MINI PROJECT REPORT

DRIVER FATIGUE DETECTION AND PREVENTION SYSTEM

ECD334 B.Tech : MINI PROJECT

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CERTIFICATE

This is to certify that the report entitled **DRIVER FATIGUE DETECTION AND PREVENTION SYSTEM** *submitted by* **NITHINKRISHNA N (PKD22EC047), MUHAMMED MUJAID K (LPKD22EC072), PRANAV M (LPKD22EC073), SANIA CT (LPKD22EC074)***, to the Department of Electronics and Communication Engineering, Government Engineering College Palakkad, Sreekrishnapuram-678633, in partial fulfilment of the requirement for the award of B-Tech Degree in Electronics and Communication Engineering, is a bonafide record of the project carried out by them under our guidance and supervision.*

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ABSTRACT

Driver drowsiness and inattentiveness significantly contribute to the growing number of road accidents worldwide. Long hours of driving, fatigue, and distractions often lead to delayed reaction times or even complete loss of control over the vehicle. To address this pressing issue, a driver monitoring system has been developed that utilizes real-time sensing to detect signs of fatigue and distraction. This intelligent system employs an eye-blink sensor and an ultrasonic sensor integrated with an ESP32 microcontroller to monitor the driver's alertness level and engagement with the steering wheel.

The core functionality of the system revolves around tracking two key indicators: eye closure duration and the presence of the driver’s hands on the steering wheel. The eye-blink sensor monitors how long the driver’s eyes remain closed; if the duration exceeds a safety threshold, indicating possible drowsiness, an immediate buzzer alert is triggered to regain the driver's attention. Simultaneously, the ultrasonic sensor checks if the driver’s hands are positioned on the steering wheel. A hands-off condition for a prolonged time, which could signify distraction or loss of consciousness, also activates the buzzer alarm. This dual-sensor approach ensures that both visual and physical attentiveness are constantly monitored.

Moreover, the system is designed with an advanced alert mechanism for detecting frequent blinking patterns within short intervals. By integrating these smart alerts, the system not only warns the driver but also helps prevent potential accidents before they occur. Overall, this driver monitoring system enhances road safety by offering a proactive solution to combat drowsiness and inattentiveness in real time.

ORGANISATION OF REPORT

The main body of the report is preceded by detailed contents including abstract. This is followed by system description.

- Chapter 1 gives a brief introduction about the aim of the paper.
- Chapter 2 provides the literature review.
- Chapter 3 gives a detailed discussion on the proposed system.
- Chapter 4 explains the requirements and specifications of hardware and software components.
- Chapter 5 presents analysis of the results and its review.
- Chapter 6 is the conclusion of the report along with the limitations and future work.

The main report is then followed by references.

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Chapter 1

INTRODUCTION

Driver drowsiness and inattentiveness are major causes of road accidents, especially during long or late-night journeys. To address this issue, the "Anti Sleep Alert System for Drivers" monitors the driver’s alertness using an eye-blink sensor and an ultrasonic sensor. The eye-blink sensor detects prolonged eye closure and excessive blinking, while the ultrasonic sensor checks for hand presence on the steering wheel. These sensors are interfaced with an ESP32 microcontroller, which processes the data in real-time and triggers a buzzer alert if signs of fatigue or distraction are detected. This system provides timely warnings, helping to prevent accidents and enhance road safety.

1.1 PROBLEM STATEMENT

Driver drowsiness and inattentiveness are major causes of road accidents, especially during long or late-night journeys. To address this issue, the "Anti Sleep Alert System for Drivers" monitors the driver’s alertness using an eye-blink sensor and an ultrasonic sensor. The eye-blink sensor detects prolonged eye closure and excessive blinking, while the ultrasonic sensor checks for hand presence on the steering wheel. These sensors are interfaced with an ESP32 microcontroller, which processes the data in real-time and triggers a buzzer alert if signs of fatigue or distraction are detected. This system provides timely warnings, helping to prevent accidents and enhance road safety.

1.2 OBJECTIVE

The primary objective of this project is to design a real-time alert system that detects driver drowsiness and inattentiveness to prevent road accidents. This is achieved by monitoring the driver's eye-blink patterns to identify prolonged eye closure or excessive blinking, which are signs of fatigue. An ultrasonic sensor is used to check the presence of the driver’s hands on the steering wheel, helping to detect distractions or unconsciousness. When any abnormal behavior is identified, the system triggers a buzzer alert to regain the driver’s attention. The ESP32 microcontroller ensures quick and reliable processing of sensor data, while proper sensor calibration is applied to improve the system's accuracy across various driving conditions.

