Smart Bicycle Helmet for Improved Safety: Automated Features for Rider Protection

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DOI: https://doi.org/10.51244/IJRSI.2026.13010146

Received: 19 January 2026; Accepted: 24 January 2026; Published: 07 February 2026

ABSTRACT

This paper presents the design and development of a smart bicycle helmet aimed at improving cyclist safety through integrated manual and automated safety features. The proposed system employs a dual-microcontroller architecture consisting of an ESP32-C3 for the handlebar unit and a Wemos D1 Mini (ESP8266) for the helmet unit. The handlebar unit controls an automatic headlight using a light-dependent resistor and processes manual left and right turn signal inputs, which are transmitted wirelessly to the helmet unit via ESP-NOW communication.

The helmet unit integrates LED turn indicators, a BMI160 accelerometer for accident detection, and a GSM module for emergency notification. Accident detection is based on accelerometer-derived G-force thresholds, classifying impacts into mild (2 Gs), moderate (3 Gs), and severe (4 Gs) events. Severe impacts trigger SMS alerts to pre-registered emergency contacts. Experimental evaluation through ten trial tests demonstrated consistent turn signal operation, reliable accident detection, and successful emergency message transmission with no false alerts during normal riding conditions. The proposed system provides a practical and cost-effective safety solution suitable for bicycle applications in low-visibility and traffic-dense environments.

Keywords: Smart Bicycle Helmet, Accelerometer-Based Accident Detection, GSM Emergency Alert System, Turn Signal System, Automatic Headlight Control

INTRODUCTION

Cycling is an increasingly popular mode of transportation, offering benefits such as reduced traffic congestion, lower environmental impact, and improved physical health. However, despite its advantages, cycling remains one of the most vulnerable activities on the road due to the exposure of cyclists to traffic hazards and the lack of protective infrastructure. Traditional bicycle helmets primarily serve to protect the rider's head in the event of an accident but do not offer active safety features to prevent accidents or provide real-time alerts during emergencies. As cycling continues to grow in urban environments, the need for enhanced safety solutions has become more pressing.

The smart bicycle helmet introduced in this paper aims to address these safety concerns by incorporating automated features designed to improve visibility, rider awareness, and emergency response. The helmet integrates three key functionalities: an automatic headlight, turn signals controlled by a 3-way switch, and an accident notification system. These features work together to enhance the rider's safety in real-time, reducing the risk of accidents caused by human error and ensuring timely emergency alerts in the event of a crash.

The objective of this research is to develop a cost-effective and efficient solution that increases rider protection while maintaining ease of use and long battery life. By integrating innovative technologies such as sensors and microcontrollers, the system offers cyclists an intelligent safety solution that adapts to their needs, particularly in low-visibility or emergency situations. This paper discusses the system design, technical implementation, and testing results, demonstrating the potential of this smart helmet to enhance bicycle safety and support proactive measures for rider protection.

Importance and Relevance of the Study

Cycling, especially in urban areas, is becoming an increasingly popular mode of transportation due to its environmental benefits and health advantages. However, despite the growth of cycling, cyclists remain one of the most vulnerable groups on the road. According to the World Health Organization (WHO), road traffic injuries are one of the leading causes of death globally, with cyclists facing significant risks due to their exposure to traffic and lack of protective infrastructure. As urban cycling continues to rise, the need for innovative safety technologies to protect cyclists has become more urgent.

Traditional bicycle helmets provide passive protection, offering little more than impact mitigation in the event of an accident. These helmets do not address the active safety requirements of cyclists, such as improving visibility, signaling intentions to other road users, or providing emergency notifications. This study presents a smart bicycle helmet that integrates several advanced features: an automatic headlight, turn signals, and a realtime accident notifier. The automatic headlight enhances the rider's visibility during low-light conditions, while the turn signals provide clear communication with other road users. In the event of an accident, the helmet sends real-time alerts to emergency contacts, ensuring swift assistance.

This research contributes to the growing field of smart helmet technology, which combines traditional protective measures with modern Internet of Things (IoT) technologies. Prior studies, such as those by Akter et al. (2024), have demonstrated the effectiveness of IoT-enabled smart helmets for accident detection and real-time communication, offering a foundation for this study's development. By combining these technologies in an integrated system, this research aims to provide a reliable, cost-effective, and scalable safety solution that can enhance cyclist protection in both urban and rural environments.

