Smart Helmet with Sensor Based Ignition Control and Accident Detection System

A

Project Report

Submitted in the partial fulfillment of the requirement for the award of the degree of

Bachelor of Technology

In

Electronics and Communication Engineering

By

KAJAL YADAV (2022041031)

KAVYA GUPTA (2022041033)

NIKHIL PANDEY (2022041045)

PRINCE CHAUDHARY (2022041155)

Under the supervision of

Dr. Prince Kumar Singh

(Assistant Professor)

Department of Electronics and Communication Engineering

Madan Mohan Malaviya University of Technology, Gorakhpur (U.P.) INDIA

November 2025

November-2025

CANDIDATE'S DECLARATION

I declare that this written submission represents my work and ideas in my words and where other's ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented, fabricated or falsified any idea, data, fact, or source in my submission. I understand that any violation of above will be cause for disciplinary action by the university and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken wherever required.

Kajal Yadav
2022041031
Electronics and Communication Engineering
Date:

Kavya Gupta
2022041033
Electronics and Communication Engineering
Date:

Nikhil Pandey
2022041045
Electronics and Communication Engineering
Date:

Prince Chaudhary
2022041155
Electronics and Communication Engineering
Date:

CERTIFICATE

Certified that Kajal Yadav (2022041031), Kavya Gupta (2022041033), Nikhil Pandey (2022041045) and Prince Chaudhary (2022041155) has carried out the research work presented in this report entitled **"Smart Helmet with Sensor Based Ignition Control and Accident Detection System"** for the award of Bachelor of Technology from Madan Mohan Malaviya University of Technology, Gorakhpur under my supervision. The report embodies the result of original work and studies carried out by Students themselves and the contents of the report do not form the basis for the award of any other degree to the candidate or to anybody else.

Dr. Prince Kumar Singh
Assistant Professor
Electronics and Communication Engineering Department
M. M. M. U. T. Gorakhpur

Date:

APPROVAL SHEET

The report titled **"Smart Helmet with Sensor Based Ignition Control and Accident Detection System"** by Kajal Yadav (2022041031), Kavya Gupta (2022041033), Nikhil Pandey (2022041045) and Prince Chaudhary (2022041155) has been approved for the degree of Bachelor of Technology in Electronics and Communication Engineering.

Examiner

____

____

____

Supervisor

____

Head of Department

____

Date:

Place:

ACKNOWLEDGEMENT

We are fortunate to have this opportunity to do this project work under the guidance of **Dr. Prince Kumar Singh**, Department of Electronics and Communication Engineering, Madan Mohan Malaviya University of Technology, Gorakhpur. We extend our sincere thanks and deepest gratitude to our guide for their unwavering support, invaluable guidance, and boundless encouragement.

We express our gratitude to **Proff. Sanjay Kumar Soni**, Head of the Department of Electronics and Communication Engineering at Madan Mohan Malaviya University of Technology, Gorakhpur, for providing comprehensive infrastructural support during our research work.

We extend our appreciation to all the faculty members and staff of the Department of Electronics and Communication Engineering for their wholehearted cooperation, which has contributed to the authenticity of this work.

ABSTRACT

The Smart Helmet with Sensor Based Ignition Control and Accident Detection System is designed to increase two-wheeler rider's safety by integrating several safety features into a device. The system includes alcohol detection, helmet-wearing verification, accident detection, and automatic emergency alert features.

A limit switch is used to ensure that bike starts only when the helmet is worn properly. A MQ-3 sensor detects alcohol levels in rider's breath. If the rider has consumed alcohol, the bike will not start.

For accident detection, the MPU6050 sensor constantly tracks acceleration and angular motion to identify crash like impacts. When the system detects an accident, GSM and GPS modules gets activated to immediately send alerts with the rider's real-time location to pre-registered emergency contacts. These alerts provide exact coordinates and a clickable Google Maps link of rider, which helps emergency responders to find the accident site more quickly.

The prototype works on start mode, running mode and accident mode with different functionalities in each mode. This combined approach improves rider safety by prohibiting drunk driving, ensuring helmets are used, and allowing for quick emergency responses. The proposed system seeks to significantly lower fatalities due to delayed medical help and unsafe riding habits. The prototype has been tested thoroughly and shows excellent accuracy in detecting accident and reliable emergency communication.

LIST OF FIGURES

LIST OF TABLES

TABLE OF CONTENTS

CHAPTER - 1
INTRODUCTION

1.1 Overview of Road Safety Challenges

These days, two-wheeler transportation has become one of the most popular ways to get around. However, the increased use of two-wheelers has also resulted in a noticeable rise in accident-related fatalities and injuries.
Many riders, especially young people, ignore helmet usage or drive under the influence of alcohol. According to WHO (2023), more than 1.19 million deaths occur globally each year due to road accidents, and India contributes to nearly 11% of these deaths. The main purpose of traditional helmets is to shield the head from harm. However, they are unable to communicate with emergency contacts or identify accidents.

Studies have shown that most of road accident fatalities occur because the rider was not wearing a helmet, was driving under the influence of alcohol or delay in receiving medical assistance after the accident. These real life challenges emphasise the need for a smart helmet that can operate autonomously without depending on user.

Unlike traditional helmets, smart helmet integrate sensors and communication technologies to actively identify accidents and initiate emergency procedures. Motorcyclists particularly benefit from them because two wheelers are more prone to collisions.

Smart helmets can improve road safety by reducing the time between an accident and medical assistance by incorporating impact detection, alcohol sensing, helmet-wearing monitoring, GPS tracking, and GSM based communication. This integration represents a proactive approach to road safety, transforming a simple protective device into a life-saving system.

1.2 Objectives

- The goal is to build a smart safety system for bike riders that reduces accident risks and ensures immediate response after an accident.

- Design a low-cost and automated smart helmet system
- Ensure that vehicle starts only when rider wears the helmet and not consumed alcohol
- Implement real time GPS tracking
- Send automated emergency SMS alerts
- Create a reliable and easy to install system

1.3 Features of System

- Real time accident alert
- Device requires minimal maintenance once installed.
- Ignition turns ON only when safety conditions are satisfied.

