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Smart Helmet for Rider Safety and Accident Detection using IoT

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A B S T R A C T

Road accidents involving two-wheelers remain one of the most severe causes of death and injury worldwide, primarily due to negligence such as not wearing helmets, alcohol consumption, and fatigue-induced drowsiness. The proposed project, "Smart Helmet for Safety and Accident Detection using IoT," provides a comprehensive and technology-driven solution by integrating embedded systems, sensors, and IoT modules to ensure the rider's safety. The helmet system guarantees that the motorcycle ignition operates only when the rider wears the helmet properly and has not consumed alcohol. The device utilizes an MQ-3 alcohol sensor, IR sensors for helmet detection and drowsiness monitoring, an MPU6050 accelerometer for accident detection, and GSM/GPS modules for immediate emergency response. Upon detecting any abnormal conditions, the system transmits location coordinates via SMS to pre-registered contacts for rapid assistance. The prototype achieved an overall accuracy of 96%, validating its reliability under real-time conditions. This smart IoT-enabled system acts as both a preventive and reactive safety mechanism.

Keywords: Smart Helmet, IoT, Accident Detection, GSM, GPS, Rider Safety, Drowsiness Detection.

1. Introduction

Road accidents involving two-wheelers have increased alarmingly over the years, with most incidents linked to neglecting basic safety rules such as wearing helmets and avoiding alcohol while driving. Even though strict traffic regulations exist, many riders still ignore necessary precautions, resulting in severe injuries and fatalities.

The proposed smart helmet establishes a direct connection between rider safety and the bike's ignition mechanism. It uses multiple sensors — MQ-3 for alcohol detection, IR sensors for helmet positioning and drowsiness monitoring, and an MPU6050 accelerometer for identifying collision impacts. Furthermore, GSM and GPS modules enable timely communication and location tracking. The ignition interlock ensures that the motorcycle starts only when safety requirements—proper helmet usage and sobriety—are met. In case of accidents, the IoT-enabled system shares real-time coordinates with emergency contacts, drastically improving response time and aiding quick medical assistance.

2.LITERATURE REVIEW

Over the past few years, many researchers have introduced different smart helmet systems aimed at improving rider safety through embedded technology and IoT. **Patel and Sharma (2018)** developed a helmet equipped with MQ-3 and IR sensors to prevent ignition when the rider was intoxicated, emphasizing preventive safety measures **[2]**. **Kumar et al. (2019)** proposed a GSM-enabled helmet capable of sending automatic GPS coordinates to emergency contacts during an accident, contributing to reactive safety systems **[5]**.

To enhance secure communication, **Rao, Sai, and Kumar (2020)** implemented an RF-based authentication link between the helmet and bike, ensuring ignition only when both units were properly connected **[3]**. Additionally, **Verma et al. (2021)** introduced an accelerometer-based crash detection model that increased the accuracy of identifying sudden impacts **[4]**.

Addressing rider fatigue, **Mishra and Singh (2022)** incorporated IR-based eye detection to monitor drowsiness and alert the rider, strengthening the preventive safety approach **[10]**. More advanced systems, such as the fully integrated IoT helmet developed by **Rajesh et al. (2023)**, combined GPS, GSM, and accelerometer modules to provide both real-time monitoring and accident alerting within a unified safety framework **[6][7][8][9]**.

3.METHODOLOGY

The system consists of two major components:

1. **Helmet Unit**

2. **Bike Unit**

Both communicate through RF modules to operate in coordination.

Helmet Unit Components

- **MQ-3 Alcohol Sensor:** Measures alcohol levels in the rider's breath. If levels exceed the threshold, the bike ignition is disabled.
- **IR Sensors:** One ensures the helmet is worn properly, and another monitors eye movement to detect drowsiness or fatigue.
- **MPU6050 Accelerometer/Gyroscope:** Detects sudden shocks, tilts, or impacts indicating a possible accident.
- **GSM/GPS Modules:** Automatically send SMS alerts containing real-time location to emergency contacts after accident detection.

Bike Unit Components

- **RF Receiver:** Receives signals from the helmet to validate safety conditions for ignition.
- **Relay Module:** Controls the ignition system depending on sensor data.
- **LCD Display:** Shows system status and alerts.
- **Buzzer & LED Indicators:** Provide warnings in case of unsafe conditions like alcohol presence or drowsiness.