REVIEW OF RELATED LITERATURE

The development of smart helmets for enhancing safety in cycling has been an emerging area of research over recent years. These smart helmets integrate various technologies to improve rider protection, such as automatic lighting systems, accident detection, and real-time notifications. This literature review explores existing studies and developments in smart helmet technology, focusing on their features, functionalities, and the underlying technologies that make them effective.

Smart Helmet Technology

Several studies have explored the use of smart helmets for motorcyclists and cyclists, highlighting key technologies such as accident detection, real-time alerts, and visibility enhancement. Manjesh N and Sudarshan Raj (2024) explored the integration of IoT-based technologies in smart helmets, focusing on how GSM and GPS systems can be used to detect accidents and send alerts to emergency contacts. Their study presents the effectiveness of these technologies for improving real-time emergency responses, demonstrating the potential of smart helmets in enhancing safety.

In line with this, studies by Akter et al. (2024) discussed the integration of IoT in smart helmets, focusing on how technologies like Bluetooth and GSM modules can be used for accident detection and communication. These smart helmets provide enhanced safety through real-time interaction and emergency alerts, which are crucial for preventing severe outcomes in the event of a crash.

Automatic Headlights and Visibility

Visibility is a critical concern for cyclists, especially during low-light conditions. Several studies have explored automatic lighting systems, with LDR-based (Light Dependent Resistor) systems being commonly used to control headlamps based on ambient light levels. Akter et al. (2024) presented a smart helmet system that integrates IoT-based accident detection and emergency notification, demonstrating the effectiveness of real-time communication technologies for rider safety. The system demonstrates IoT-based accident detection and emergency notification, highlighting the effectiveness of real-time communication technologies for rider safety. Similarly, Telgi et al. (2025) explored smart helmets that incorporate turn signals and automatic headlights to enhance rider visibility and communication with other road users. These systems provide critical safety benefits by ensuring that cyclists are visible at all times, reducing the likelihood of collisions, especially in poorly lit areas.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue I January 2026

Accident Detection and Real-Time Notifications

The integration of accident detection systems into smart helmets is another significant aspect of enhancing cycling safety. Several studies have focused on impact sensors and GSM/GPS technologies for detecting accidents and sending real-time notifications to emergency contacts. Sudarshan et al. (2024) presented a smart helmet using GSM and GPS technologies for accident detection and reporting, showing that these technologies can provide real-time accident alerts to registered contacts, improving response times and increasing rider safety

Kumar et al. (2024) developed a smart helmet system that combines IoT-based accident detection with real-time reporting. This system monitors the rider's movements and detects abnormal conditions such as sudden impact or fall. Once detected, the system sends notifications to emergency contacts, thereby reducing response time during critical moments

Table 1. Comparison Matrix of Related Studies and Current Research

Study	Sensors Used	Controller	Main Outputs	Scope	Key Features	Gap Addressed by This Study
Agarwal et al. (2015)	Vibration sensor, IR sensor	Microcontroller	Accident alerts	Rider safety	Detects accidents and sends alerts	Lacks automatic lighting and turn signal integration
Akter et al. (2024)	Accelerometer	Microcontroller	SMS alerts, accident detection	Smart helmet safety	IoT-based accident detection and notification	Does not include turn signal or bicycle-focused lighting system
Amulya et al. (2018)	Vibration sensor	Microcontroller	Message alerts	Helmet safety	Sends alert messages during accidents	No automatic headlight or turn signal features
Khangar, D. et al (2023)	Ultrasonic, RF, GSM	Arduino UNO	Accident alerts, GPS location	Two-wheeler rider safety	Accident detection; emergency SMS with GPS	Does not include bicycle turn signal or automatic headlight integration; primarily relies on ultrasonicbased detection.
Kumar et al. (2024)	Accelerometer, vibration sensor	Microcontroller	Safety alerts	Helmet safety enhancement	Improves rider safety through smart helmet features	No bicyclespecific system and no automatic headlight