1.3 MOTIVATION

The motivation for doing this project are listed below:

- **Increasing Road Accidents Due to Fatigue:** A large number of accidents are caused by drowsy or inattentive drivers, especially during long drives or at night. This highlights the urgent need for a system that can detect and respond to early signs of fatigue.

- **Lack of Affordable Safety Solutions:** Most advanced driver monitoring systems are available only in high-end vehicles. Developing a low-cost, sensor-based solution makes such safety features accessible to all drivers.

- **Potential to Save Lives:** By providing timely alerts, the system can help prevent accidents, protect passengers, and save lives—making roads safer for everyone.

Chapter 2

LITERATURE REVIEW

2.1 Driver Drowsiness Detection – IEEE Xplore: This study explores various techniques for detecting driver drowsiness, including eye tracking, physiological signals, and machine learning algorithms. It emphasizes the effectiveness of eye-blink patterns in identifying fatigue, which aligns with the approach used in this project. The paper also highlights the importance of real-time systems for timely alerts and accident prevention.

2.2 A Systematic Review on Detection and Prediction of Driver Drowsiness–ScienceDirect: This review analyzes the strengths and limitations of existing drowsiness detection systems. It categorizes methods based on behavioral, physiological, and vehicle-based measures. The study concludes that behavioral methods, such as eye monitoring and head movement detection, are among the most practical and non-invasive solutions for real-world applications.

2.3 Real-Time Drowsiness Detection for Drivers Using Eye Blink Patterns – International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (IJAREEIE): This paper presents a real-time driver drowsiness detection system based on monitoring eye-blink frequency and duration. It demonstrates the feasibility of using microcontrollers and simple sensors to implement an effective alert system. The results support the reliability and accuracy of eye-blink sensors for detecting early signs of fatigue, which inspired the hardware design of this project.

Chapter 3

PROPOSED SYSTEM

3.1 BLOCK DIAGRAM

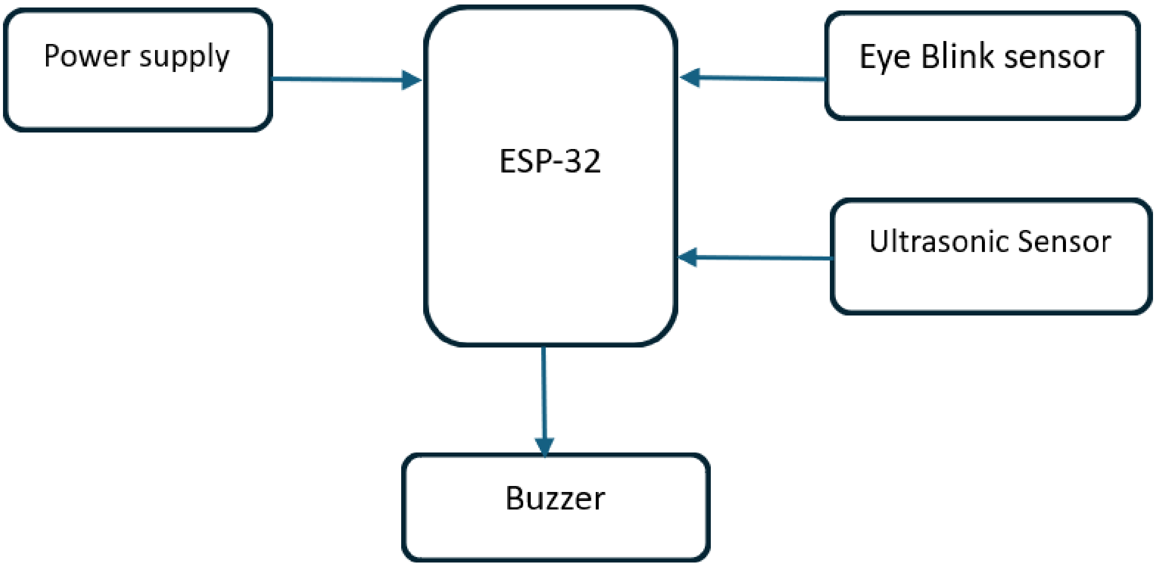

Figure 3.1 BLOCK DIAGRAM

ESP-32 (Main Controller): Acts as the central processing unit of the system; receives data from sensors and controls the output device.

