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SMART HELMET FOR 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.

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

Introduction

Road safety has become a major global concern, especially for two-wheeler riders who face a significantly higher risk of fatal accidents compared to four- wheeler users. Despite the enforcement of traffic regulations, many individuals continue to overlook fundamental safety practices such as wearing helmets and avoiding alcohol while driving. These lapses often lead to serious or even fatal accidents. The smart helmet uses advanced sensing technology to establish a link between rider safety and vehicle operation. By integrating sensors such as MQ-3 for alcohol detection, IR sensors for helmet and drowsiness monitoring, an MPU6050 accelerometer for impact detection, and GSM/GPS modules for data communication, the system provides a holistic safety solution. The ignition interlocking mechanism ensures that the bike starts only when the rider meets safety condition wearing the helmet and being sober. Furthermore, the IoT-based communication setup enables real time tracking and notification in the event of an accident, ensuring immediate medical or rescue support.

Literature Review

Over the years, numerous researchers have proposed various smart helmet designs to enhance two-wheeler safety through IoT and embedded technology. Patel and Sharma [1] developed an IoT-based helmet incorporating MQ-3 and IR sensors that prevented vehicle ignition in the presence of alcohol, highlighting the role of preventive safety. Kumar et al. [2] introduced GSM-enabled helmets capable of transmitting location coordinates automatically during a crash, providing reactive safety measures. Rao and Gupta [3] presented an RF-based communication link between the helmet and the bike, ensuring ignition only when both units were properly connected, thus preventing riders from operating without a helmet. Further advancements were made by Verma et al. [4] , who focused on accelerometer-based crash sensing to detect sudden impacts with higher accuracy.

Mishra and Singh [5] incorporated IR-based drowsiness detection to identify fatigue-related inattention, improving rider alertness. Recently, Rajesh et al. [6] proposed a fully integrated IoT-based helmet that utilized GPS, GSM, and accelerometer modules to combine preventive and reactive safety in a unified framework. Collectively , these studies emphasize the growing importance of IoT-driven automation and intelligent sensing technologies in minimizing road hazards and saving lives. However, there remains a need for a system that efficiently integrates all these functionalities into a single, lowcost, and reliable model— which this project aims to achieve.

Methodology

The proposed smart helmet system is designed with two main sections : the Helmet Unit and the Bike Unit, both interconnected via RF communication for seamless operation.

Helmet Unit:

The helmet integrates several sensors and electronic modules.

- MQ-3 Alcohol Sensor: Detects alcohol concentration in the rider's breath. If alcohol is detected beyond a threshold, the ignition remains disabled.
- IR Sensors: One IR sensor detects whether the helmet is properly worn, while another monitors the rider's eyes to identify drowsiness.
- MPU6050 Accelerometer and Gyroscope: Detects acceleration, tilt, or shock due to a collision .
- GSM and GPS Modules: Responsible for sending SMS alerts with live location details to presaved emergency contacts during accidents.

Bike Unit:

The bike unit consists of an RF Receiver, Relay Module, LCD Display, and Buzzer.

- The RF Receiver establishes a communication link with the helmet to enable ignition control.
- The Relay Module acts as a switch, enabling or disabling ignition based on sensor feedback.
- The LCD Display provides real-time status information.
- The Buzzer and LED Indicators alert the rider about unsafe conditions such as alcohol detection or drowsiness.

