IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 2, May 2025
Impact Factor: 7.67

IOT-Based Bike Rider Safety Monitoring System

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Abstract: *Road safety for two-wheeler riders is a significant concern due to helmet non-compliance, drunk driving, signal violations, and delayed emergency response. This project presents an IoT-based bike rider safety and traffic monitoring system that improves safety through real-time monitoring, automated alerts, and cloud-based data storage. The system consists of three primary units: Helmet Unit, Bike Unit, and Signal Unit, each designed to enhance road safety. The Helmet Unit ensures that the rider wears a helmet and is not intoxicated using IR and MQ-3 sensors. If the rider fails to meet these conditions, the bike remains locked, and the event is recorded in the IoT cloud. The Bike Unit monitors side stand position, oil level, and obstacle detection using a limit switch, ultrasonic sensors, and an LCD display. It also integrates a MEMS sensor that detects if the bike tilts 90 degrees, indicating a possible accident. Upon detection, the GSM module sends an emergency SMS alert with GPS coordinates to predefined contacts. The Signal Unit enforces traffic signal compliance using an RFID scanner and ultrasonic sensors, ensuring no vehicle crosses during a red light. All real-time data from the Helmet Unit and Bike Unit is uploaded to the IoT cloud, allowing remote monitoring and quick emergency response. By combining IoT connectivity, sensor-based automation, and cloud-based monitoring, this system provides an efficient and scalable solution for accident prevention, traffic regulation, and improved rider safety.*

Keywords: IoT-based bike safety, Smart helmet system, Real-time accident detection, Traffic rule enforcement, Emergency alert system

I. INTRODUCTION

Road safety for two-wheeler riders is a growing concern due to factors such as helmet non-compliance, drunk driving, traffic signal violations, and delayed emergency responses. The high rate of accidents involving motorcycles often results in severe injuries or fatalities, emphasizing the need for an advanced safety system. Traditional safety measures and enforcement methods are often ineffective, making it crucial to integrate modern technology for enhanced rider protection and traffic regulation.

This project introduces an IoT-based bike rider safety and traffic monitoring system designed to improve road safety through real-time monitoring, automated alerts, and cloud-based data storage. The system comprises three main components: Helmet Unit, Bike Unit, and Signal Unit. The Helmet Unit ensures that the rider wears a helmet and is not under the influence of alcohol using IR and MQ-3 sensors. If these conditions are not met, the bike remains locked, and a record is sent to the IoT cloud. The Bike Unit enhances safety by monitoring the side stand position, oil level, and nearby obstacles. Additionally, it includes a MEMS sensor that detects if the bike tilts beyond a certain angle, indicating a potential accident, triggering an emergency alert via a GSM module with GPS coordinates.

To enforce traffic regulations, the Signal Unit is equipped with RFID and ultrasonic sensors to ensure vehicles comply with traffic signals, preventing red-light violations. All collected data from the Helmet Unit and Bike Unit is transmitted to a cloud-based platform, allowing for remote monitoring and quick emergency response. By integrating IoT connectivity, sensor-based automation, and cloud computing, this system provides an innovative and scalable solution for accident prevention, improved traffic compliance, and enhanced rider safety.

DOI: 10.48175/IJARSCT-26246

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PROBLEM STATEMENT

Road accidents involving two-wheelers have become a major concern worldwide, with a significant portion attributed to factors such as drunk driving, not wearing helmets, and reckless speeding. This project aims to address these issues by developing an IoT-based bike rider safety monitor system. This system will incorporate various sensors to detect and prevent unsafe riding behaviors, thereby significantly reducing the risk of accidents and promoting safer riding practices.

OBJECTIVE

- To develop an IoT-based bike rider safety monitoring system for real-time threat detection and safety enhancement using PIC18F4520 Microcontroller.
- To improve early accident detection and provide real-time monitoring.
- To minimize the risk of riding under unsafe conditions.

II. LITERATURE SURVEY

Road safety for two-wheeler riders has been a growing concern due to an increase in accidents caused by helmet non-compliance, drunk driving, red light violations, and delayed emergency response. Various studies have explored the role of IoT, sensor-based automation, and cloud-based monitoring in improving road safety and enforcing traffic regulations. Researchers have developed helmet compliance systems that use infrared (IR) sensors to detect whether a rider is wearing a helmet and MQ-3 sensors to monitor alcohol levels. Studies have shown that integrating these sensors with the bike ignition system effectively prevents unsafe riding conditions. Some researchers have further enhanced these systems by implementing RFID or Bluetooth communication, ensuring that the bike starts only when the rider meets safety criteria. Additionally, cloud-based monitoring has been introduced to help authorities track violations in real time.