- Power Supply: Provides the necessary 5V power to the ESP-32 and connected components.

- Eye Blink Sensor: Monitors the driver's eye activity; sends signals to ESP-32 when prolonged eye closure or rapid blinking is detected.

- Ultrasonic Sensor: Detects the presence or absence of the driver’s hands on the steering wheel; sends input data to ESP-32 for decision-making.

- Buzzer (Output): Activated by ESP-32 as a warning alert; triggers sound when signs of drowsiness or inattentiveness are detected.

3.2 FLOWCHART

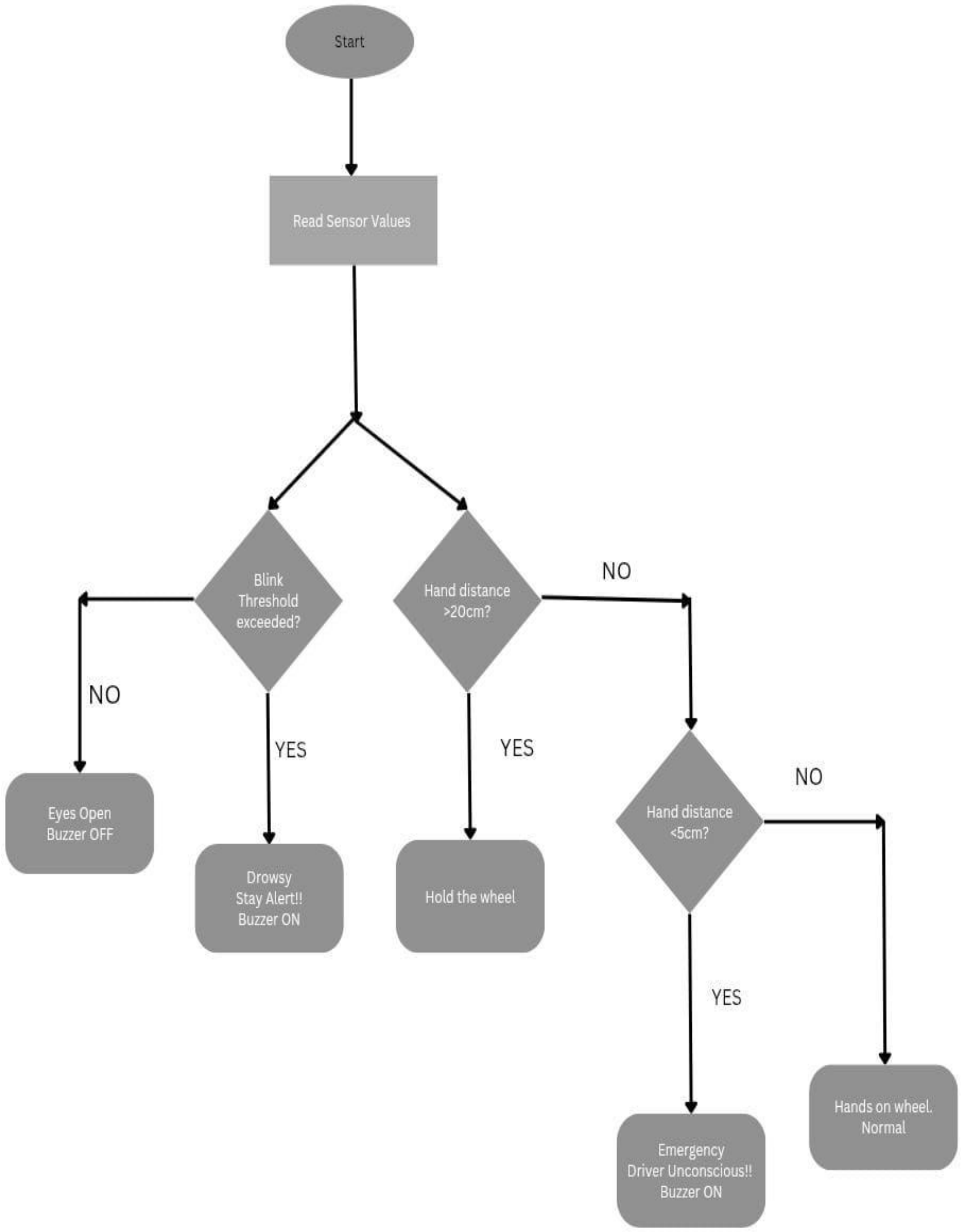

Figure 3.2 FLOW CHART

The Driver Fatigue detection and Prevention system is designed to monitor and respond to driver's fatigue and drowsiness using ultrasonic sensor and eye blink sensor. The following steps explain the working of the system in detail:

1. System Start

- The system is powered on and initiates its operation.