Patil, S. (2020)	Alcohol sensor, Fog sensor, Helmet detection, Accelerometer, RF module	ATMega328-PU (Arduino)	GPS-based location tracking, accident alerts	Location tracking, accident alerts	Integrated alcohol, helmet detection, and GPS; accident detection	Complex multisensor system without IoT integration; not specifically bicycle focused
Punitha et al. (2024)	Accelerometer, vibration sensor	Arduino / Microcontroller	Accident alerts	Motorcycle safety	Smart helmet system for enhanced rider safety	Designed for motorcycles; lacks bicyclespecific implementation and lighting automation
Rahman, M. A. (2020)	IR sensor, Alcohol sensor, 3-axis accelerometer	Arduino (unspecified MCU)	Crash detection, accident SMS	Two-wheeler safety	Real-time accident detection + database Update via app	Does not integrate automated bicycle turn signaling or headlight; lacks separate handlebar unit
Telgi et al. (2025)	Accelerometer, vibration sensor	Arduino Microcontroller	Accident alerts	Rider safety system	Real-time accident detection and alert system	Not designed for bicycles; lacks turn signal integration
This Study (Smart Bicycle Helmet)	BMI160 accelerometer, LDR, SPDT switch	ESP32-C3 (handlebar unit), ESP8266 (helmet unit)	Turn signals, automatic headlight control, real-time SMS alerts	Bicycle Safety System	Integrates automatic headlight, manual turn signals, and real-time accident notification	Combines multiple active safety features into a bicyclespecific smart helmet

Problem Statement And Objectives

Problem Statement

Cycling is an environmentally friendly and cost-effective mode of transportation that continues to grow in urban areas worldwide. However, cyclists remain among the most vulnerable groups of road users due to factors such as poor visibility, lack of proper signaling, and the absence of real-time emergency response systems. Traditional bicycle helmets provide passive protection, primarily focusing on impact absorption, but fail to address the active safety concerns associated with visibility and communication, particularly during low-light conditions or in the event of an accident.

Current cycling helmets lack integration with intelligent systems that could help reduce accidents, improve rider visibility, and provide immediate emergency notifications to enhance safety. Additionally, most existing solutions focus on individual features like accident detection or lighting but fail to offer an integrated, automated approach that addresses multiple safety aspects simultaneously. As urban cycling increases, there is a clear need for innovative helmet systems that integrate automated safety features, accident detection, and real-time communication to reduce the risk of accidents and ensure prompt assistance when needed.

General Objective

To design and develop a smart bicycle helmet that integrates automated safety features, including an automatic headlight, turn signal system, and accident detection, to enhance rider safety, visibility, and emergency response during cycling.

Specific Objectives

- To develop an automatic headlight system**:** Implement a light-dependent resistor (LDR) to activate the headlight based on ambient light conditions for improved visibility.
- To integrate a manual turn signal system: Add a 3-way switch on the helmet for manually controlling turn signals to enhance rider communication.
- To implement an accident notification system: Use sensors to detect accidents and send real-time SMS/email alerts to registered contacts.
- To utilize the ESP32-C3 (handlebar unit) microcontroller: Control system components with the ESP32C3 (handlebar unit) for efficient power usage and reliable operation.
- To design for low power consumption**:** Ensure the system operates on minimal power for extended battery life.
- To test system performance: Evaluate the functionality of the headlight, turn signals, and accident detection in real-world conditions.

SYSTEM DESIGN AND METHODOLOGY

Research Design

This study follows a developmental and experimental research design aimed at creating a smart bicycle helmet with integrated safety features such as an automatic headlight, turn signals, and accident detection. The design and development process focuses on integrating these features into a single embedded system for enhanced safety and rider visibility.

The system was designed as a prototype for testing in real-world conditions, with an emphasis on practical functionality and usability. The helmet's components include an automatic headlight that adjusts based on ambient light conditions, turn signals controlled by a manual switch, and an accident detection system that sends real-time alerts to registered contacts in case of a fall or impact. This methodology combines sensor-based feedback with embedded control, ensuring real-time responses to environmental changes and emergency situations.

Accident Detection Threshold Selection

The accident detection mechanism of the Smart Bicycle Helmet is based on accelerometer-derived G-force thresholds obtained from the BMI160 sensor. Threshold values were selected through a combination of empirical testing and reference to existing wearable accident detection studies. Three impact levels were defined: mild (2 Gs), moderate (3 Gs), and severe (4 Gs).