1.4 Proposed Solution

It will be implemented with a smart helmet that embodies a limit switch for helmet detection, and MQ-3 sensor for alcohol detection, and an MPU6050 sensor for accident monitoring. These inputs are processed by an ESP32 microcontroller, which wirelessly transmits the data to the bike unit controlling ignition and sends alerts via a GSM and GPS module. The integrated system ensures that the bike starts only under safe conditions and automatically sends location-based emergency messages in case of an accident.

CHAPTER-2

LITERATURE REVIEW

Recent advancements in embedded systems and sensor-based technologies have enabled the development of intelligent safety solutions for motorcycle riders. Smart helmet systems are widely recognized as effective tools to reduce road fatalities by integrating sensing mechanisms, microcontrollers, and wireless communication. Existing research highlights key safety features such as alcohol detection, helmet-wear verification, accident identification, GPS-based location monitoring, and GSM-enabled emergency messaging.

Early smart helmet designs focused primarily on alcohol sensing and ignition control using gas sensors and microcontroller-based logic. These systems demonstrated that preventing intoxicated riders from starting a vehicle can significantly reduce accident risk. Subsequent work expanded the scope by introducing multi-domain helmet systems that integrate fall detection, location tracking, and automated emergency alerts, improving both preventive and post-accident safety.

A major line of research has explored accelerometer and gyroscope-based accident detection. Sudden changes in acceleration or orientation are processed by microcontrollers to differentiate between normal riding motion and crash-like impacts. When thresholds are exceeded, the system triggers GSM modules to send distress messages along with GPS coordinates. Studies consistently report that automated notification systems greatly reduce the delay in obtaining medical assistance, which is often critical for accident survival.

Further advancements introduced IoT integration, enabling helmets to communicate with mobile applications and cloud platforms for real-time monitoring, data logging, and extended safety analytics. These systems emphasize multi-sensor fusion to reduce false positives and enhance decision accuracy. Improvements in wireless modules, GPS precision, and embedded processing have also contributed to more responsive and reliable designs.

Despite considerable progress, research identifies several persistent challenges. Highly sensitive accelerometers often generate false accident alerts; GPS modules face delays in calibration and signal acquisition and conventional GSM modules send messages sequentially, creating communication delays. Power consumption remains a limitation as well, particularly for systems that continuously operate GPS and GSM modules.

The present smart helmet design builds upon the collective findings of earlier studies by integrating alcohol detection, helmet-wear verification, crash detection via MPU6050 sensors, GPS tracking, GSM communication, and ignition control using ESP32 microcontrollers. This approach addresses key limitations and aims to provide a more reliable and comprehensive real-time safety solution for motorcyclists.

CHAPTER-3
SYSTEM DESIGN

3.1 Block Diagram

The entire design is classified into two parts transmitting part (helmet unit) and receiving part (bike unit).

The transmitting part contains ESP32 as main controller, a limit switch, and MQ-3 alcohol sensor. The limit switch is set inside the top of the helmet that is utilized to detect whether rider is wearing helmet or not and alcohol sensor (MQ-3) is placed close to rider's mouth for identifying any liquor substance before riding. The microcontroller processes these inputs and sends the status wirelessly to bike unit to control ignition.

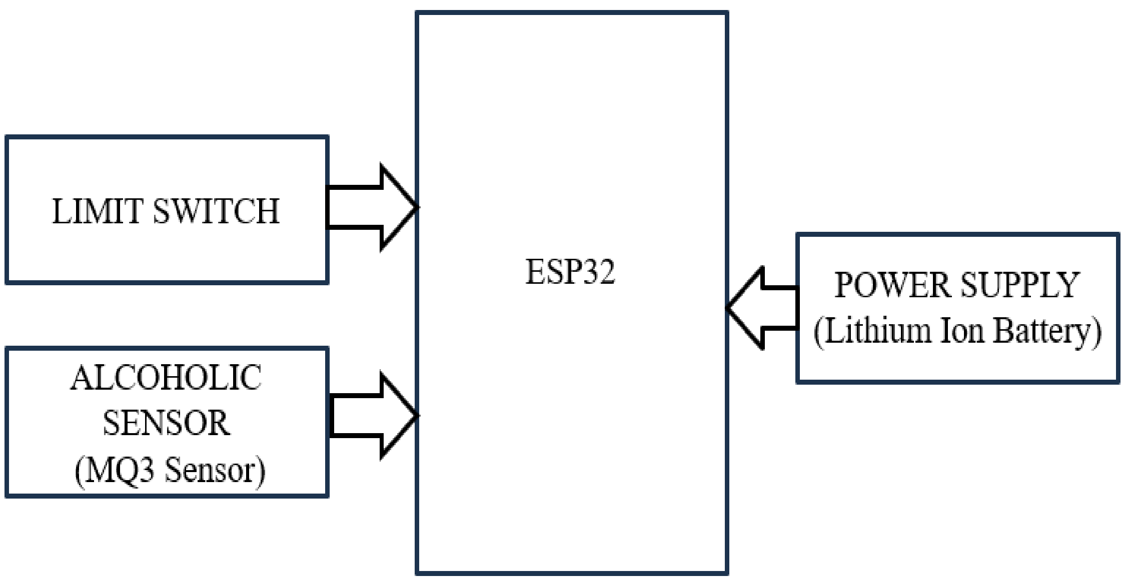

Figure 3.1: Transmitting Part (Helmet Unit)

The receiving part consists of ESP32, MPU6050, GSM, GPS and relay module. The MPU6050 is utilized to detect sudden impact or crash-like vibrations in bike. If any vibration is detected it will send the data to microcontroller and then GPS gets location coordinates and with help of GSM sends alert message to pre-saved emergency contact. The relay module controls the ignition system and turns the engine ON or OFF based on helmet-wearing status and alcohol status.