2. Reading Sensor Values

- The system reads real-time values from the eye blink sensor and hand distance sensor.
- These values are continuously monitored to assess the driver's alertness and grip on the steering wheel.

3. Blink Threshold Check

- **Condition:** Is the blink threshold exceeded?
  - This determines whether the driver is blinking too slowly or too frequently, indicating drowsiness.

a. If NO (Blink threshold not exceeded):

- **Actions Taken:**
  - Eyes are open and normal.
  - The buzzer remains OFF.
  - No alert is given.

b. If YES (Blink threshold exceeded):

- **Actions Taken:**
  - Drowsiness detected.
  - A warning message is generated: "Drowsy - Stay Alert!!"
  - The buzzer is turned ON to alert the driver.

4. Hand Distance Check (First Level)

- **Condition:** Is the hand distance greater than 20 cm?
  - This checks whether the driver has taken their hands off the wheel.

a. If YES (Hand distance > 20 cm):

- **Actions Taken:**
  - The system prompts the driver to "Hold the wheel".
  - This acts as a cautionary measure.

b. If NO (Hand distance ≤ 20 cm):

- The system proceeds to a second level of hand distance evaluation.

5. Hand Distance Check (Second Level)

- **Condition:** Is the hand distance less than 5 cm?
    - This check is used to detect if the driver may have slumped over the steering wheel, possibly unconscious.

a. If YES (Hand distance < 5 cm):

- **Actions Taken:**
    - Emergency situation detected.
    - Alert: "Emergency - Driver Unconscious!!"
    - The buzzer is turned ON to notify nearby individuals and possibly trigger emergency protocols.

b. If NO (Hand distance between 5 cm and 20 cm):

- **Actions Taken:**
    - Driver's hands are on the wheel in a normal position.
    - System status is "Normal".
    - No alerts or warnings triggered.

6. Continuous Monitoring

- The system continuously loops back to **Read Sensor Values**, ensuring real-time response to the driver's condition.
- This closed loop enables quick detection of drowsiness or emergency states and ensures driver safety through timely alerts.

