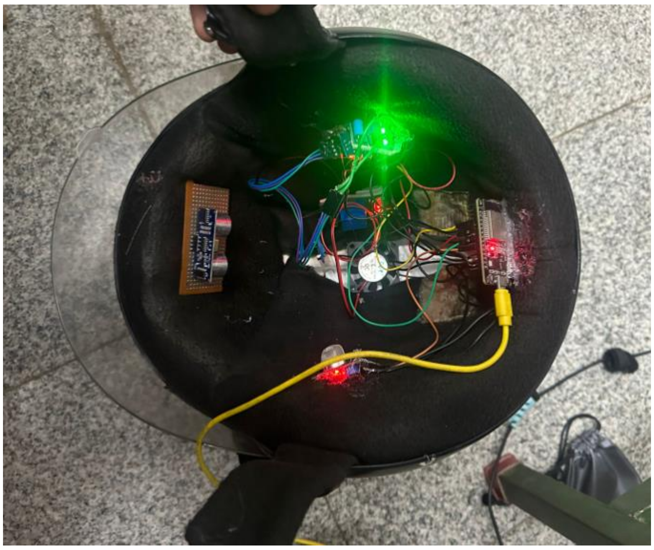
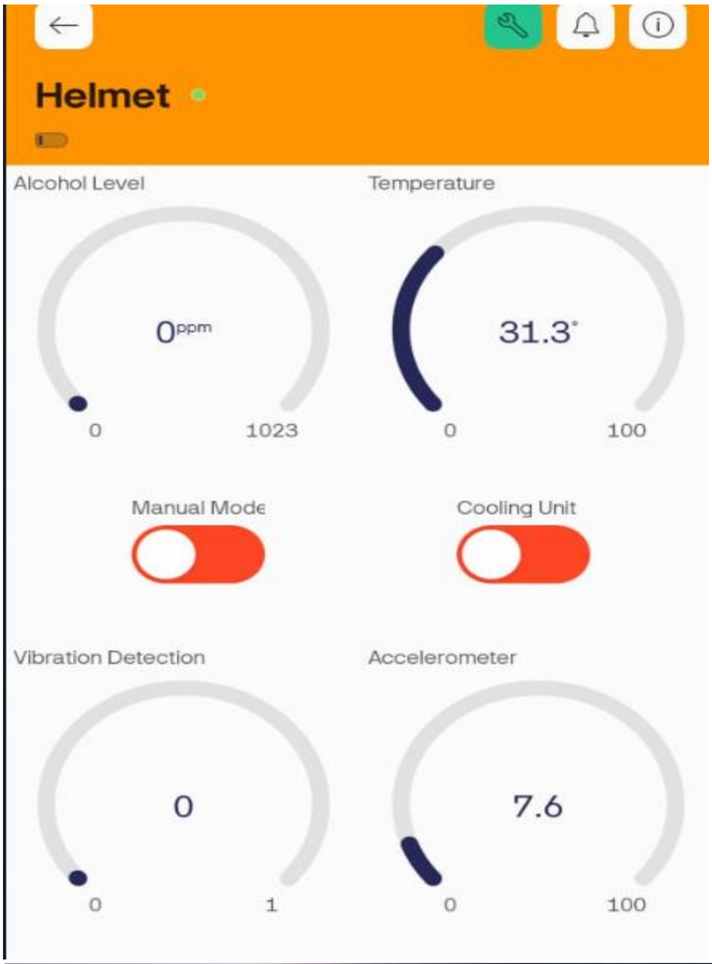


Fig: 3.3.5 SW420(vibration sensor)

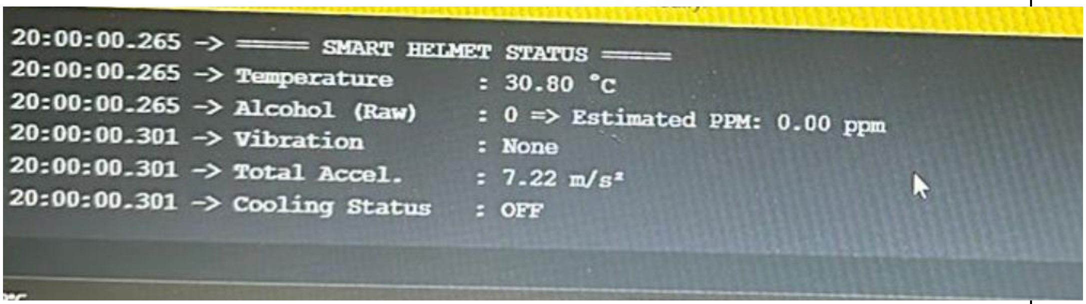
CHAPTER 4
RESULTS

4.1. HARDWARE MODEL:




Helmet
Alcohol Level
0ppm
0
1023
Temperature
31.3°
0
100
Manual Mode
Cooling Unit
Vibration Detection
0
0
1
Accelerometer
7.6
0
100


value 1
Interpolate
STOP



CHAPTER 5
CONCLUSION

The Smart Helmet project presents a comprehensive and innovative approach to enhancing two-wheeler rider safety by integrating advanced sensor technologies, wireless communication, and real-time monitoring. With features like alcohol detection, fall detection using the SW-420 vibration sensor, airbag deployment, temperature control with a Peltier module, microphone-based voice communication, and mobile app integration, the helmet not only detects and responds to emergencies but also improves overall riding comfort and awareness.