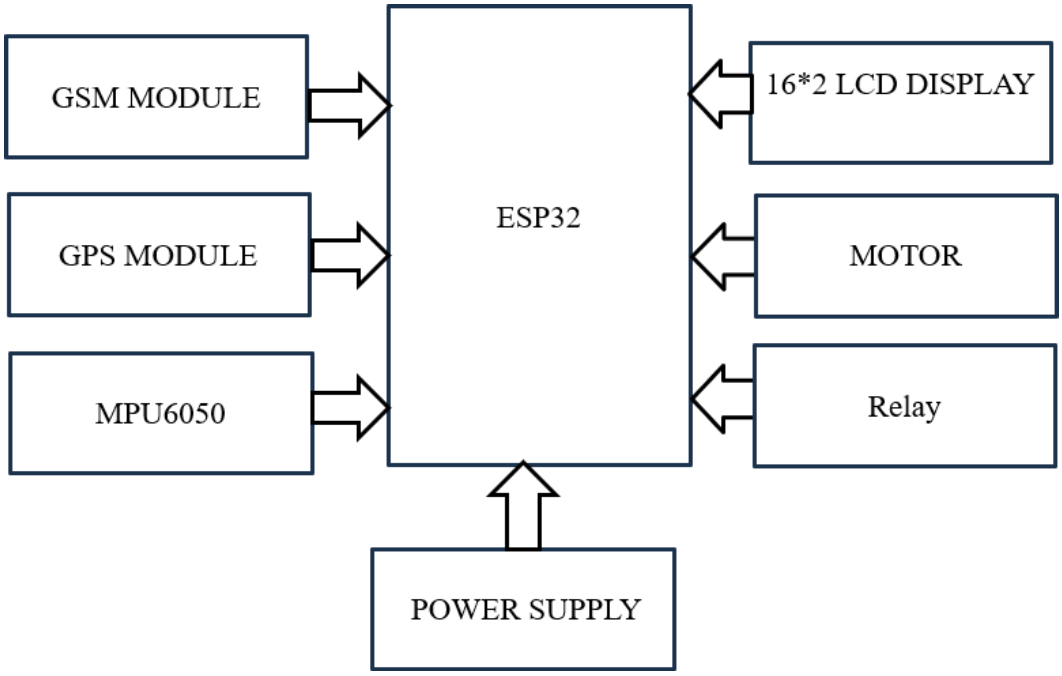

Figure 3.2: Receiving Part (Bike Unit)

3.1.1 ESP32 Microcontroller

The ESP32 is a family low cost, low power microcontrollers developed by Espressif Systems, which integrate both Wi-Fi and Bluetooth capabilities for wireless communication in embedded and Internet of Things (IoT).

Figure 3.3 ESP32 Microcontroller

Specifications	Details
Microcontroller	Tensilica Xtensa LX6
Operating Voltage	3.0 – 3.6 V
Input Voltage	3.3 V
Digital I/O pins	34
Analog Input Pins	Up to 18
Flash memory	4 MB
SRAM	520 kB
Clock Speed	160 MHz
Wi-Fi	802.11 b/g/n (2.4 GHz)
Bluetooth	Bluetooth v4.2 + BLE

Table 3.1: ESP32 Microcontroller Specifications

3.1.2 MQ-3 Gas Sensor

An alcohol sensor detects the attentiveness of ethanol in the air when the drunk person breathes near this sensor, it discloses the alcohol gas in his breath and obtain the output based on alcohol concentration. It is placed in the helmet such a way that it can easily sense the breath of the person. It is a low cost sensor which can detect the presence of alcohol gases at concentrations from 0.05 mg/L to 10 mg/L. This module provides both digital and analog outputs. It has a high sensitivity and fast response time.

Figure 3.4: MQ-3 Gas Sensor

Specifications	Details
Power requirements	5 VDC @ ~165 mA (heater on) / ~60 mA (heater off)
Current Consumption	150mA
D0 output	TTL digital 0 and 1 (0.1 and 5V)
A0 output	0.1- 0.3 V (relative to pollution), the maximum concentration of a voltage of about 4V.
Interface	1 TTL compatible input (HSW), 1 TTL compatible output (ALR)
Heater consumption	less than 750mW
Clock Speed	Operating temperature
EEPROM	1 kB

Table 3.2: MQ-3 Gas Sensor Specifications

3.1.3 Limit Switch

Limit switch is an electromechanical switch that operates by any physical force or the movement of a machine.

These switches are very helpful in detecting the absence or presence of an object. This switch is placed inside on top of the helmet and it is pressed when the rider wears the helmet and it released when helmet takes off. Based on the switch condition the bike ignition key will be ON/OFF.

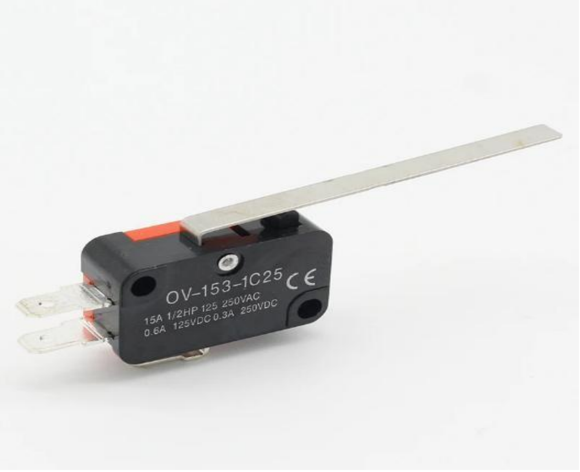

Figure 3.5: Limit Switch

Specifications	Details
Type	Roller Lever
Housing Material	Polycarbonate/Metal
Operating Voltage	250 V DC
Operating Force	0.5-1.5 N
Contact Resistance	< 100 mOhm
Rated Current	5A-10A max

Table 3.3: Limit Switch Specifications

3.1.4 GSM Module

GSM enables SMS-based communication by sending accident alerts to preconfigured contacts. GSM SIM900A works on 900/1800 MHz GSM bands and communicates with ESP32 via UART serial communication. The microcontroller sends AT commands to the module, which carries out tasks such as sending SMS, network status checking, or even calling.

Figure 3.6: GSM Module 900A

Specifications	Details
Operating Voltage	3.4-4.4V
Frequency Range	900/1800 MHz
Data Services	GPRS multi-slot class 10
Communication	UART interface, baud rate 9600
Power Consumption	Idle: ~1.5 mA
Antenna Requirements	External antenna

Table 3.4: GSM Module 900A Specifications

3.1.5 MPU6050 Sensor

The MPU6050 is a 6-axis sensor combining a 3-axis accelerometer and 3-axis gyroscope in a single chip. This module is of very small in size, has low power consumption requirements and highly accurate. It can be easily interfaced with different components such as microcontrollers.