3.3 CIRCUIT DIAGRAM- DESIGN AND WORKING

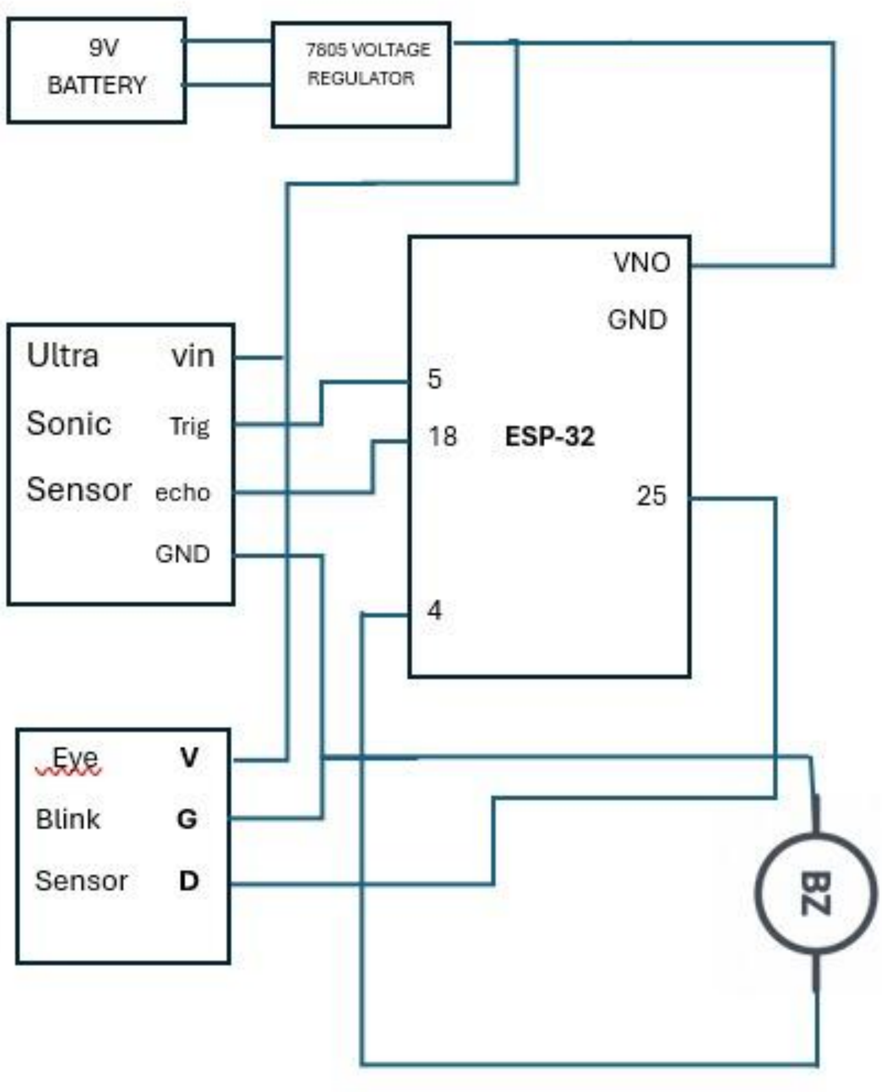

Figure 3.3 CIRCUIT DIAGRAM

This circuit is designed to monitor a driver's alertness and provide a warning if signs of fatigue are detected. The core of the system is an ESP-32 microcontroller, which coordinates input from an ultrasonic distance sensor and an eye blink sensor. These components are powered by a 9V battery. Since most electronic components operate at 5V, a 7805 voltage regulator is used to step down the 9V from the battery to a stable 5V supply for the sensors and microcontroller.

The ultrasonic sensor, typically an HC-SR04, is used to determine if the driver is seated in front of the steering wheel. It does this by emitting ultrasonic pulses and measuring the time it takes for the echo to return. This sensor is connected to the ESP-32 via two digital pins: one to trigger the pulse and the other to receive the echo signal. If the sensor detects an object (the driver) within a predefined range, it confirms the presence of the driver.

Simultaneously, an eye blink sensor is used to monitor the driver's eye activity. This sensor detects the movement or state of the eyes — whether they are open, blinking normally, or closed for an extended duration. It is connected to a digital input pin of the ESP-32, and based on the sensor’s output, the ESP-32 evaluates whether the driver might be drowsy or falling asleep.

If the ultrasonic sensor confirms that the driver is present and the eye blink sensor indicates prolonged eye closure — a common sign of fatigue — the ESP-32 activates a buzzer connected to one of its output pins. The buzzer sounds an audible alert to wake or warn the driver, potentially preventing a road accident. This simple yet effective combination of sensors and logic helps improve road safety by detecting and responding to signs of driver drowsiness in real-time.

Chapter 4

HARDWARE AND SOFTWARE REQUIREMENTS

4.1 HARDWARE

4.1.1 ESP32

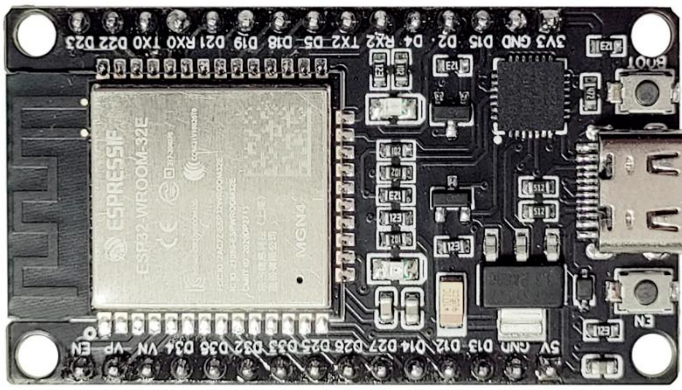

Figure 4.1.1: ESP32

The ESP32 is a powerful and energy-efficient microcontroller that serves as the core processing unit of the driver fatigue detection system. It continuously collects data from the eye-blink sensor (connected to GPIO 25) to detect prolonged eye closure or rapid blinking, which are key indicators of drowsiness. Simultaneously, it monitors the ultrasonic sensor (Trigger – GPIO 5, Echo – GPIO 18) to check if the driver's hands are off the steering wheel. When signs of fatigue or distraction are detected, the ESP32 triggers a buzzer via GPIO 4 to alert the driver in real-time. With built-in Wi-Fi and Bluetooth capabilities, it also offers potential for future enhancements such as data logging or remote monitoring**.**

