A PROJECT REPORT

On

IoT-Based Smart Helmet for Rider Safety, Accident Detection & Emergency Alerts

For

IIS2270 – Project Based Learning II

By

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CONTENTS

1. ABSTRACT

The rising rate of two-wheeler rider road accidents demands innovative safety solutions. This project suggests an IoT-based Smart Helmet that is capable of imposing helmet use and real-time accident detection, with emergency alert capabilities. The helmet uses an RFID module to identify the helmet, allowing vehicle ignition only in cases of helmet wear, hence facilitating preventive safety practices. Moreover, an MPU6050 gyroscope and accelerometer sensor is utilized to detect sudden impacts or unusual tilting patterns that signal an accident. On detection, an alert is sent through the ESP8266 Wi-Fi module to a mobile app using the Blynk IoT platform, allowing for instant notification and possible emergency response. The implementation showcases an economical, scalable solution that blends embedded systems and wireless communication for improved rider safety and decreased response time to accidents. The proposed system is an approach towards smart city infrastructure's intelligent transportation safety mechanisms.

2. INTRODUCTION

Over the past few years, the sudden surge in two-wheeler accidents has become a pressing public safety issue, especially in developing nations like India. Most of these accidents can be traced to the non-adherence of wearing helmets and delayed emergency services. Even with strict laws in place, helmet usage by riders is patchy, which is usually proved to be the reason for causalities in accidents. Hence, there is an urgent need for smart, automated systems that can enforce safety measures and issue real-time accident notifications.

This project offers an IoT-based Smart Helmet system to address this problem through a combination of helmet detection, accident/crash detection, and emergency alert features. The suggested solution incorporates an RFID-based helmet detection module to prevent the vehicle from starting unless the rider has the helmet on. Apart from that, an MPU6050 motion sensor is utilized to sense jerk or crash, which in turn activates an alarm via an ESP8266 Wi-Fi module linked to a smart phone through the Blynk IoT platform.

By integrating embedded systems, sensor technologies, and cloud-based IoT platforms, the smart helmet not only encourages safe riding practices but also facilitates quicker emergency response, which could save lives. The system is inexpensive, scalable, and deployable for real-world applications, particularly in urban areas where two-wheelers are widely used.

2.1 LITERATURE RIVIEW

Within the domain of road safety and wearable technology, there have been various studies and prototype systems developed to counteract the threat of accidents and ensure safe riding practices. The idea of a smart helmet is not novel per se; yet, most of the available solutions revolve around helmet detection, alcohol detection, or accident notification systems independently.

Sharma et al. (2021) suggested a helmet detection system based on an RFID module to make sure that the rider is not able to start the vehicle without wearing the helmet. Their system was mainly rule enforcement based but did not include real-time accident monitoring features.

Verma and Singh (2020) incorporated an alcohol sensor (MQ3) within a smart helmet to avoid drunk driving in a different study. While useful for addressing an essential safety issue, the system failed to provide real-time crash detection or emergency notification.

More recent developments have incorporated MPU6050 sensors for accelerometer- and gyroscopic-based crash detection. Such systems were widely prevalent but were mostly based on local alert systems such as buzzers or LEDs and did not extend to wireless connectivity for remote monitoring. GSM modules have been used by some researchers for alerts via SMS, though the systems suffered from limitations of scalability and direct real-time integration into apps.

With the development of IoT platforms such as Blynk and ThingSpeak, increasingly sophisticated smart helmet solutions are available with remote access to data, cloud monitoring, and immediate notifications. Research indicates that using ESP8266 Wi-Fi modules in combination with microcontrollers like Arduino Uno provides effortless communication between the device and mobile apps.

Yet, most current solutions are either too expensive, cumbersome, or not sufficiently modular for implementation. The system presented in this project overcomes these challenges by providing a compact, affordable, and feature-packed smart helmet that integrates helmet detection, accident detection, and real-time IoT notifications in one solution.

2.2 OBJECTIVE

The main goal of this project is to create an IoT-based Smart Helmet system that improves the safety of two-wheeler drivers by incorporating intelligent monitoring and alerting mechanisms. The particular objectives of the system are as follows:

Helmet Detection Enforcement
To create a system that makes sure the rider is wearing a helmet using an RFID-based authentication mechanism, thus not allowing the vehicle to start unless the helmet is being worn.

Accident Detection Capability

To sense crashes or falls via an MPU6050 accelerometer and gyroscope sensor, based on actual motion data like acceleration and tilt angles.

IoT-Based Emergency Alerts
To provide real-time emergency notifications via the ESP8266 Wi-Fi module, utilizing platforms such as Blynk to alert contacts or emergency services in the case of an accident.

Low-Cost and Scalable Implementation
To create a low-cost and modular solution that is simple to replicate or scale for deployment in actual applications, most importantly in urban and semi-urban areas with high two-wheeler penetration.

By harnessing embedded hardware and IoT technologies, the project targets to offer an active and reactive safety system that minimizes the chances of fatalities and injuries to motorcycle riders.

2.3 CONTRIBUTION

This project adds to the existing research in intelligent transportation and road safety by introducing a low-cost, compact, and functional IoT-powered Smart Helmet system. The major contributions of this work are as follows:

Integrated Safety Solution
In contrast to current systems that address individual safety features in isolation, this project integrates helmet detection, accident/crash detection, and real-time IoT alerting on a single comprehensive platform.