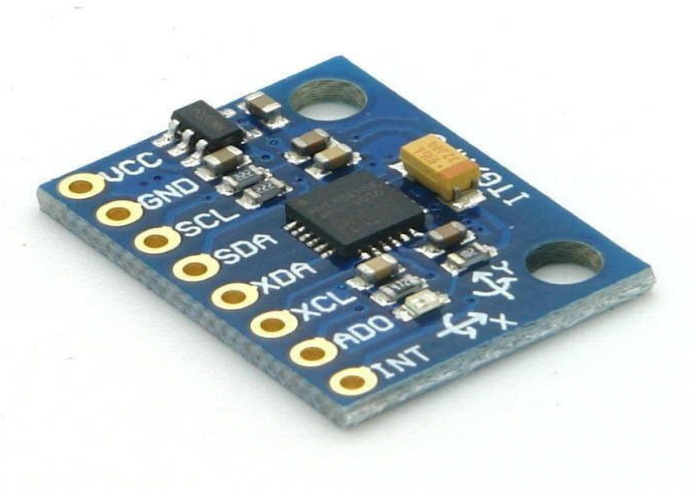

Figure 3.7: MPU6050

Specifications	Details
Operating Voltage	2.3V – 3.4V DC
Accelerometer Range	±2g, ±4g, ±8g, ±16g
Gyroscope Range	±250, ±500, ±1000, ±2000 °/s
Output Type	Digital
Power Consumption	~3.50 microAmpere

Table 3.5: MPU6050 Specifications

3.1.6 GPS Neo-6M Module:

GPS (Global Positioning System) is a satellite navigation system that furnishes location and time information in all climate conditions to the user. The information that is collected from the device is stored on the device inside and then is transmitted through a wireless network or cellular network.

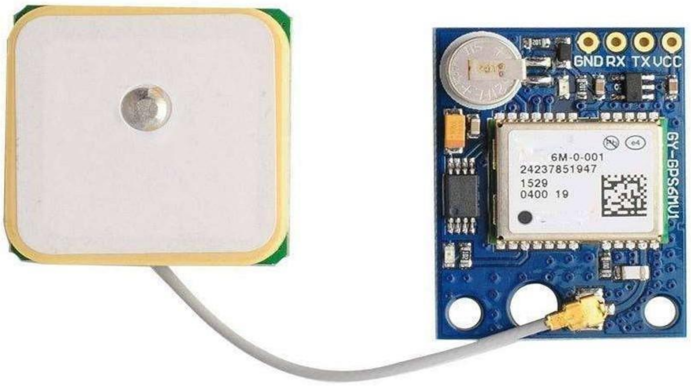

Figure 3.8: GPS Neo-6M

Specifications	Details
Position Accuracy	2.5 meters
Time to first fix	27 seconds
Velocity Accuracy	0.1 m/s
Update Rate	Up to 5 Hz
Operating Voltage	2.7V-3.6V
Antenna Requirements	External antenna

Table 3.6: GPS Neo-6M Specifications

3.1.7 Voltage Regulator

7805 Voltage Regulator, a member of the 78xx series of fixed linear voltage regulators used to maintain such fluctuations, is a popular voltage regulator integrated circuit (IC). It is a 5V fixed three terminal positive voltage regulator IC. Output currents up to 1A can be drawn from the IC provided that there is a proper heat sink.

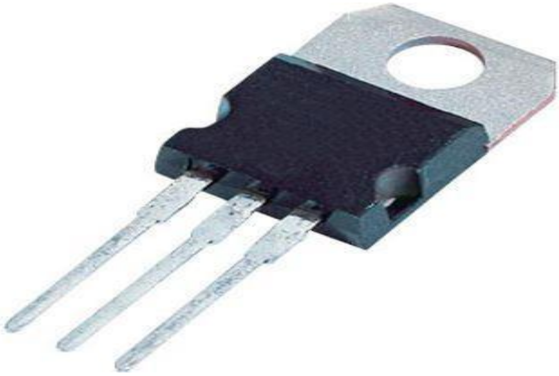

Figure 3.9: 7805 Voltage Regulator

Specifications	**Details**
Output Voltage	5V
Input Voltage Range	7V-25V
Output Current	Up to 1.5A
Operating Temperature	-40 ℃ to +125 ℃

Table 3.7: 7805 Voltage Regulator Specifications

3.1.8 LCD 16X2 Display

LCD stands for liquid crystal display that it uses liquid crystals for operation. A 16×2 LCD (Liquid Crystal Display) screen is an electronic display module used in various devices and circuits. It displays system status, accident detection messages, and location data for user feedback. A 16×2 LCD can display 16 characters per line with the characters stretched between 2 rows (i.e. lines).

Figure 3.10: LCD 16X2 Display

Specifications	Details
Display Type	Character-based (16x2)
Interface	4-bit or 8-bit parallel
Operating Voltage	4.7V-5.3V
Current Consumption	Without Backlight: ~ 1 mA With Backlight ~ 15 mA
Character Size	5x8 dot matrix
Viewing Area	~64x16 mm
Backlight Type	LED (White/Green)

Table 3.8: LCD 16X2 Specifications

3.1.9 12V Power Adapter

A 12V adapter is a power supply device that converts alternating current into direct current at 12 volts. It typically has a two-prong plug for connecting to an AC power source and a barrel connector on the other end to provide the 12V DC output. They come in different ampere ratings (e.g., 1A, 2A, 3A) to match the power requirements of the connected device.

Figure 3.11: 12V Power Adapter

Specifications	Details
Input Voltage	100-240V AC
Output Voltage	12V DC
Output Current	1A / 2A
Power Rating	12W(for 1A) / 24W(for 2A)
Connector Type	DC Barrel Jack
Operating temperature	0-45 °C

Table 3.9: 12V Power Adapter Specifications

3.1.10 Lithium-ion Battery

A Lithium-Ion (Li-ion) battery is a rechargeable battery which store energy using lithium ions that move between the anode and cathode during charging and discharging. Li-ion batteries provide a stable output voltage, typically around 3.7V per cell, and maintain energy efficiently for long periods.

