IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.67
Volume 5, Issue 3, March 2025

Smart Helmet

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Abstract: *The Smart Helmet project aims to significantly enhance motorcycle rider safety through the integration of advanced technologies designed to prevent accidents and provide immediate assistance in case of emergencies. The project addresses the alarming rates of road accidents involving two wheeler motorcycles, which are one of the leading causes of death and injury worldwide. The system employs a combination of sensors, including alcohol detection sensors (MQ-3), helmet detection sensors (IR and PIR), and accident detection systems (accelerometers) to always ensure the rider's safety. The smart helmet involves acting as a key to the motorcycle, ensuring that the vehicle can only start when the rider is both wearing a helmet and not under the influence of alcohol. The MQ-3 alcohol sensor detects the presence of alcohol in the rider's breath, and if alcohol is detected above a certain threshold, the engine is automatically locked to prevent the rider from starting the motorcycle while intoxicated. The IR and PIR sensors are responsible for verifying whether the rider is wearing the helmet, as the system will not permit the bike to start if the helmet is not detected. Additionally, the system features an obstacle detection mechanism that alerts the rider when an obstacle is too close.*

Keywords: Alcohol Detection, Helmet Detection, Accelerometer, GSM & GPS Module, Emergency Alert System

I. INTRODUCTION

Motorcycle accidents have long been a leading cause of death and injury worldwide, particularly due to the vulnerability of riders to external forces and the lack of protective barriers compared to occupants of four-wheel vehicles. In countries such as India, where motorcycles are a popular and affordable mode of transportation, the situation is dire. These accidents often occur due to factors such as speeding, lack of protective gear, impaired riding due to alcohol consumption, and poor visibility. Despite numerous campaigns to increase helmet usage and discourage drunk driving, these issues persist, demanding more effective solutions. The MQ-3 alcohol sensor is used to detect alcohol in the rider's breath, and if the rider is impaired, the system automatically locks the motorcycle engine, preventing it from starting. This feature aims to prevent accidents caused by drunk driving, a common and often fatal risk factor for motorcyclists. In addition to alcohol detection, the smart helmet is equipped with IR and PIR sensors to detect whether the rider is wearing the helmet properly. If an accident is detected, the GSM module sends an automated message, including the rider's location through GPS technology, to pre-programmed emergency contacts, such as family members or emergency services. An obstacle detection system alerts the rider when any object is too close This project not only aims to reduce fatalities and injuries but also educates riders on the importance of safety measures while encouraging responsible riding habits.

II. LITERATURE REVIEW

Research on smart helmets focuses on enhancing rider safety through technology. Studies show that integrating accelerometers and gyroscopes enables real-time accident detection, reducing emergency response time (Sobhana et al., 2021). Dharani et al. (2020) highlight IoT-enabled helmets using GSM and GPS for crash detection and alerts. Alcohol detection using MQ-3 sensors prevents intoxicated riders from starting motorcycles, effectively reducing accidents (Wasnik & Koli, 2023). Helmet detection via IR and PIR sensors ensures compliance with safety regulations (Dharani et al., 2020).

Commercial smart helmets like Skully Fenix AR and Forcite MK1S offer features such as Bluetooth, HUD displays, and rear-view cameras for enhanced safety. However, challenges like sensor accuracy, power consumption, and affordability

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remain (Wasnik & Koli, 2023). Ongoing AI and IoT advancements aim to improve these aspects, making smart helmets more efficient and accessible.

III. METHODOLOGY

The smart helmet project follows a structured methodology to ensure rider safety through real-time monitoring and automated responses. The system begins by verifying whether the rider is wearing the helmet using an IR sensor and checking for alcohol consumption with an MQ-3 sensor. If any of these conditions are violated, the vehicle remains locked. Additionally, the helmet is equipped with a drowsiness detection system that monitors the rider's eye activity and triggers an alarm if fatigue is detected. In case of an accident, the system automatically sends the rider's live location to emergency contacts via a GSM and GPS module. A QR code system is integrated, allowing easy retrieval of rider details during emergencies. The vehicle ignition is controlled by a microcontroller (Arduino Uno), which ensures that all safety conditions are met before starting. This methodology enhances road safety by integrating sensor-based automation with real-time communication and alert systems

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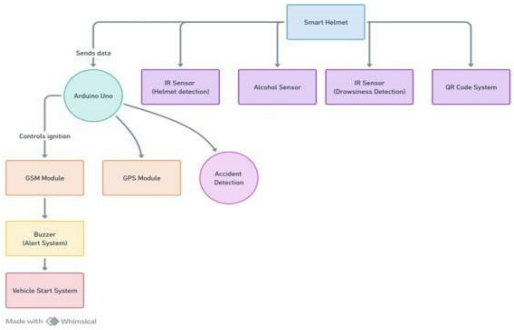

Fig 1: Block Diagram

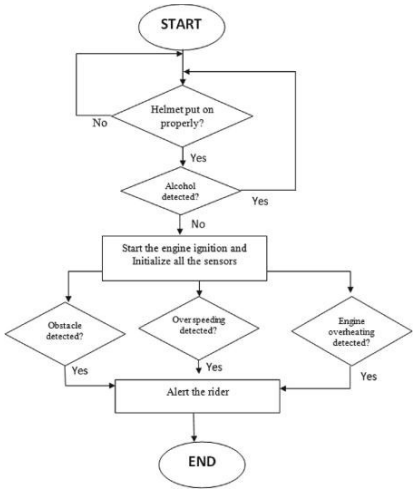

Fig 2: Workflow

Agile Development Process

The project was divided into short iterations (sprints) lasting one to four weeks, ensuring efficient and modular development.