Mild and moderate thresholds correspond to normal riding conditions such as road bumps, uneven terrain, and sudden braking. These values were intentionally configured to avoid false positives during typical cycling activity. A threshold of 4 Gs was selected to represent severe impacts consistent with fall or collision scenarios.

During system testing, only impacts exceeding this threshold triggered emergency notifications, demonstrating reliable accident detection while minimizing false alerts.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue I January 2026

GSM Alert Latency and Power Considerations

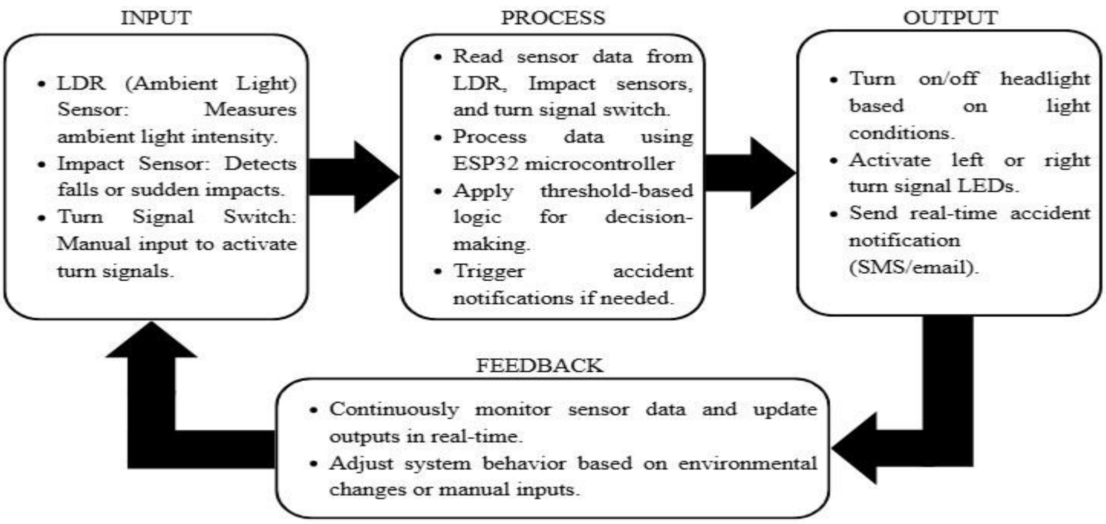
Upon detection of a severe impact, the system activates the GSM module to transmit SMS alerts to pre-registered emergency contacts. Observed message delivery times ranged from approximately 5 to 10 seconds, depending on network signal availability. This latency is considered acceptable for emergency notification systems intended for cyclist safety.

Power consumption was optimized by separating tasks between the handlebar and helmet units. The ESP32-C3 and ESP8266 microcontrollers operate in low-power modes during idle states, contributing to extended battery life using a 2000 mAh Li-ion battery.

Input–Process–Output (IPO) Model

The IPO model for the Smart Bicycle Helmet system works as a continuous loop, where the system takes in environmental and user data, processes it in the microcontroller, and produces appropriate outputs based on predefined conditions. This model ensures real-time responses to dynamic conditions, improving rider safety and system efficiency.

Figure 1. Input–Process–Output (IPO) Model



The feedback loop enables continuous monitoring of sensor inputs and system outputs, allowing the system to dynamically adjust headlight activation, turn signal status, and accident detection in real time.

System Architecture

The Smart Bicycle Helmet system is designed as a distributed embedded safety system consisting of two interconnected subsystems: a handlebar unit and a helmet unit. This dual-microcontroller architecture enables efficient task separation, real-time communication, and reliable system performance while maintaining low power consumption.

The handlebar unit is controlled by an ESP32-C3 microcontroller and is responsible for managing the automatic headlight and rider input controls. A light-dependent resistor (LDR) continuously monitors ambient light conditions, allowing the system to automatically activate the headlight during low-visibility situations. Left and right turn signals are manually activated by the rider using push buttons mounted on the handlebar. When a turn signal is selected, the ESP32-C3 transmits the corresponding command wirelessly to the helmet unit using ESPNOW communication.