Figure 3.12: Lithium-Ion Battery

Specifications	Details
Battery Type	Lithium-ion
Nominal Voltage	3.7V per cell
Total Voltage	11.1V (combined)
Capacity	~2000 mAh per cell
Energy Density	~150 Wh/kg
Rechargeable	yes
Operating temperature	Charging: 0-45 ℃ Discharging: -20 to 60 ℃

Table 3.10: Lithium-Ion Battery Specification

3.2 Software Tools

1. Arduino IDE

The Arduino IDE is open source software platform and is primarily used for writing, compiling and uploading code to microcontroller.
It supports the C/C++ programming language and has simple user friendly interface.

Key features of the Arduino IDE include:

Code Editor

The IDE features an intuitive editor with syntax highlighting and auto-formatting, making the writing and debugging of code quite easy.

Library Support

Arduino IDE provides a variety of built-in and downloadable libraries to control components such as sensors, GSM and GPS modules. This makes interfacing with the hardware simple.

Debugger and Compiler

The IDE compiles C/C++ code into machine-readable instructions. It will also do real- time error checking to help find syntax and logic errors before uploading.

Upload Functionality

The IDE uploads the compiled program to the ESP32 using a USB interface. In this project, the Arduino IDE was used to write the program that controls the sensors and communication modules.

2. ESP32 Board Manager Package

For the Arduino IDE to work with ESP32 boards, it requires the ESP32 Board Manager to be installed via Boards Manager.

CHAPTER-4

IMPLEMENTATION AND METHODOLOGY

The implementation of the Smart Helmet with Sensor-Based Ignition Control and Accident Detection System integrates a number of sensors, communication modules, and ESP32 microcontrollers in order to achieve rider safety and real-time monitoring.

This also explains the systems's programming logic, important mechanisms, and design and methodology.

4.1 Data Collection and Processing

The system continuously gathers data from various sensors installed on the helmet and bike units, such as helmet-wearing status (limit switch), alcohol level (MQ-3), motion data (MPU6050), and GPS coordinates. The ESP32 processes these inputs in real time before carrying out emergency alert and ignition control functions.

4.2 Identification of Helmet Wearing

A limit switch is installed within the helmet's top as part of the helmet unit. When the rider is wearing the helmet, the switch stays pressed; when it is not, it remains released. After reading this digital input, the ESP32 sends the helmet-wearing status to the bike unit . When helmet is worn properly then only ignition is permitted.

4.3 Alcohol Detection System

The MQ-3 alcohol sensor is positioned close to the rider's mouth to detect alcohol vapors in the breath.

The sensor outputs an analog voltage which is proportional to the alcohol concentration. This value is read by the ESP32 via one of its ADC pins.

If the measured value is higher than the calibrated threshold, the system detects alcohol consumption. In these situations:

- The bike unit's ignition relay stays OFF
- The LCD displays the message "Alcohol Alert".

This mechanism keeps the rider from starting bike while under the influence of alcohol.

4.4 Gathering and processing Accident Data

The MPU6050 continuously measures angular rotation and acceleration along the X, Y, and Z axes. The threshold value and the acceleration values in real time are compared by the ESP32. The deviation is considered an accident if it exceeds predetermined thresholds.

Threshold values are selected (chosen, assigned) based on experimental data in order to distinguish between abnormal impacts(like collisions) and normal movements (like riding and turning).

The system initiates location tracking and an emergency alert when it detects an accident.

4.5 Ignition Control Mechanism

A relay module attached to the bike unit ESP32 controls the ignition system. When both safety requirements are met then only ignition is permitted:

- Wearing a helmet.
- Amount of alcohol is below the threshold value

The relay stays off and the bike cannot start if either condition is not met.

4.6 Location Tracking System

The GPS Neo-6M module is responsible for obtaining geographic coordinates in real time. Coordinates for latitude and longitude are retrieved by this module. This information is converted into a Google Map link that is texted to emergency contacts.

4.7 Emergency Alert System

When an accident is detected:

1. The GPS module first acquires the current coordinates.
2. The GSM module and the ESP32 establish serial communication.
3. The pre-saved emergency contact number receives an automated SMS.
4. A clickable Google Maps link and an accident alert message are included in the SMS.

Example of an SMS:

“Accident alert! Google Maps: http://maps.google.com/maps?q=26.7541,83.3731”

4.8 Programming and Libraries Used

The Arduino IDE is used for all programming, and the ESP32 code makes use of several important libraries:

1. Hardwareserial.h: Controls the GPS and GSM modules' serial communication.
2. TinyGPS++: Converts GPS data into coordinates that are understandable by humans.
3. LiquidCrystal_I2C.h: Shows alerts and messages on the 16x2 LCD.
4. MPU6050.h: To read gyroscope and accelerometer readings.

4.9 Working of Smart Helmet System

The Smart Helmet involves several components to identify collisions and send warning messages during emergencies. The following sequential steps are how the system functions:
The system operates in the following sequential steps:

4.9.1 Operation of Helmet Unit

- The ESP32 initialises all associated parts, such as the limit switch and alcohol sensor, when the helmet is turned on.
- The limit switch checks whether the rider is wearing a helmet and MQ-3 sensor measures alcohol concentration.
- The helmet unit transmits the data wirelessly to bike unit.

4.9.2 Operation of Bike unit

- When bike unit powered ON, ESP32 initializes MPU6050, GPS and GSM module, LCD and relay.
- Based on helmet and alcohol status, relay module enables or disables ignition.
- The LCD displays system status messages like:
- Helmet Worn," "Ignition ON," "Alcohol Detected," etc.

4.9.3 Accident Response Sequence

- After bike starts , The MPU6050 continuously measures acceleration along the X, Y, and Z axes and angular rotation.
- The ESP32 compares the real-time acceleration values with the threshold value.

- If the deviation exceeds predefined thresholds, it is detected as accident. The GPS Neo-6M provides real time location.
- The ESP32 communicates with GSM to send SMS with map link to emergency contacts and LCD displays the status alerts.