Each sprint focused on developing a specific set of safety features, such as helmet detection, alcohol detection, accident alert systems, and drowsiness monitoring, prioritizing those crucial to rider safety.

Feedback from testing and potential users was incorporated into each sprint, refining functionalities and ensuring that the system evolved based on real-world requirements.

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Each feature underwent rigorous testing, including sensor accuracy checks and emergency alert system validations, to guarantee system reliability, accuracy, and usability.

A multidisciplinary team, including hardware engineers, embedded system developers, and UX designers, worked together to integrate sensors, GPS/GSM modules, and microcontrollers seamlessly, enhancing the overall system performance.

By implementing Agile methodology, the Smart Helmet project benefited from iterative improvements, faster feature deployment, and adaptability to user needs. Each sprint ensured progressive enhancement of rider safety, making the helmet more intelligent, efficient, and responsive with every iteration.

Iterative Development Process

The project followed an iterative approach, where the Smart Helmet system was developed in multiple cycles, with each iteration refining and enhancing the previous version.

Initial iterations focused on core functionalities like helmet detection and alcohol detection. Later iterations introduced advanced features such as accident detection, drowsiness monitoring, and real-time GPS tracking.

Each iteration included rigorous testing of sensors and communication modules, with user and expert feedback incorporated into subsequent iterations to improve performance and reliability.

By refining the system in small steps, potential risks such as sensor inaccuracy, power inefficiency, or communication failures were identified and addressed early, reducing the chances of major system failures

Based on real-world testing, adjustments were made to sensor sensitivity, emergency alert mechanisms, and system usability, ensuring continuous enhancement of the helmet's safety features.

By following the iterative development methodology, the Smart Helmet project progressively improved through systematic refinements. Each iteration enhanced the system's stability, functionality, and responsiveness, ensuring a reliable and effective safety solution for motorcyclists.

IV. FUTURE SCOPE

A concealed, high-resolution camera can be integrated into the helmet to capture accident details automatically. This will assist in future investigations by providing real-time evidence and reducing disputes in case of collisions. The camera could be programmed to activate only in the event of an accident, ensuring privacy and optimal storage management. To protect the camera from damage, a retractable mechanism can be implemented. The camera will remain inside the helmet when not in use and will extend only when required, enhancing durability and usability. The current battery system can be replaced or supplemented with a solar panel to make the helmet more energy-efficient and sustainable. Solar power can extend battery life, reduce dependency on frequent charging, and make the helmet more eco-friendly. A security mechanism can be introduced where users authenticate via fingerprint scanning or a passcode to prevent unauthorized use. This feature will ensure that only the rightful owner can operate the helmet and start the vehicle, reducing theft and unauthorized access. Future versions of the Smart Helmet can include AI-powered voice assistance to provide real-time navigation, weather updates, and emergency alerts. AI can also analyze riding patterns and alert riders about potential hazards, enhancing overall road safety.

V. CONCLUSION

The smart helmet project successfully enhances rider safety by integrating multiple advanced features such as helmet detection, alcohol detection, drowsiness monitoring, accident detection, and real-time emergency alerts. By ensuring that the vehicle only starts when the helmet is worn and the rider is sober, it prevents accidents caused by negligence. The inclusion of a drowsiness detection system helps reduce the risks of fatigue-related crashes, while the accident detection module, coupled with GPS and GSM, enables quick emergency response by sending the rider's live location to family members or emergency services. The QR code system further aids in retrieving rider information during emergencies, making it easier for responders to provide necessary assistance.

Furthermore, the system operates efficiently using a rechargeable battery, ensuring portability and reliability without frequent battery replacements. The combination of sensor-based automation, real-time monitoring, and smart communication technologies makes this helmet an innovative and practical safety solution. By addressing major

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concerns in motorcycle safety, including drunk driving, fatigue, and accidents, this project significantly contributes to reducing road fatalities and enhancing traffic safety. With potential future improvements such as IoT integration, AI-driven accident prediction, and cloud-based health monitoring, the smart helmet can become an even more powerful tool for ensuring rider security. Overall, this project serves as a life-saving innovation that promotes responsible riding and enhances road safety on a larger scale.

VI. ACKNOWLEDGMENT

We would like to express our heartfelt gratitude to everyone who contributed to the successful completion of our Smart Helmet project. Firstly, we extend our sincere thanks to our project guide, Ms. S. K. Kawale, for her invaluable guidance, continuous support, and encouragement throughout the project. Her insights and expertise played a crucial role in shaping our research and implementation. We also extend our appreciation to Mrs. S. S. Kadam, our project coordinator, for her valuable suggestions and motivation, which greatly contributed to the project's progress. A special thanks to our institution, Sou. Venutai Chavan Polytechnic, Pune, for providing us with the necessary resources and a conducive environment to conduct our research and development. We are also grateful to our peers, friends, and family members for their unwavering support, constructive feedback, and encouragement throughout this journey. Finally, we acknowledge the contributions of various researchers and authors whose work provided the foundation for our study. Their valuable research in the field of smart helmets and road safety helped us develop a more comprehensive and effective system.

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