
Smart Helmet Using Embedded Iot System

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Abstract.

The integration of Internet of Things (IoT) technology with embedded systems has revolutionized personal safety devices, resulting in the development of smart helmets that go far beyond conventional protective equipment. A smart helmet integrates sensors, microcontrollers, and wireless modules into a wearable platform to provide accident detection, alcohol consumption monitoring, environmental sensing, and real-time alerts to authorities or emergency contacts. Such systems can also employ GPS modules for location tracking, cloud platforms for data storage, and mobile applications for visualization and user interaction. This review paper investigates the architecture, functionality, challenges, and recent research advancements in smart helmet systems. It further highlights methodologies adopted in the design of energy-efficient embedded platforms, low-latency communication protocols, and intelligent algorithms for context-aware decision-making. The findings suggest that IoT-enabled smart helmets present strong potential in transportation, industrial safety, and healthcare applications, though issues such as power management, scalability, and data privacy remain active areas of research.

Keywords. Smart Helmet, IOT, Embedded System, Accident Detection, Real Time Monitoring, Wearable Technology, Vehicle Ignition Control, Microcontroller.

1. INTRODUCTION

The rapid growth of Internet of Things (IoT) has enabled the development of intelligent systems for real-time monitoring, control, and communication in various domains. One such promising application is the smart helmet, a wearable device that integrates sensing, computing, and communication capabilities within conventional safety gear. Traditional helmets primarily offer passive protection during accidents, whereas smart helmets provide proactive safety features by continuously monitoring the user's state and the surrounding environment [1]. Smart helmets are particularly valuable in road safety, where they can

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detect accidents through sudden impacts, monitor alcohol consumption using gas sensors, and alert emergency services via wireless communication. They are equally important in industrial and mining environments, where monitoring hazardous gases, worker fatigue, and compliance with safety rules can prevent accidents. Furthermore, integration with healthcare systems allows continuous monitoring of vital signs such as heart rate or oxygen saturation. This paper provides a comprehensive review of smart helmet research, focusing on the technical architecture, design methodologies, challenges, and future directions. Section II discusses the major challenges faced in smart helmet design, Section III highlights recent advancements and methodologies, Section IV presents a summary of findings, and Section V concludes with future perspectives.

2. SYSTEM ARCHITECTURE OF SMART HELMET

The overall architecture of the proposed Smart Helmet system consists of sensing units, processing unit, communication module, cloud service, and a user interface application.