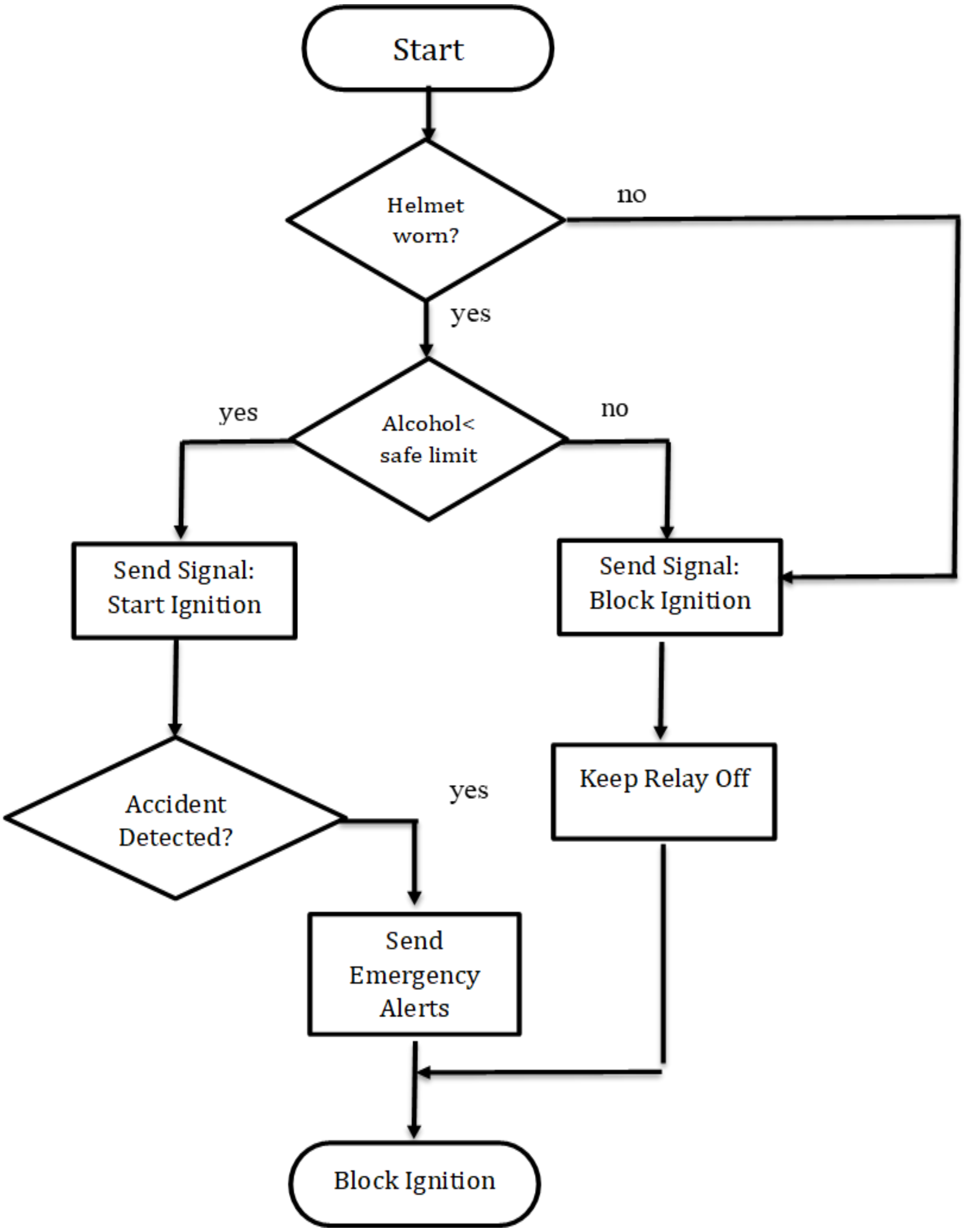

Figure 4.1: Working Flow

CHAPTER-5

RESULT AND DISCUSSION

The Smart Helmet with Sensor-Based Ignition Control and Accident Detection System was assembled, tested, and evaluated under real-time conditions successfully to enhance rider safety. The main goal of the testing was verifying the effectiveness of helmet detection, alcohol detection, accident detection emergency alert systems and ignition control. The results show that the smart helmet offers a practical and effective way to minimise traffic accidents caused by drunk driving, helmet carelessness, and delayed emergency assistance.