4.1.2 EYE BLINK SENSOR

Figure 4.1.2: EYE BLINK SENSOR

The eye blink sensor is an essential component of the anti-sleep alert system, used to monitor the driver's eye activity in real-time. It operates using an infrared (IR) transmitter and receiver pair, which detects the reflection of IR light from the surface of the eye. When the eye is open, the reflected light is detected by the receiver, while eye closure interrupts this reflection, indicating a blink. This sensor outputs an analog signal corresponding to the eye's state, which is read by the ESP32 through GPIO pin 25. If the sensor detects that the driver's eyes remain closed beyond a predefined threshold (e.g., 2 seconds), it triggers a drowsiness alert by activating a buzzer and sending a warning via Bluetooth. Compact in size and efficient in response time, the sensor operates on a voltage range of 3.3V to 5V, making it ideal for low-power embedded applications.

4.1.3 ULTRASONIC SENSOR

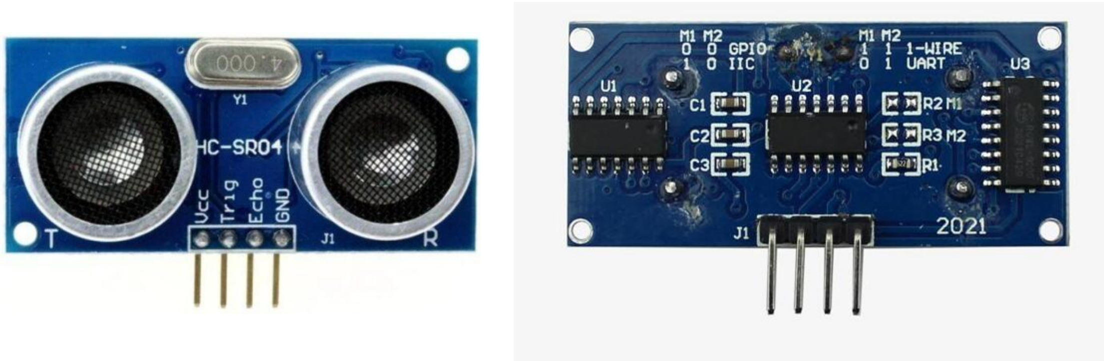

Figure 4.1.3 ULTRASONIC SENSOR

The HC-SR04 ultrasonic sensor is used to detect the presence of the driver's hands on the steering wheel and to sense if the driver has fallen onto it. It works by sending out ultrasonic waves and measuring the time taken for the echo to return, allowing it to calculate the distance of nearby objects. In this system, the sensor helps identify if the driver's hands are within a safe range (less than 20 cm) or if the face is too close to the wheel (less than 5 cm), which may indicate drowsiness or unconsciousness. It is connected to the ESP32 through GPIO 5 (TRIG) and GPIO 18 (ECHO).

4.1.4 BUZZER

Figure 4.1.4 BUZZER

The buzzer in this system serves as an alert mechanism to immediately notify the driver in case of drowsiness or unsafe conditions. It produces a loud sound when triggered, helping to regain the driver's attention. The buzzer is connected to GPIO 4 of the ESP32 and is activated when the eye blink sensor detects prolonged eye closure or when the ultrasonic sensor senses that the driver's hands are off the wheel or if the driver has collapsed forward. Operating on 5V,the buzzer provides a simple yet effective way to deliver real-time warnings.

4.1.5 POWER SUPPLY

The system is powered using a 9V battery connected through a 7805 voltage regulator, which steps down the voltage to a stable 5V required for operating the components such as the ESP32, sensors, and buzzer. The 7805 regulator ensures a consistent 5V output despite fluctuations in battery voltage, thereby protecting the electronic components and ensuring reliable performance. This setup provides a compact and portable power solution suitable for in-vehicle applications.

4.2 SOFTWARE

4.2.1 ARDUINO IDE

Arduino IDE is a free, open-source software used to write, compile, and upload programs to Arduino-compatible boards, including the powerful ESP32 microcontroller. It provides a simple and user-friendly interface, making it accessible for both beginners and experienced developers. The IDE supports C and C++ programming languages and offers a wide range of built-in libraries, code examples, and tools that simplify development.

When using the ESP32, the Arduino IDE allows seamless integration and programming through board support packages that can be easily installed. The ESP32 is known for its dual-core processor, built-in Wi-Fi, Bluetooth capabilities, and a rich set of peripherals, making it ideal for IoT and embedded applications.