The helmet unit is controlled by a Wemos D1 Mini (ESP8266) microcontroller. This unit receives turn signal commands from the handlebar and activates the corresponding LED indicators mounted on the helmet. The helmet unit also integrates a BMI160 accelerometer, which is used exclusively for measuring linear acceleration and performing G-force–based accident detection. Accelerometer-based G-force detection is implemented using

INTERNATIONAL JOURNAL OF RESEARCH AND SCIENTIFIC INNOVATION (IJRSI)
ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue I January 2026

predefined thresholds: mild (2 Gs), moderate (3 Gs), and severe (4 Gs). When a severe impact is detected, the system classifies the event as an accident.

Upon accident detection, the helmet unit activates a GSM module to send SMS emergency notifications to preregistered contacts. All electronic components are enclosed in a protective junction box and securely mounted on the helmet using zip ties to ensure durability, user comfort, and safety during operation.

Block Diagram

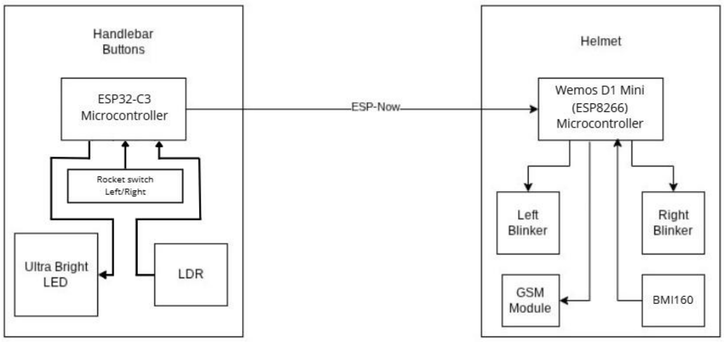
The block diagram illustrates the logical flow of data and control within the Smart Bicycle Helmet system, highlighting the interaction between the handlebar unit and the helmet unit.

In the handlebar unit, the ESP32-C3 microcontroller receives input from the LDR and push buttons. Based on ambient light levels, the ESP32-C3 controls the automatic headlight. When a push button is pressed, the microcontroller generates a turn signal command and transmits it wirelessly to the helmet unit using ESP-NOW.

In the helmet unit, the Wemos D1 Mini (ESP8266) receives the transmitted turn signal commands and activates the corresponding LED indicators. Simultaneously, the BMI160 accelerometer continuously monitors linear acceleration values. If the measured acceleration exceeds the predefined severe impact threshold, the microcontroller triggers the GSM module to send an SMS alert to emergency contacts.

Power is supplied by a 2000 mAh rechargeable battery, ensuring portable operation and extended usage time. The modular structure of the block diagram emphasizes task separation between sensing, processing, communication, and actuation, contributing to improved system reliability and scalability.

Figure 2. Block diagram of the ESP-based wireless helmet and handlebar safety system using ESP-NOW communication.



Schematic Diagram

The schematic diagram presents the complete electrical connections of the Smart Bicycle Helmet system, including power management, control logic, sensing, and communication subsystems.

The handlebar unit schematic shows the ESP32-C3 microcontroller interfaced with an LDR for ambient light detection and push buttons for manual turn signal activation. The automatic headlight is driven through transistor-based switching circuits with current-limiting resistors to ensure safe operation.

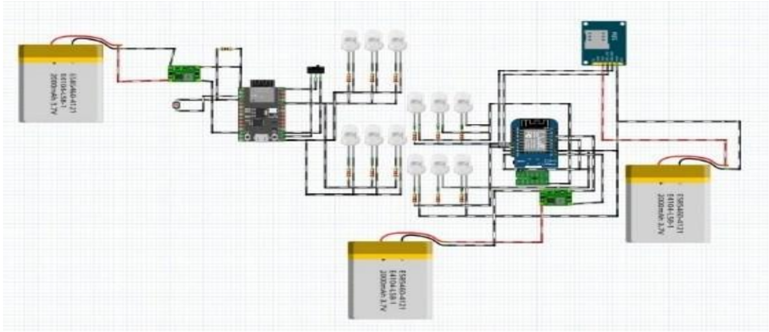
The helmet unit schematic illustrates the Wemos D1 Mini (ESP8266) connected to LED turn signal indicators through transistor driver circuits. The BMI160 accelerometer is interfaced with the microcontroller via the I2C communication protocol for real-time acceleration data acquisition. A GSM module is connected through serial communication to enable SMS-based emergency alerts during accident events.