RFID-Based Ignition Control
The application of an RFID tag within the helmet provides a convenient yet efficient way to guarantee that the vehicle ignition is only activated when the rider has the helmet on, enhancing safety compliance.

Accident Detection Using MPU6050
An MPU6050 sensor is calibrated to identify unusual acceleration or tilt patterns that can be indicative of a crash, adding to the reliability of accident detection in real-time applications.

IoT Integration for Emergency Alerts
The system makes use of the ESP8266 Wi-Fi module to provide real-time alerts through the Blynk platform, allowing for real-time smartphone notifications, which can greatly minimize emergency response time.

Feasibility and Scalability
The prototype is developed on Arduino Uno and readily available components, making it cost-effective as well as scalable for deployment in high-density two-wheeler areas.

This project seeks to fill the gap between enforcement of rider behavior and response after accidents, introducing a pragmatic and effective solution to one of the key causes of road fatalities.

3. METHODOLOGY

Step 1: Sensor Integration

- Mount the accelerometer and gyroscope in the helmet to detect sudden changes in orientation
- Calibrate the sensors to identify threshold values indicating a crash.

Step 2: Microcontroller Programming

- Write a program to continuously monitor sensor data.
- If the impact value exceeds the predefined threshold, the controller flags it as a crash event.

Step 3: Location Tracking

- Once a crash is detected, the GPS module fetches the current coordinates.
- Coordinates are formatted into a message with a Google Maps link.

Step 4: Alert System

- The GSM module sends an emergency SMS with location details to pre-set contacts.
- Optionally, integrate a buzzer or voice output for rider status check before sending an alert.

Step 5: IoT Dashboard (Optional)

- Use Blynk or ThingSpeak to visualize real-time sensor data and crash history.
- Alerts can also be pushed via email, app notifications, or a custom mobile app.

Step 6: Testing and Calibration

- Perform multiple simulations (fall from a height, sharp movements, etc.).
- Adjust thresholds to reduce false positives.

4. RESULT

The envisioned IoT-based Smart Helmet system was effectively developed, installed, and tested under controlled conditions. Every module was individually verified and then integrated into a whole functional prototype. Results for every working component are highlighted below:

Helmet Detection Results

- The RFID-based detection mechanism effectively detected if the rider had on the helmet.
- When the helmet with the attached RFID tag was brought close to the reader:
- The relay/LED was triggered, mimicking successful ignition.
- Without the RFID tag, the system properly inhibited ignition.
- Success Rate: 100% detection in all test attempts when the tag was in range (2–3 cm).

Accident Detection Results

- The MPU6050 sensor was set to record acceleration and angular velocity.
- A custom threshold was set to identify sudden motions similar to a crash.
- When simulated (e.g., dropping the helmet suddenly), the system:
- Detected abnormal acceleration over the threshold.
- Alerted the event as a crash in the Arduino serial monitor.
- Detection Time: Under 200 ms after the crash occurrence.

IoT Alert System Results

- The ESP8266 Wi-Fi module connected to the local network and communicated with the Blynk platform successfully.
- When crash detection occurred, the Arduino activated the ESP8266 to:
- Issue emergency alert messages through Blynk to the smartphone of the user.
- Notifications were received within 3–5 seconds.
- Alert Delivery Success: 95% success rate via Wi-Fi (small failures due to disconnections).

Integrated System Performance

- When all the modules were combined, the smart helmet performed as anticipated:
- Ignition was allowed only when the helmet was being worn.
- Accidents were sensed in real-time, and alerts were delivered immediately.

Power Supply: Smooth operation via USB power bank and stable 5V/3.3V supply for ESP8266.

User Interface: The Blynk app offered an interactive and quick method of obtaining alerts and observing helmet status.

These outcomes establish the practicability of the suggested system as a low-cost, real-time safety tool for two-wheeler operators. The efficiency can be augmented by incorporating GPS modules for monitoring locations and updating crash detection mechanisms using machine learning in subsequent updates.

5. CONCLUSION

The IoT-Based Smart Helmet for Rider Safety, Accident Detection, and Emergency Alerts achieves the integration of wearable safety features with real-time IoT-based communication systems successfully. The prototype ensures key safety checks like helmet donning prior to vehicle start-up and offers early accident detection as well as prompt alert transmission that can save lives in emergency situations.

The modular structure of the system—using RFID to detect the helmet, MPU6050 for crash detection, and ESP8266 for wireless transmission—makes it scalable and versatile. Connecting the helmet to platforms such as Blynk helps bridge the space between physical safety measures and intelligent digital actions and opens up opportunities for next-generation rider protection accessories.

Though the current implementation lacks alcohol detection and GPS monitoring, both of these can easily be added in future releases to offer an even more holistic solution. Further extending its capability is cloud-based logging of data, machine learning to estimate crash severity, and automated emergency services alerting.

In summary, the project not only is an operating proof-of-concept for IoT-enabled safety wearables but also is a contribution to the wider objective of lessening road accidents and enhancing post-crash response times for users of two-wheelers.

6. REFERENCES

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