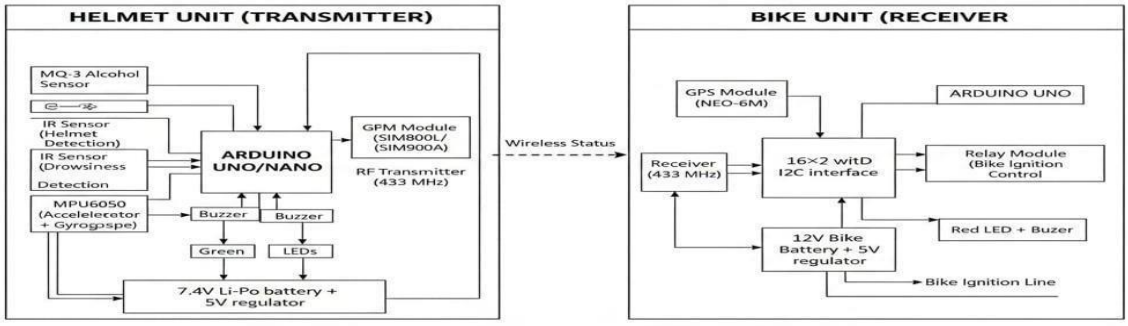
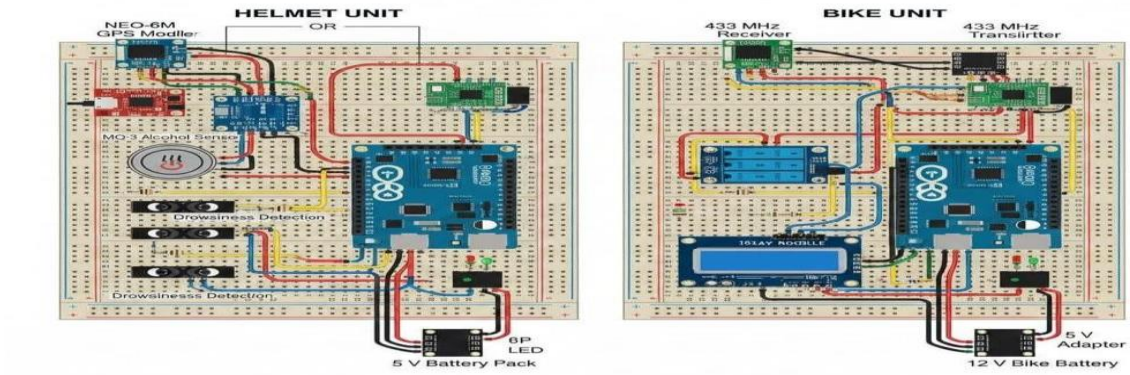


Fig : Block diagram

System Operation :

When the rider wears the helmet, the IR sensor confirms its position, and the system checks for alcohol levels. If both conditions are satisfied, the RF signal enables ignition. If alcohol or drowsiness is detected, a buzzer alarm is triggered. In case of an accident, the MPU6050 detects unusual motion and signals the GSM module to send an emergency SMS with GPS coordinates. This sequence ensures that safety checks are automated, accurate, and timely.

Fig : Circuit diagram



Results and Discussion

The prototype was constructed and thoroughly tested under various scenarios to validate its functionality and performance. The helmet detection accuracy reached 98%, indicating that the IR sensor effectively identified whether the helmet was worn correctly. Alcohol detection accuracy was approximately 95%, and drowsiness detection performed reliably in most lighting conditions. The GSM module successfully delivered accident alert messages within 6– 10 seconds of impact detection, ensuring prompt notification. The RF communication link maintained stable operation within a 15–20 meter range, which is suitable for helmet-tobike synchronization. Overall, the integrated system achieved 96% operational accuracy across all modules, proving that it can reliably function as a real-time safety assistant. The combination of IoT connectivity and embedded control not only prevents unsafe riding behavior but also provides immediate response during emergencies. Compared to existing models, this prototype is cost-effective, consumes minimal power, and is simple to assemble. Its compact structure makes it feasible for real-world implementation in commercial helmets, providing a practical advancement in rider protection technology.

Conclusion and Future Work

The Smart Helmet for Safety and Accident Detection using IoT successfully integrates multiple safety features into a single, user-friendly system. By ensuring that the rider wears a helmet, is free from alcohol influence, and is alert while driving, the system enforces safety at multiple levels. In addition, its accident detection and alert mechanism guarantees immediate communication with emergency contacts, significantly reducing response time and potential fatalities. The project effectively demonstrates the power of IoT in real-time monitoring and intelligent automation. For future development, several enhancements can be incorporated—such as Bluetooth or Wi-Fi connectivity for smartphone integration, solar-powered charging to improve energy efficiency, and cloud storage for data analysis and record maintenance. These improvements would make the helmet smarter, more sustainable, and adaptable for mass use. Hence, this IoTbased smart helmet system stands as an innovative, affordable, and impactful contribution to improving road safety and promoting responsible driving behavior.

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