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SMART HELMET WITH ALCOHOL DETECTION AND VEHICLE CONTROL SYSTEM

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ABSTRACT

Road accidents involving two-wheeler riders remain a major safety concern worldwide. A significant percentage of these accidents occur due to failure to wear helmets and driving under the influence of alcohol. This paper presents a Smart Helmet with Alcohol Detection and Vehicle Control System designed to improve rider safety through automatic monitoring and vehicle authorization. The proposed system utilizes two ESP32 microcontrollers, an MQ-3 alcohol sensor, a helmet detection mechanism, and wireless communication between the helmet and vehicle units. The helmet unit continuously verifies helmet usage and detects alcohol concentration in the rider's breath. The vehicle unit receives authorization signals from the helmet unit and permits vehicle operation only when the rider is wearing the helmet and no alcohol is detected beyond the predefined threshold. The system offers a low-cost, reliable, and practical solution for enforcing safety regulations and reducing accident risks. Experimental testing demonstrated successful helmet detection, alcohol sensing, wireless communication, and vehicle control operation. The proposed system can significantly contribute to improving road safety and promoting responsible riding behavior.

KEYWORDS: Smart Helmet, ESP32, Alcohol Detection, MQ-3 Sensor, Vehicle Control System, Road Safety, Wireless Communication.

1. INTRODUCTION

Two-wheelers are among the most widely used modes of transportation due to their affordability, fuel efficiency, and convenience. However, motorcycle riders remain highly vulnerable to road accidents because they lack the protective structures available in four-

wheeled vehicles. Failure to wear helmets and riding under the influence of alcohol are among the leading causes of severe injuries and fatalities.

Traditional safety measures rely heavily on traffic regulations and law enforcement agencies. However, these methods cannot continuously monitor every rider. Therefore, there is a growing need for intelligent safety systems capable of automatically enforcing safety requirements before vehicle operation begins.

This research proposes a Smart Helmet with Alcohol Detection and Vehicle Control System that integrates helmet detection, alcohol sensing, wireless communication, and vehicle authorization into a unified platform. The system prevents vehicle operation unless the rider wears a helmet and passes the alcohol detection test.

2. LITERATURE REVIEW

Several researchers have proposed smart helmet systems to improve rider safety. Early systems focused primarily on accident detection and emergency notifications. Recent developments have integrated wireless communication, embedded systems, and IoT technologies to enhance functionality.

Muneshwara et al. developed a wireless smart helmet system capable of monitoring rider safety conditions and improving compliance with traffic regulations. Tapadar and Ray proposed a Bluetooth-enabled helmet system with alcohol detection capabilities. Sharma et al. introduced an IoT-based smart helmet incorporating sensors and wireless monitoring technologies. Akbar et al. focused on alcohol detection and vehicle interlocking mechanisms to prevent drunk driving.

Although significant progress has been achieved, many existing systems focus on post-accident response rather than accident prevention. The proposed system addresses this gap by actively preventing vehicle operation under unsafe conditions.

3. PROBLEM STATEMENT

Road accidents caused by helmet non-compliance and alcohol consumption continue to result in serious injuries and fatalities. Existing enforcement mechanisms cannot guarantee continuous monitoring of rider behavior. Therefore, an automated system is required to:

- Ensure helmet usage before vehicle operation.
- Detect alcohol consumption by the rider.
- Establish reliable communication between helmet and vehicle units.
- Prevent vehicle operation under unsafe conditions.

- Promote responsible riding behavior and road safety.

4. PROPOSED METHODOLOGY

The proposed system consists of two independent units:

A. Helmet Unit

The helmet unit contains:

- ESP32 Microcontroller
- MQ-3 Alcohol Sensor
- Helmet Detection Sensor
- Li-ion Battery
- Voltage Regulation Circuit

The MQ-3 sensor continuously monitors alcohol concentration in the rider's breath. Simultaneously, the helmet detection sensor verifies whether the helmet is being worn properly.

B. Vehicle Unit

The vehicle unit consists of:

- ESP32 Microcontroller
- Motor Driver Module
- DC Motor (Prototype Vehicle)
- Power Supply Unit

Wireless communication is established between the helmet and vehicle units using ESP32 Wi-Fi/ESP-NOW technology.

System Operation

1. Rider wears the helmet.
2. Helmet sensor verifies helmet usage.
3. MQ-3 sensor checks alcohol concentration.
4. ESP32 processes sensor data.
5. Authorization signal is transmitted to vehicle unit.
6. Vehicle starts only when both safety conditions are satisfied.
7. Vehicle operation is disabled if alcohol is detected or the helmet is removed.

5. Hardware Components

Component	Quantity
ESP32 Development Board	2
MQ-3 Alcohol Sensor	1
Helmet Detection Sensor	1
Buck Converter	2
Li-ion Battery	1
Motor Driver Module	1
DC Motor	1
Power Supply	1

6. RESULTS AND DISCUSSION

The developed prototype was successfully tested under various operating conditions. The helmet detection mechanism accurately identified helmet usage. The MQ-3 sensor successfully detected alcohol presence and transmitted corresponding information to the controller.

Wireless communication between the helmet unit and vehicle unit remained reliable throughout testing. The motor driver enabled vehicle operation only when the rider wore the helmet and alcohol levels remained below the predefined threshold.

The system effectively prevented unauthorized vehicle operation and demonstrated the feasibility of integrating embedded systems and wireless communication technologies into motorcycle safety applications.

7. Advantages of the Proposed System

- Prevents drunk driving.
- Enforces mandatory helmet usage.
- Low-cost implementation.
- Wireless communication using ESP32.
- Easy installation and maintenance.
- Suitable for real-world deployment.
- Supports future IoT integration.

8. Future Scope

Future enhancements may include:

- GPS tracking and navigation.
- Accident detection using accelerometers.
- Emergency alert notifications.

- Mobile application integration.
- Cloud-based monitoring systems.
- Bluetooth communication.
- Rider health monitoring.
- AI-based predictive safety analytics.

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9. CONCLUSION

The Smart Helmet with Alcohol Detection and Vehicle Control System provides an effective solution for improving motorcycle rider safety. By integrating helmet detection, alcohol sensing, wireless communication, and vehicle authorization, the system ensures that the vehicle operates only under safe conditions. Experimental results confirm reliable performance of the proposed system. The implementation demonstrates how embedded systems and IoT technologies can be utilized to reduce accidents, promote responsible riding behavior, and enhance overall transportation safety. The proposed solution has strong potential for practical deployment and future expansion.

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