Accident detection and emergency response systems have also been widely explored in recent studies. Researchers have implemented MEMS-based sensors that detect abnormal bike tilting beyond a threshold (usually 90 degrees), which may indicate an accident. In such cases, GSM modules are used to send an emergency SMS with GPS coordinates to predefined contacts, significantly reducing emergency response times. Studies have found that faster emergency response can reduce fatalities by up to 40%. Some advanced models incorporate machine learning algorithms to analyse riding patterns and predict potential accidents before they occur, offering an additional layer of safety. The use of real-time cloud integration in accident detection systems further ensures that emergency data is logged and accessible to medical responders.

Traffic rule enforcement, particularly in the case of red light violations, has been another focus of research. Some studies have introduced RFID-based systems, where vehicles are equipped with RF tags scanned at traffic signals to detect and log violations. Others have explored AI-based computer vision models, which use cameras to monitor and recognize vehicles that cross red lights, improving the accuracy of rule enforcement. Ultrasonic sensors have also been used to detect vehicle movement when the signal is red, helping to record violations in real time. The integration of IoT and cloud computing in these traffic monitoring systems allows authorities to access and analyse violation data remotely, enabling stricter enforcement of road safety regulations.

Overall, the literature suggests that an integrated IoT-based system combining helmet compliance, accident detection, and traffic rule enforcement can provide a scalable and effective solution for improving road safety. By leveraging sensor technologies, automated alerts, and cloud-based monitoring, these systems offer a proactive approach to accident prevention and emergency response. The advancements in machine learning and AI-based detection further enhance the capabilities of these systems, ensuring better compliance with traffic regulations and improved rider safety.

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III. PROPOSED SYSTEM

The Fig.1 shows the block diagram of Helmet Unit. The Helmet Unit ensures rider safety by verifying **helmet compliance and alcohol consumption**. It consists of an **IR sensor** to detect if the helmet is worn and an MQ-3 sensor to check for alcohol levels in the rider's breath. If the rider is not wearing the helmet or is intoxicated, the system prevents the bike from starting by keeping the ignition locked. The event is recorded in the IoT cloud, enabling remote monitoring.

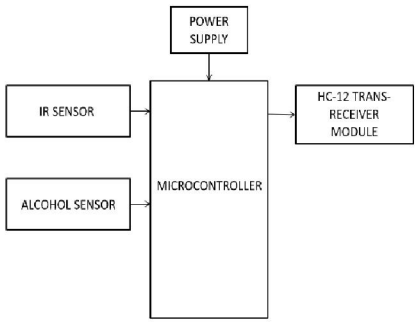

Fig. 1 Block Diagram (Helmet Unit)

The Fig. 2 shows the block diagram of Bike Unit. The Bike Unit focuses on ensuring operational safety and detecting accidents. It monitors the **side stand position, oil level, and obstacles** using various sensors. Additionally, a **MEMS sensor** detects if the bike tilts **90 degrees**, indicating a potential accident. If an accident is detected, the **GSM module** sends an emergency **SMS alert with GPS coordinates** to predefined contacts, ensuring a quick response.

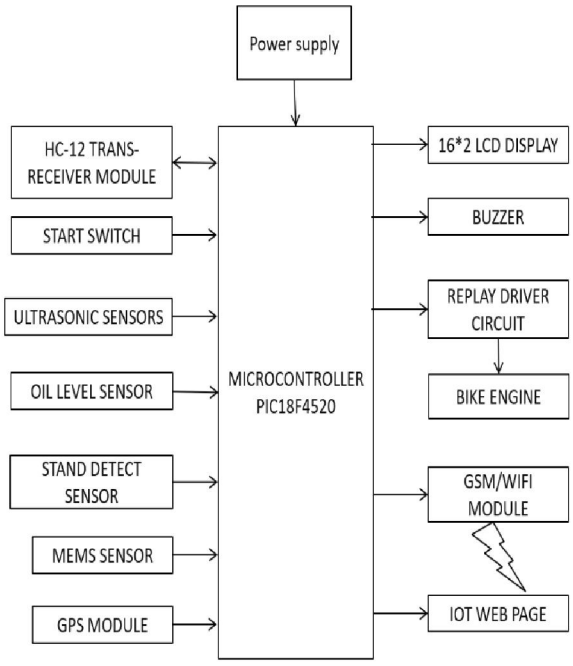

Fig. 2 Block Diagram (Bike Unit)

The Fig. 3 shows the block diagram of Signal Unit. The Signal Unit enforces **traffic signal compliance** to prevent accidents caused by red-light violations. It uses an **RFID scanner** and **ultrasonic sensors** to monitor vehicles at intersections. If a vehicle crosses a red light, the system logs the violation in the **IoT cloud**, enabling authorities to track and take necessary action.