Chapter 5

RESULTS AND DISCUSSION

The Driver Fatigue Detection and Prevention System effectively was successfully implemented and tested . the system utilized the Eye Blink Sensor and Ultrasonic sensor hc-SR04 to monitor drowsiness and fatigue of driver , and the ESP#2 microcontroller processed this data in real time . upon reaching a predefined threshold level , the following results were observed :

1. Eye closure detection:

The eye blink sensor accurately detected prolonged eye closure (more than 2 seconds). When this occurred, the system triggered a buzzer and sent a Bluetooth alert: “DROWSY! Stay Alert!”. Normal blinks under 2 seconds were ignored to avoid false alarms. Once the eyes reopened, the buzzer turned off and a message—“Eyes Open - Buzzer OFF”—was sent. The sensor operated continuously in real-time alongside the hand detection module to ensure quick response..

2. Hands on wheel monitoring:

The ultrasonic sensor reliably detected the distance between the driver’s hands and the steering wheel. If hands were within 20 cm, the system stayed normal and sent: “Hands on Wheel - Normal”. If hands were absent for over 3 seconds, a buzzer and warning—“Hold the Wheel!”—were activated. When an object was detected very close (less than 5 cm), the system assumed a collapse and triggered a 3-second buzzer with the message: “EMERGENCY! Driver Unconscious?”. This module also ran in parallel with the eye detection system.

3. Alert system and Data monitoring :

The system provided real-time feedback through both audio and Bluetooth alerts. In cases of drowsiness, missing hands, or possible collapse, it immediately triggered a buzzer and sent appropriate messages to a connected device. Simultaneously, all events and sensor outputs were displayed on the serial monitor, allowing easy testing and debugging.

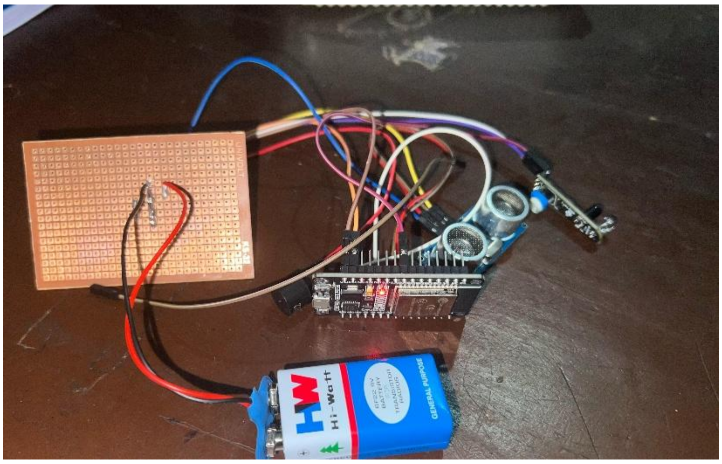

Figure 5.1 RESULTING WORKING MODEL

Chapter 6

CONCLUSION

The Anti-Sleep Alert System for Drivers is an effective embedded solution designed to enhance road safety by detecting signs of drowsiness and inattentiveness. Using an eye blink sensor and an ultrasonic sensor, the system monitors the driver's eye activity and hand position on the steering wheel. If abnormal conditions are detected—such as eyes closed for too long or hands off the wheel—a buzzer is activated and a Bluetooth alert is sent. This real-time response helps reduce the risk of accidents caused by driver fatigue.

Although the system performs well, it has a few limitations, such as sensitivity to lighting conditions and fixed detection thresholds. Future improvements could include camera-based detection, mobile app integration, and advanced alert features. Despite its simplicity, the project demonstrates a strong potential for improving driver safety in personal and commercial vehicles.

FUTURE SCOPE

The Anti-Sleep Alert System can be enhanced in various ways to increase its accuracy, usability, and practical applications. Integrating a camera-based eye tracking system can provide more precise detection of drowsiness and facial expressions. Implementing machine learning algorithms would allow the system to adapt to individual driver behavior, reducing false alerts.

A mobile application can be developed for real-time monitoring, alert history tracking, and data logging. Integration with cloud services can further help in long-term analysis and fleet management. Additionally, the system can be extended to control vehicle functions, such as slowing down or sending an emergency alert to contacts or authorities, making it more effective in critical situations. Enhancing power efficiency and enabling rechargeable or vehicle-powered operation would also support long-duration use.