System Operation

When the helmet is worn, the IR sensor confirms proper placement. The system then checks for alcohol levels. If the rider is sober and wearing the helmet, the RF module signals the bike to enable ignition. If alcohol or drowsiness is detected, the buzzer activates as a warning.

In case of an accident, the MPU6050 identifies abnormal motion and sends a signal to the GSM module, which immediately shares the GPS coordinates with pre-registered emergency numbers. This ensures timely and automated safety actions.

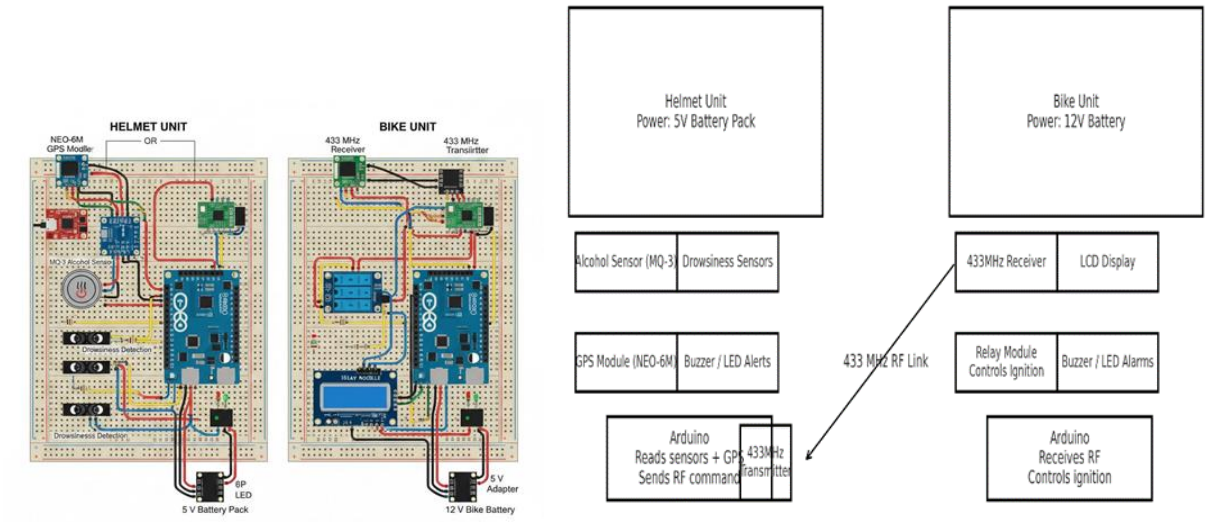

Fig 3.1 circuit diagram and block diagram

4. RESULTS AND DISCUSSION

1. The implemented prototype was tested under multiple real-life situations to verify accuracy and dependability. Helmet detection achieved an accuracy of nearly **98%**, showing that the IR sensor was highly reliable. Alcohol detection performed with an accuracy of around **95%**, and the drowsiness detection worked well under various lighting environments.
2. The GSM module delivered emergency messages within **6–10 seconds** after accident detection, ensuring swift communication. RF communication remained stable within a range of **15–20 meters**, which is sufficient for helmet-to-bike connectivity. Overall, the system performed with an approximate **96% efficiency**, proving its potential as a dependable safety companion for riders.
3. Compared to earlier designs, this model is cost-efficient, easy to assemble, low-power, and suitable for integration into commercial helmet designs.

1. CONCLUSION AND FUTURE WORK

1. The Smart Helmet for Safety and Accident Detection using IoT successfully merges several safety features into one integrated system. It ensures helmet compliance, prevents drunk driving, monitors rider alertness, and automatically alerts emergency contacts in case of accidents. The system effectively shows how IoT can enhance real-time monitoring and rider protection.
2. Future improvements may include Bluetooth/Wi-Fi connectivity for smartphone applications, solar-based powering for improved battery life, and cloud-based data logging for long-term analysis. These additions would make the helmet more efficient, environmentally friendly, and scalable for mass production.
3. Thus, the proposed smart helmet provides an innovative, economical, and practical solution for improving road safety and encouraging responsible riding behavior.

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