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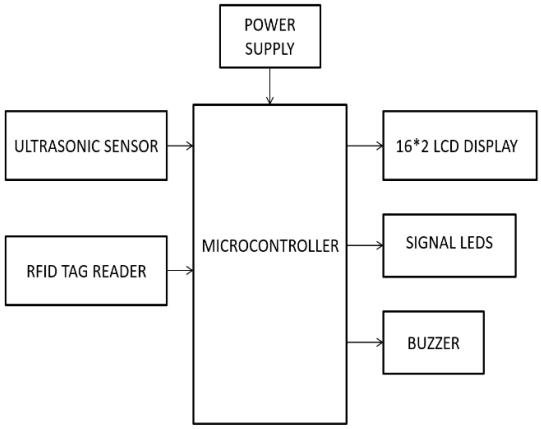

Fig. 3 Block Diagram (Signal Unit)

IV. DISCUSSION AND SUMMARY

The development and implementation of the IoT-Based Bike Rider Safety Monitoring System represent a significant step forward in enhancing road safety and reducing motorcycle-related accidents. This system combines intelligent monitoring with real-time communication to provide proactive safety measures for both the rider and the vehicle. By integrating modern technologies into an automated platform, the system is capable of detecting abnormal riding behaviour, potential accident conditions, while also ensuring immediate response through wireless alerts. Its modular design and ease of integration make it a practical and scalable solution for improving rider awareness and emergency handling, ultimately contributing to safer road travel and smarter transportation systems.

Hardware Components:

- **PIC Microcontroller**: Serves as the core controller, managing all operations and coordinating inputs from various modules.
- **Motion Sensors**: Monitor the rider's posture and detect unusual movements or accidents.
- **Alcohol Detection Module**: Identifies the presence of alcohol to prevent unsafe riding.
- **Ultrasonic Sensor**: Aids in obstacle detection to avoid collisions.
- **Stand Detection Unit**: Ensures the bike stand is properly retracted before motion.
- **GPS Module**: Tracks the bike's real-time location for navigation and emergency alerts.
- **GSM/Wi-Fi Module**: Facilitates wireless communication with the rider's emergency contacts or control centre.
- **LCD Display**: Allow the rider to receive status updates.
- **Buzzer**: Issues audible alerts in case of safety warnings or violations.
- **Battery Pack**: Powers the entire system with portability and reliability.
- **HC-12 Module**: Enables communication between the helmet and bike units.

Software Components:

- **Embedded Firmware**: Custom code running on the PIC microcontroller that manages sensor data, performs safety logic, and controls communication.
- **Web-Based Dashboard** : Provides an interface for users to monitor system status and receive alerts.
- **Communication Protocols**: Handle the transmission of critical data between the helmet, bike, and external systems reliably and securely.

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- **Alert System Logic**: Determines when and how to notify emergency contacts or display warnings based on real-time inputs.

In summary, the IoT-Based Bike Rider Safety Monitoring System combines intelligent hardware with smart software to deliver a comprehensive safety solution for motorcyclists. The hardware components work together to monitor rider behaviour, vehicle status, while the software components process this data to generate timely alerts and enable seamless communication. This system not only improves rider safety by providing real-time feedback and emergency response capabilities but also offers a scalable and adaptable framework for future enhancements in smart transportation and accident prevention technologies.

V. RESULT

The IoT-based bike rider safety system effectively enhances road safety by ensuring helmet compliance, detecting accidents, and enforcing traffic rules. The Helmet Unit prevents the bike from starting if the rider is not wearing a helmet or is intoxicated. The Bike Unit monitors safety parameters and detects accidents, triggering emergency alerts with GPS coordinates. The Signal Unit enforces traffic compliance by detecting red-light violations. Real-time data transmission and cloud-based monitoring improve accident prevention and emergency response, making the system a reliable solution for rider safety.

VI. FUTURE SCOPE

The proposed IoT-based bike rider safety monitoring system has significant potential for future advancements. Integrating AI and machine learning can enhance accident prediction and rider behaviour analysis, enabling proactive safety measures. Advanced computer vision techniques can be incorporated for more accurate traffic rule enforcement and automatic number plate recognition for violators. The system can also be extended with vehicle-to-infrastructure (V2I) communication, allowing real-time data exchange with traffic management systems for better coordination and road safety improvements. Additionally, integrating a mobile application can provide riders and authorities with instant alerts, ride analytics, and emergency response tracking. With continuous technological advancements, this system can be expanded into a fully automated intelligent transportation system, contributing to safer and smarter road networks.

VII. CONCLUSION

This IoT-based bike rider safety monitoring system provides an effective solution to enhance road safety by integrating real-time monitoring, automated alerts, and cloud-based data storage. The Helmet Unit ensures that riders wear helmets and are not intoxicated, the Bike Unit monitors essential safety parameters and detects accidents, while the Signal Unit enforces traffic signal compliance. By leveraging sensor-based automation and IoT connectivity, the system helps in accident prevention and enables quick emergency response.

With features such as GSM-based emergency alerts, GPS tracking, and cloud integration, this system offers a proactive approach to traffic safety and regulation enforcement. The ability to monitor real-time data remotely ensures efficient accident handling and law enforcement actions. This solution has the potential to significantly reduce road accidents and improve rider safety, paving the way for smarter and safer transportation systems.

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