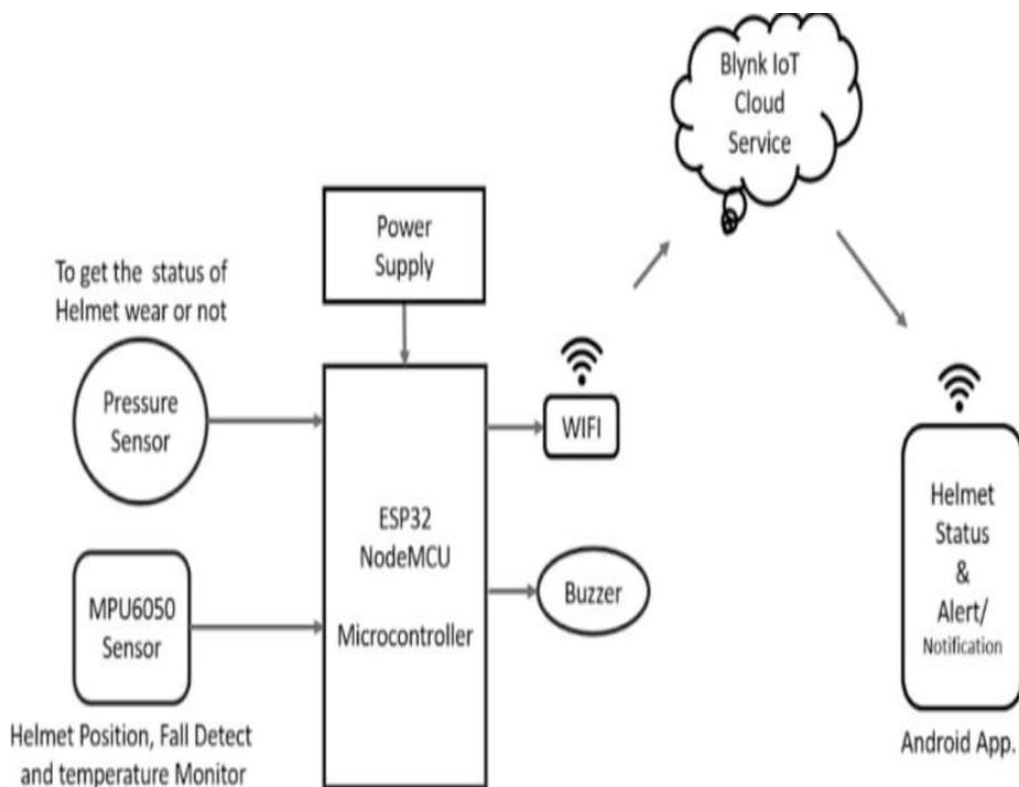


Figure 2.1 shows the block diagram of the Smart Helmet using an Embedded IoT system.

1. Power Supply

The power supply provides the required electrical energy to operate the entire smart helmet system. It usually consists of a rechargeable lithium-ion or lithium-polymer battery along with voltage regulation circuitry to supply stable power to the ESP32 and sensors.

2. Pressure Sensor

The pressure sensor is used to detect whether the helmet is being worn or not. When the rider wears the helmet, pressure is applied inside the helmet, which is sensed and sent to the microcontroller. This helps in enforcing safety rules such as enabling the vehicle only when the helmet is worn.

3. MPU6050 Sensor

The MPU6050 is a MEMS-based sensor that combines a **3-axis accelerometer and a 3-axis gyroscope**. It is used to:

- Detect helmet orientation and movement
- Identify sudden impacts or falls (accident detection)
- Monitor motion patterns that indicate unsafe riding behavior

It can also assist in temperature or motion-based monitoring depending on configuration.

4. ESP32 NodeMCU Microcontroller

The ESP32 NodeMCU acts as the **brain of the system**. It:

- Collects data from the pressure sensor and MPU6050
- Processes the sensor data to determine helmet status or accidents
- Controls the buzzer for alerts
- Manages Wi-Fi communication with the cloud server

The ESP32 is chosen for its high processing capability, built-in Wi-Fi, and low power consumption.

5. Wi-Fi Module

The Wi-Fi functionality (built into the ESP32) enables wireless data transmission. It sends helmet status and alert data to the Blynk IoT Cloud and receives commands or updates if required.

6. Buzzer

The buzzer provides **local audible alerts** to the rider. It is activated when:

- The helmet is not worn
- An abnormal condition or accident is detected
- Warning notifications are required

This ensures immediate feedback without relying only on the mobile application.

7. Blynk IoT Cloud Service

The Blynk IoT Cloud acts as a **remote server** that receives data from the smart helmet via Wi-Fi. It stores, processes, and forwards the information to the mobile application, enabling real-time monitoring and notifications.

8. Android Application (Helmet Status & Alert/Notification)

The Android app provides a **user interface** to display:

- Helmet wearing status
- Accident or fall alerts

- System notifications and warnings

It allows riders or guardians to monitor safety information in real time from anywhere.

2.2 Communication and Cloud Integration

The ESP32 transmits processed data to the Blynk IoT cloud platform using Wi-Fi. The cloud service stores and manages data, enabling real-time monitoring through an Android mobile application.

2.3 Power Consumption in Smart Helmet

Power efficiency is a crucial factor in wearable IoT devices. The ESP32 consumes higher power during active Wi-Fi transmission, while sensors consume relatively low power. By implementing sleep modes and periodic data transmission, the overall power consumption is optimized. The system typically operates within 150–300 mA during active mode, ensuring prolonged battery life.

3. REFERENCES

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