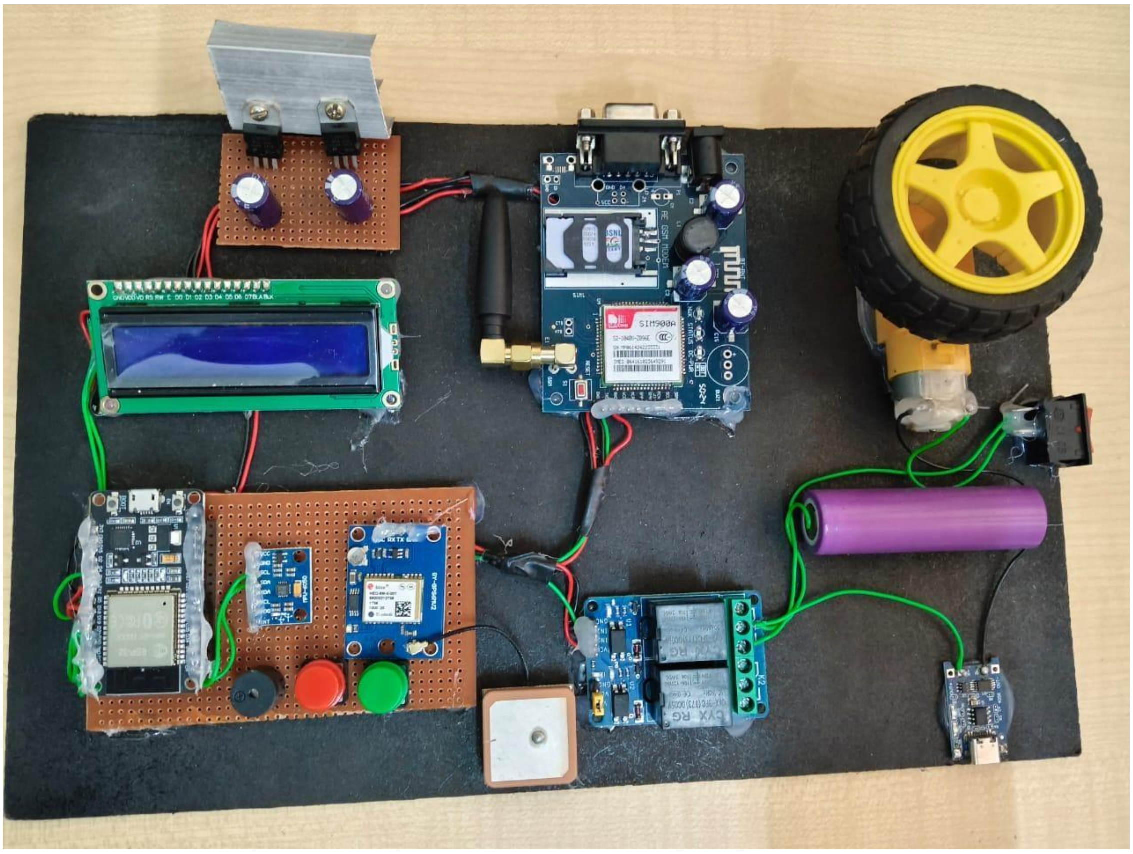

Figure 5.1: Bike Unit Circuit

Figure 5.2: Helmet Unit Circuit

5.1 Analysis of Helmet Detection

The helmet-wearing recognition system is first initialised when the system is turned on. The ESP32 shows the status after continuously reading the switch signal. There were no false triggers during testing because the detection was accurate and responded quickly.

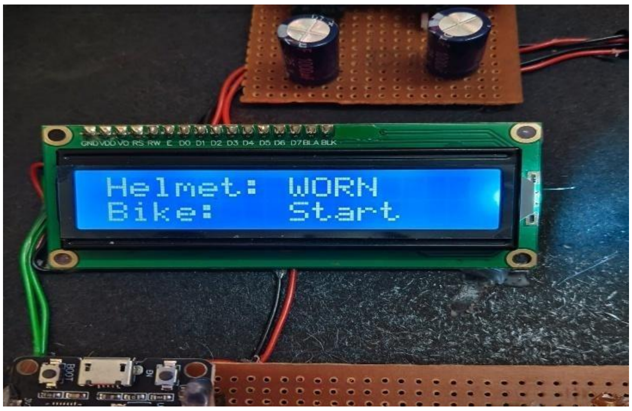

Figure 5.3: Helmet worn, Bike start

5.2 Analysis of Alcohol Detection

The MQ-3 sensor was able to identify alcohol vapour after being exposed for two to three seconds. Slight variations were brought on by ambient vapours, but overall detection accuracy stayed high.. The ignition relay consistently turned off when alcohol was detected, assuring complete avoidance of drunk riding.

Figure 5.4: Alcohol Detected

5.3 Accident Detection Performance and Accuracy

5.3.1 Impact Detection

The MPU6050, which monitors both linear acceleration and angular velocity, is essential for accident detection. In the event of a simulated accident:

1. The threshold crossing was verified by ESP32
2. The GPS module obtained location coordinates
3. A SMS alert was automatically sent by the GSM module

After threshold calibration, accident detection showed satisfactory accuracy with few false alerts. Between 5-10 seconds passed between impact detection and SMS transmission.

Figure 5.5: Accident Detected

5.3.2 GPS performance and Emergency SMS

The GPS Neo-6m module successfully provided location coordinates in open environments. The GPS took an average of 20-30 seconds to acquire a signal under normal conditions, with longer delays in urban areas.

The GSM 900A module successfully sent SMS alerts in 95% of the cases. Alerts contained the following information:

1. Accident detection message.
2. A clickable Google Maps link.

Sample SMS:

"Accident Alert! Location: 26.7541, 83.3731"

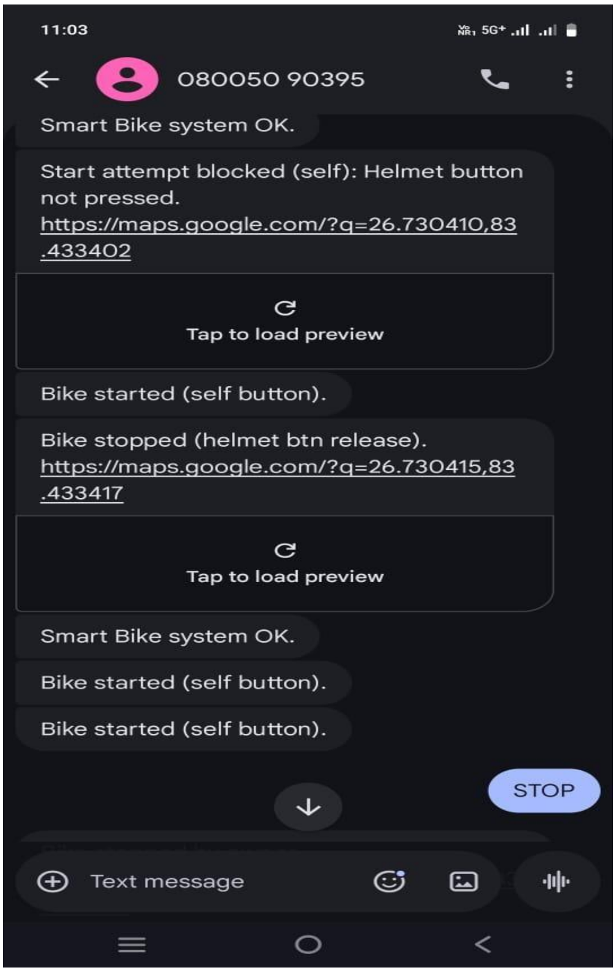

Figure 5.6: Message Received

CHAPTER-6

PRACTICAL APPLICATIONS

6.1 Real-Time Safety System Integration in Bikes

Smart helmets can be an essential part of a real-time safety system for two-wheelers. The helmet is able to identify unusual occurrences like unexpected falls, or collisions by continuously observing the rider's movements and surroundings. These realisations might instantly set off safety reactions, such calling emergency services or turning on car features like automated braking in more recent models. Both rider safety and accident prevention are improved by this real-time integration.

6.2 GSM Technology for Emergency Alerts

In the event of an accident, smart helmets can use GSM (Global System for Mobile Communications) technology to automatically phone or send messages to pre-registered contacts, like family members or emergency personnel. Even if the rider is unconscious or unable to use their phone, this feature makes sure that loved ones are informed right away.