LIMITATIONS

Despite its effectiveness, the current system has several limitations:

- Lighting and Noise Sensitivity: The IR-based eye blink sensor may give inaccurate results in bright sunlight or if there's electrical noise.
- Sensor Placement: Requires precise sensor positioning near the eyes and steering wheel, which may vary with driver posture or vehicle model.
- No Personalization: The system uses fixed thresholds for eye closure and distance detection, which may not be optimal for all drivers.
- Limited Emergency Response: While the system alerts the driver, it does not currently notify emergency services or take action beyond buzzer alerts.
- Power Dependency: The use of a 9V battery limits operation time; frequent battery replacement may be needed for long-duration travel.

Despite these limitations, our project remains a highly effective system for detecting fatigue and drowsiness of driver.

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[2] S. Tripathi and S. D. Agrawal, "Design and Implementation of Driver Drowsiness Detection System using Eye Blink Sensor and Microcontroller," International Journal of Engineering Research & Technology (IJERT), vol. 7, no. 5, pp. 210–213, May 2018.

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Appendix A

Working Code

```
#include <NewPing.h>
#include <BluetoothSerial.h> // Add Bluetooth Serial

BluetoothSerial SerialBT; // Create a Bluetooth Serial object

#define TRIG_PIN 5
#define ECHO_PIN 18
NewPing sonar(TRIG_PIN, ECHO_PIN, 50); // Steering hand & fall detection

const int blinkSensorPin = 25;
const int blinkThreshold = 500;
const int eyeClosedTimeLimit = 2000; // 2 seconds
const int handThreshold = 20;
const int faceCloseThreshold = 5;
const int handsOffWarningTime = 3000;

unsigned long eyeCloseStartTime = 0;
bool eyesClosed = false;

bool handsDetected = true;
unsigned long handsOffStart = 0;

const int buzzerPin = 4;

void setup() {
  Serial.begin(115200);
  SerialBT.begin("ESP32_Drowsiness"); // Bluetooth device name
```

```
  Serial.println("Bluetooth started. Connect to 'ESP32_Drowsiness'");
  SerialBT.println("Bluetooth Ready!");

  pinMode(blinkSensorPin, INPUT);
  pinMode(buzzerPin, OUTPUT);
  digitalWrite(buzzerPin, LOW);
}

void loop() {
  int sensorValue = analogRead(blinkSensorPin);
  int handDistance = sonar.ping_cm();

  // EYE BLINK MONITORING
  if (sensorValue > blinkThreshold) {
    if (eyeCloseStartTime == 0) {
      eyeCloseStartTime = millis();
    }
    if (millis() - eyeCloseStartTime >= eyeClosedTimeLimit) {
      if (!eyesClosed) {
        String msg = "DROWSY! Stay Alert! Buzzer ON";
        Serial.println(msg);
        SerialBT.println(msg);
        digitalWrite(buzzerPin, HIGH);
        eyesClosed = true;
      }
    }
  } else {
    if (eyesClosed) {
      String msg = "Eyes Open - Buzzer OFF";
      Serial.println(msg);
      SerialBT.println(msg);
      digitalWrite(buzzerPin, LOW);
```

```
    eyesClosed = false;
   }
   eyeCloseStartTime = 0;
  }

  // STEERING WHEEL MONITORING
  if (handDistance > 0 && handDistance < handThreshold) {
   if (!handsDetected) {
    String msg = "Hands on Wheel - Normal";
    Serial.println(msg);
    SerialBT.println(msg);
    handsDetected = true;
    handsOffStart = 0;
   }
  } else {
   if (handsDetected) {
    String msg = "Hands Off Detected - Monitoring...";
    Serial.println(msg);
    SerialBT.println(msg);
    handsDetected = false;
    handsOffStart = millis();
   }
  }

  if (!handsDetected && handsOffStart > 0 && millis() - handsOffStart > handsOffWarningTime)
 {
   String msg = "Hold the Wheel!";
   Serial.println(msg);
   SerialBT.println(msg);
   digitalWrite(buzzerPin, HIGH);
   delay(1000);
   digitalWrite(buzzerPin, LOW);
```

```
 }

 // FALLING ONTO STEERING DETECTION
 if (handDistance > 0 && handDistance < faceCloseThreshold) {
   String msg = "EMERGENCY! Driver Unconscious? Buzzer ON";
   Serial.println(msg);
   SerialBT.println(msg);
   digitalWrite(buzzerPin, HIGH);
   delay(3000);
   digitalWrite(buzzerPin, LOW);
 }

 delay(100);
}
```