Power is provided by a 3.7 V 2000 mAh Li-ion battery, regulated to meet the voltage requirements of both microcontrollers and peripheral components. All modules share a common ground, and protective components are included to prevent overcurrent and voltage instability. The schematic demonstrates the integration of

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XIII Issue I January 2026

sensing, processing, communication, and actuation elements into a coordinated and reliable embedded safety system.

Figure 3. Schematic diagram of the ESP-based wireless helmet and handlebar safety system.



Components and Their Functions

The system is composed of input sensors, a central controller, and multiple output devices. Each component performs a specific role in implementing the sensor-based safety and communication mechanism of the smart bicycle helmet system.

Table 2. System Components and Corresponding Functions

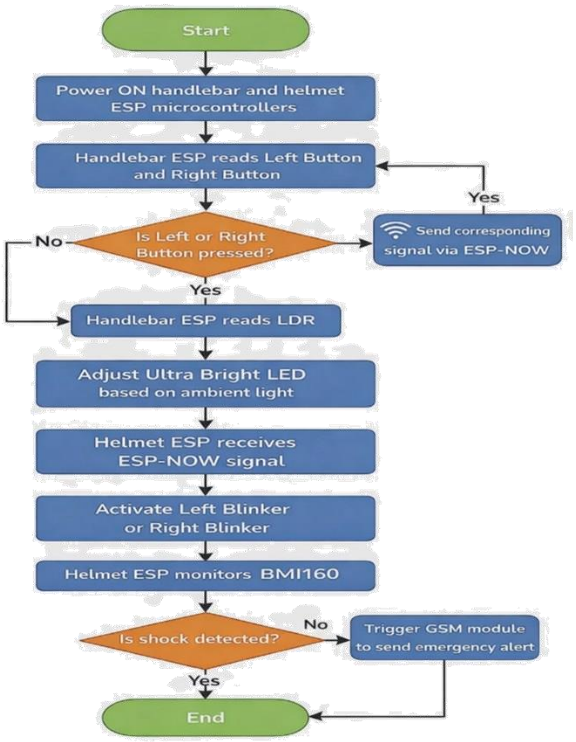
Category	Component	Function
Controller	ESP32-C3 (Handlebar Unit)	Controls the automatic headlight, processes left and right pushbutton inputs, and transmits turn signal commands wirelessly to the helmet unit
Controller	Wemos D1 Mini (ESP8266) (Helmet Unit)	Receives turn signal commands, processes accelerometer data, and controls GSM-based emergency communication
Input	LDR (Light Dependent Resistor)	Detects ambient light levels to automatically activate the bicycle headlight
Input	Push Buttons	Allows manual activation of left and right turn signals from the handlebar
Input	BMI160 Accelerometer	Measures linear acceleration and G-force values for accident detection
Input	SPDT Switch	Provides directional control for turn signal selection
Input	Toggle Switch	Controls system power ON and OFF
Output	LED Turn Signals	Displays left and right turn signal indicators on the helmet
Output	Bicycle Headlight	Provides illumination during low-light or nighttime conditions
Output	GSM Module	Sends SMS emergency alerts to pre-registered contacts during severe impact events
Power	2000 mAh Battery	Supplies portable power to the entire system
Supporting	Transistor	Enables safe switching of LEDs and headlight loads
Supporting	Resistors	Limits current and stabilizes signal levels

Supporting	Jumper Wires	Provides electrical interconnections between components
Supporting	Junction Box	Protects electronic components from physical and electrical damage
Supporting	Zip Ties	Secures electronic components to the helmet and handlebar
Supporting	Bike Helmet	Serves as the mounting platform for the smart safety system

Operation Flow of the System

The flowchart describes the operation of the system starting from powering on the device using Li-ion batteries. The batteries pass through charging and protection modules to ensure safe and stable power delivery to the ESP microcontrollers. Once powered, the system initializes all components, including the LED outputs and the GSM/SIM communication module. The system then checks the power and operational status; if the power is insufficient, the system enters standby mode. If normal conditions are detected, the main ESP controls the LED arrays by turning them on or off according to the programmed logic. Simultaneously, the communication ESP manages data transmission and reception through the GSM/SIM module. The system continuously updates its status and repeats the process in a loop to maintain normal operation.