6.3 GPS-Based Tracking for Theft Prevention and Usage Monitoring

Smart helmets with GPS tracking serve as a barrier to theft in addition to providing location tracking in an emergency. The owner may be notified if the bike is moved while the helmet is not on or if it leaves a specified area. This function helps prevent unauthorized use and ensures the vehicle is not misused.

6.4 Vehicle Ignition Control for Safety Compliance

The vehicle ignition control system in the smart helmet ensures that the bike can only start when safety conditions are met. A relay is connected to the ignition circuit, and it acts as a switch controlled by the microcontroller. The helmet sensors first check whether the rider is wearing the helmet and confirm that no alcohol is present. Only when both conditions are satisfied does the relay turn on, allowing the ignition to activate. If the helmet is not worn or alcohol is detected, the relay remains off, preventing the engine from starting. This helps enforce safe driving and reduces the chances of accidents.

CHAPTER-7

FUTURE TRENDS

7.1 Parallel Communication for Emergency Alerts

Delays occur because the current GSM module sends the SMS notifications in sequence. Some possible future designs could be:

- Parallel Messaging Systems: The enhancement of GSM modules or software, enabling the sending of more than one message at a time.
- Cloud-Based Alerts: online alerting platforms, such as email and smartphone notifications, allow wider and faster communication.

7.2 Mobile Application Integration

A companion mobile application can extend the functionality of the system by:

- User ability to personalize lists of emergency contacts.
- Monitor the life of the battery and condition of the helmet.
- Offering family members manual override or additional features such as real-time tracking.

7.3 Voice and Audio Feedback Integration

Future helmets can include audio alerts, such as "Helmet not worn," "Alcohol detected," "Accident detected", or GPS guidance using a small speaker or a bone-conduction audio unit.

7.4 Machine Learning for Enhanced Decision-Making

A machine learning model can be trained to differentiate normal movement versus crash- like events, to help reduce false alarms and increase accident detection accuracy.

7.5 Camera Based Monitoring

A small front or rear camera can be integrated to capture accident footage or record the ride for safety or, if needed, for any legal purposes.

CHAPTER-8

CHALLENGES AND LIMITATIONS

8.1 High Sensitivity of the MPU6050 Causing False Positives

The super-sensitive MPU6050 used for accident detection, even though it was designed to be more responsive, would often send unnecessary alerts. Sometimes, normal motions- like fast bike manoeuvres, speed bumps, or rapid braking-were mistaken as crash incidents. These false positives caused emergency alerts when there wasn't really an emergency, which may eventually weaken the dependability of this system in addition to causing worry with responders or family members.

8.2 GPS Calibration and Signal Acquisition Delays

In the context of location sharing during an emergency, GPS-based tracking is necessary. However, under certain conditions-the cycling through tunnels, dense forests, or metropolitan areas with tall structures producing an urban canyon effect-the GPS module faced problems in obtaining or updating the location. This delay in collecting GPS signals reduced the accuracy of the real-time position of the system.

8.3 Sequential Communication Using GSM Module

Only one message was able to be sent from the GSM module at any given time. This sequential release method delayed notifying several emergency contacts, especially when there were more than two or three such contacts. In any emergency, time is of vital importance; even minor delays in forwarding information to all intended recipients can result in serious ramifications.

8.4 Battery Life Constraints Due to Continuous Operation

The continuous usage of power-consuming devices like GPS and GSM greatly depleted the battery, reducing the useful operating time of the helmet. This high power consumption became problematic in real-world situations, particularly for long-distance riders or during extended operation of the device without recharging. A dead battery could result in the malfunction of smart features at a critical point in time, compromising the system’s objective.

CHAPTER-9
CONCLUSION

Road accidents are increasing day by day because the riders are not using the helmet and due to consumption of alcohol. In today's world, huge numbers of people are dying in road accidents. By using smart helmet, accidents can be detected.

The primary goal of this smart helmet system is to enhance rider safety by enforcing two critical rules: wearing a helmet and riding sober. The system includes sensors that detect whether the helmet is properly worn. Also, an alcohol sensor integrated into a helmet measures the quantity of alcohol in a rider's breath. The device effectively prevents drunk driving by turning off the bike's ignition when the alcohol content rises beyond the legal limit.

This safety system directly tackles the two major causes of traffic accidents: not wearing a helmet and driving while intoxicated, in addition to promoting safe riding practices.

With continuous data processing, the system can send immediate alerts in case of an accident and even help prevent one by notifying the rider of unsafe conditions. Overall, this intelligent integration has the potential to significantly reduce traffic-related injuries and fatalities.

REFRENCES

1. N. Faizee, P. Adyalkar , D. Parate, K. Meshram, B. Balpande, and A. Koli, “Design And Implementation Of Smart Bike Helmet,” *International Journal of Innovations in Engineering and Science,* vol. 9, no. 7, pp. 88-92, July 2024.
2. K. S, T. Loksai, V. B. Naidu, S. Kumar, any Venkatesha B. “Multi-Domain Smart Safety Helmet,” *International Research Journal on Advanced Engineering Hub (IRJAEH),* vol. 2, no. 5, pp. 1311-1317, May 2024.
3. S Shalini, J Muruganandham, and S Surya, “Identification and Prevention of Accidents Using Smart Helmet and GPS System,” *Journal of Physics: Conference Series,* vol. 1717, no. 1, January 2021.
4. A. Ajithkumar, P. Praveen , S. Suriya, and V. Vinoth. “Design of Smart Helmet for Accident Avoidance,” *International Journal of Advances in Engineering and Management (IJAEM*), Vol. 5, pp: 1264 1269, April 2023.
5. Smith, J. A., Johnson, E. R., and Brown, K. L. “Enhancing Driver Safety through Real-Time Monitoring: A Review of Sensor-Based Technologies,” *Journal of Transportation Engineering*, vol. 8, no. 3, pp: 112-118, 2022.
6. Park, S., Lee, H., and Kim, J. “Design and Implementation of a Multi-Domain Smart Helmet System with IoT Integration,” *IEEE Transactions on Vehicular Technology*, vol. 73, no. 4, pp. 567-574, 2024.
7. Jiang, Y., Zhang, L., and Wang, Q. “Development and Testing of a Multi-Domain Smart Safety Helmet for Enhanced Motorcycle Rider Safety,” *International Journal of Intelligent Transportation Systems Research*, vol. 10, no. 2, pp: 245-25, 2023.