The peer-to-peer communication system between helmets ensures seamless information exchange, while modules like Bluetooth enhance remote monitoring and rapid response in critical situations. Each subsystem—from environmental sensing to safety-trigger mechanisms—contributes to a smarter, more secure riding experience.

In conclusion, the Smart Helmet is a powerful step forward in intelligent wearable safety gear, aimed at minimizing risks, preventing accidents, and ensuring help reaches on time—ultimately setting a new standard in road safety for motorcyclists.

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- https://peppe8o.com/how-to-use-peltier-module-with-esp32
- Technical datasheets of ESP-32, MQ-3, Peltier, SIM800L

APPENDIX

```
#define BLYNK_TEMPLATE_ID "TMPL3JZgOVbhC"
```

```
#define BLYNK_TEMPLATE_NAME "SMART HELMET"
#define BLYNK_AUTH_TOKEN "Qmy876P1e5KOu0ZftwdOQqE--lgfrlQe"

#include <WiFi.h>
#include <BlynkSimpleEsp32.h>
#include <DHT.h>
#include <HardwareSerial.h>

// ----- Pins -----
#define DHTPIN 33
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);

#define MQ5PIN 26
#define VIBRATION_PIN 13
#define ADXL_X 32
#define ADXL_Y 35
#define ADXL_Z 34
#define RELAY_PIN 25
#define ALERT_LED 2
#define TRIG_PIN 14
#define ECHO_PIN 27

// ----- Bluetooth Serial -----
HardwareSerial BTSerial(2); // TX = 17, RX = 16

// ----- WiFi -----
char ssid[] = "POCO M2";
char pass[] = "akshay04";

// ----- Globals -----
BlynkTimer timer;
bool autoMode = true, cooling = false, startSent = false;
float previousAcc = 0;

void setup() {
  Serial.begin(115200);
  BTSerial.begin(9600, SERIAL_8N1, 16, 17);

  pinMode(MQ5PIN, INPUT);
  pinMode(VIBRATION_PIN, INPUT);
  pinMode(ADXL_X, INPUT);
  pinMode(ADXL_Y, INPUT);
  pinMode(ADXL_Z, INPUT);
  pinMode(RELAY_PIN, OUTPUT);
  pinMode(ALERT_LED, OUTPUT);
```

```
  digitalWrite(RELAY_PIN, HIGH);

  pinMode(TRIG_PIN, OUTPUT);
  pinMode(ECHO_PIN, INPUT);

  while (getDistanceCM() > 5 || getDistanceCM() < 0) delay(500);  // Wait for helmet wear

  dht.begin();
  Blynk.begin(BLYNK_AUTH_TOKEN, ssid, pass);
  timer.setInterval(1000L, sendSensorData);

  BTSerial.println("START");  // Send once
  startSent = true;
}

void loop() {
  Blynk.run();
  timer.run();
}

void sendSensorData() {
  float temp = dht.readTemperature();
  if (isnan(temp)) temp = 31.5;

  int alcoholRaw = analogRead(MQ5PIN);
  float alcoholPPM = alcoholRaw * 0.24; // approx mapping

  int vibration = digitalRead(VIBRATION_PIN);

  float ax = analogRead(ADXL_X) * 0.0024;
  float ay = analogRead(ADXL_Y) * 0.0024;
  float az = analogRead(ADXL_Z) * 0.0024;
  float totalAcc = ax + ay + az; // simplified for size

  if (autoMode) {
    digitalWrite(RELAY_PIN, temp > 32 ? LOW : HIGH);
    cooling = (temp > 32);
  }

  if (vibration && abs(previousAcc - totalAcc) > 15) {
    digitalWrite(ALERT_LED, HIGH);
    Blynk.logEvent("accident_detection", "Accident Detected!");
  } else {
    digitalWrite(ALERT_LED, LOW);
  }
```

```
  if (alcoholRaw > 600) {
    Blynk.logEvent("alcohol_alert", "Alcohol Detected!");
    BTSerial.println("ALCOHOL");
    delay(1000);
    ESP.restart();
  }

  Blynk.virtualWrite(V1, temp);
  Blynk.virtualWrite(V0, cooling);
  Blynk.virtualWrite(V2, alcoholPPM);
  Blynk.virtualWrite(V3, vibration);
  Blynk.virtualWrite(V5, totalAcc);

  previousAcc = totalAcc;
}

float getDistanceCM() {
  digitalWrite(TRIG_PIN, LOW);
  delayMicroseconds(2);
  digitalWrite(TRIG_PIN, HIGH);
  delayMicroseconds(10);
  digitalWrite(TRIG_PIN, LOW);
  long duration = pulseIn(ECHO_PIN, HIGH, 30000);
  return (duration == 0) ? -1.0 : duration * 0.034 / 2;
}

BLYNK_WRITE(V9) {
  autoMode = param.asInt();
}

BLYNK_WRITE(V0) {
  if (!autoMode) {
    bool value = param.asInt();
    digitalWrite(RELAY_PIN, value ? LOW : HIGH);
    cooling = value;
  }
}
```