Figure 4. Flowchart of the operational process of the ESP-based wireless helmet and handlebar safety system.



RESULTS AND DISCUSSION

Testing Procedures and Scenarios

System testing was conducted to evaluate the functionality, reliability, and performance of the Smart Bicycle Helmet under controlled and simulated real-world conditions. A total of ten (10) trial tests were performed to validate the system's accident detection capability, turn signal operation, GSM alert transmission, and overall system stability. Each trial was designed to represent a distinct operating scenario that a cyclist may encounter during actual use.

Before each trial, the system was fully charged, initialized using the toggle switch, and verified for proper sensor calibration. The BMI160 sensor thresholds were kept constant throughout the tests to ensure consistency in detection behavior. Turn signal activation, impact simulation, and message transmission were observed and recorded for every trial.

Table 3. System Testing and Validation Results

Trial No.	Test Scenario	Input Condition	Observed Output	Expected Output	Pass/Fail
1	Normal riding	Smooth motion, no impact	No alert; system in monitoring mode	No alert	Pass
2	Left turn signaling	SPDT switch set to left	Left LED blinks correctly	Left LED active	Pass
3	Right turn signaling	SPDT switch set to right	Right LED blinks correctly	Right LED active	Pass
4	Sudden stop	Moderate deceleration	No false accident alert	No alert	Pass
5	Minor vibration	Low-level vibration	No alert triggered	No alert	Pass
6	Simulated fall (side impact)	High acceleration spike	GSM SMS alert sent	Alert sent	Pass
7	Simulated fall (forward impact)	Sudden acceleration threshold exceeded	GSM SMS alert sent	Alert sent	Pass
8	Power stability test	Continuous operation	Stable performance	Stable system	Pass
9	GSM connectivity test	Accident simulation	SMS delivered successfully	SMS delivered	Pass
10	System reset test	Power cycled	Proper reinitialization	Normal startup	Pass

The Smart Bicycle Helmet system was evaluated through ten (10) controlled trial tests to assess its reliability, responsiveness, and overall performance under various riding and impact scenarios. The system utilized an accelerometer-based G-force threshold mechanism using the BMI160 sensor to classify motion events into three levels: mild (2 Gs), moderate (3 Gs), and severe (4 Gs). This classification approach enabled accurate differentiation between normal riding behavior and actual accident conditions.

During testing, motion events classified as mild (2 Gs) and moderate (3 Gs)—such as road bumps, uneven surfaces, and sudden braking—did not trigger emergency alerts. This behavior demonstrates effective prevention of false positives, which is essential for wearable safety systems. In contrast, severe impact events (4 Gs), representing simulated falls or collisions, consistently activated the GSM module and resulted in successful SMS alert transmission to pre-registered emergency contacts. These results confirm that the selected G-force thresholds provide an appropriate balance between detection sensitivity and system reliability.

The manual turn signal subsystem, controlled through an SPDT switch, performed consistently in all applicable trials. The left and right LED indicators responded immediately to rider input, providing clear and intentional signaling to surrounding road users. This manual signaling approach avoids the risk of incorrect interpretation of rider movement, a common limitation in fully automated signaling systems. The LED indicators improved rider visibility, particularly in simulated urban and traffic-dense environments.

System stability and communication performance were also validated. The GSM module demonstrated minimal latency between accident detection and SMS message delivery, indicating suitability for real-time emergency response. Power stability tests confirmed uninterrupted operation, supported by the 2000 mAh battery. The

Wemos D1 Mini microcontroller effectively managed concurrent tasks, including sensor data acquisition, threshold evaluation, LED control, and GSM communication, without observable performance degradation.

From a system design perspective, the closed-loop embedded architecture enabled continuous monitoring, rapid decision-making, and timely actuation. The accelerometer-based accident detection approach offered a simplified and energy-efficient alternative to more complex sensor fusion methods while maintaining dependable performance. These findings are consistent with existing studies on wearable safety systems and demonstrate the suitability of G-force-based detection for bicycle safety applications.

Overall, the system evaluation confirms that the proposed Smart Bicycle Helmet provides a reliable, practical, and cost-effective solution for enhancing cyclist safety. Its ability to accurately detect severe accidents, minimize false alerts, and deliver timely emergency notifications supports its potential for real-world deployment in both urban and rural cycling environments.

CONCLUSION

This study presented the design, development, and evaluation of a Smart Bicycle Helmet aimed at improving cyclist safety through automated and manual safety features. The system integrates an ESP32-C3 for the handlebar unit and a Wemos D1 Mini (ESP8266) for the helmet unit, a BMI160 accelerometer sensor, LED turn signals, and a GSM module to provide real-time accident detection and emergency notification.

Experimental results from ten trial tests confirmed that the accelerometer-based G-force threshold approach reliably detects severe impact events while avoiding false alerts during normal riding conditions. The manual turn signal system effectively enhanced rider communication, and the GSM module ensured timely delivery of emergency messages. These results indicate that the proposed system is both reliable and practical for real-world cycling applications.

In conclusion, the Smart Bicycle Helmet offers a low-cost, scalable, and efficient safety solution that addresses key challenges faced by cyclists. Its modular design and straightforward detection logic make it suitable for further enhancement and potential deployment in both urban and rural environments.

Future Enhancements

Future enhancements of the Smart Bicycle Helmet system may include the integration of GPS-based location tracking to provide precise accident location information in emergency messages. A mobile application could also be developed to allow riders and emergency contacts to configure alert settings and view system status in real time.

Additional improvements may involve implementing advanced filtering or sensor fusion techniques to further refine impact detection accuracy, as well as optimizing power management through dedicated charging circuits or energy-efficient components. Expanding the system to support cloud-based data logging could also enable long-term analysis of riding behavior and accident trends.

ACKNOWLEDGEMENTS

The authors would like to express their sincere gratitude to God for the guidance, strength, and perseverance throughout the completion of this research. The authors also extend their appreciation to their course instructor and advisers from the Department of Computer Engineering at Eulogio “Amang” Rodriguez Institute of Science and Technology (EARIST) for their valuable guidance, technical insights, and continuous support during the development and testing of the system.

Special thanks are given to the institution for providing the facilities and academic environment that made this study possible. The authors are also grateful to their classmates, friends, and families for their encouragement, cooperation, and moral support throughout the course of this project.

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About The Authors

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Mr. Dexter Caparida is a Computer Engineering student who thrives at the intersection of circuit design and logical programming. He is deeply passionate about understanding how hardware and software communicate to create seamless user experiences, ranging from embedded systems to full-scale computing. His work is centered on mastering system optimization and complex problem-solving within the ever-evolving tech landscape.

Marc Wilson F. Go currently pursuing his BS in Computer Engineering at Eulogio "Amang" Rodriguez Institute of Science and Technology contributed to documentation, system testing, and data analysis. He is responsible for preparing diagrams, and flowcharts.

Mr. Eruel Joseph F. Manales is a focused and driven Computer Engineering student at the Eulogio "Amang" Rodriguez Institute of Science and Technology (EARIST). With a strong interest in technology and innovation, he is dedicated to mastering the complexities of hardware systems and software development. As a student researcher, Eruel applies his technical skills to solve problems and contribute to the advancement of engineering solutions. His involvement in this project highlights his ability to integrate engineering principles with practical applications, ensuring that the work meets the high standards of his discipline.

Ms. Mikaella Jane T. Reyes is a Computer Engineering undergraduate student in Eulogio "Amang" Rodriguez Institute of Science and Technology in Manila, Philippines. She is currently undertaking an undergraduate degree in Computer Engineering and enjoys getting involved in practical work, combining hardware design, embedded systems and software development to solve practical engineering problems. Mikaella develops hardware installation and configuration, circuit prototyping CAD design, computer assembly, and network equipment installation skills. Course work, lab work, enable her to develop expertise in developing workable prototypes addressing real-life computing issues.

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