

Smart Helmet for Rider Protection and Location Tracking

Pappala Chandana¹, Duppada Ramya², Ketireddy Dileep Kumar³, Jarajapu Lokesh⁴
RaviKumar Palla*

GMR Institute of Technology(GMRIT-Deemed to be University) Rajam,
Andhra Pradesh, India

Email: ravikumar.p@gmrit.edu.in

Abstract—Two of the main causes of death globally, especially for two-wheeler riders, are traffic accidents and drunk driving. Smart Helmet system that combines GSM-enabled emergency alert systems, GPS-based position monitoring, alcohol detection, and accident identification is proposed. If the system detects alcohol consumption, the vehicle will not be permitted to start. In the event of an accident, the system notifies the emergency contacts with precise GPS locations. The proposed method expedites emergency response times by using low-cost embedded devices such as ESP32, MQ-3 alcohol sensor, MPU6050, GPS, and GSM modules.

Index Terms—Smart Helmet, Road Safety, Accident Detection, Alcohol Detection, ESP32, MQ-3 Sensor, MPU6050, GPS Tracking, GSM Module, IoT, Emergency Alert System, Embedded Systems.

I. INTRODUCTION

The mode of transportation using two-wheelers is highly popular because of its cost-effectiveness and ease of operation, especially in developing countries. However, the chances of accident occurrence are extremely high, especially in the case of two-wheeler riders, because of the lack of physical support in the case of an accident. The consumption of alcohol and the delay in medical assistance are the major causes that lead to the high death rate associated with such accidents. The conventional methods adopted to reduce the accident rate, such as the use of helmets, are not effective in the prevention of accidents and the response to emergencies after the occurrence of an accident. The recent developments in embedded systems and IoT devices have led to the development of intelligent safety devices that can be used to reduce the accident rate and the death rate associated with such accidents. This paper proposes a Smart Helmet that prevents drunk riding, detects accidents, and sends emergency messages. Two-wheeler riders are also a major cause of traffic accidents and fatalities, and head injuries are the most common cause of death for two-wheeler riders. The risk of accident is also compounded by factors like "drinking and riding," speeding, road conditions, and waiting for medical attention. One of the major causes of two-wheeler accidents is riding while intoxicated. Drinking and riding result in slow reaction times and cause riders to lose control of their vehicles, leading to deadly accidents. The speed of medical help also plays a crucial role in determining the survival rate of accident victims. However, even in situations where accident victims are not immediately mortally wounded, delayed accident detection and emergency medical

help often lead to fatalities. This paper outlines a smart helmet that prevents drunk riding and detects accidents in real time and sends emergency alerts in case of accidents. Whenever the accident occurs, this system immediately sends alert messages along with current location of the rider to pre-defined contacts through wireless communication technologies such as GSM or IoT-based cloud platforms. With the integration of accident prevention and emergency response into a single wearable device, this system promises to minimize the number of fatalities resulting from accidents and enhance road safety for two-wheeler riders. It is an efficient means of improving rider safety in modern transportation systems because it is cost-effective, efficient, and applicable.

II. LITERATURE SURVEY

A. Impana H. et al. (2019)

The paper offers a thorough overview of Internet of Things (IoT)-based smart helmet systems for emergency notification and accident detection. In order to automatically transmit accident information to emergency contacts and authorities, the work emphasizes the significance of combining real-time communication frameworks with location monitoring. The study highlights IoT connectivity as a crucial component that makes intelligent transportation safety solutions possible. However, the study mostly ignores actual implementation issues like energy efficiency, device cost, and real-world deployment limits in favor of conceptual analysis and system architecture. Related research cover similar IoT-based frameworks for intelligent helmets and accident detection. [2], [3].

B. Varshini P. A. et al. (2025)

This study offers a smart helmet architecture that uses automated alarm systems and Internet of Things-based accident monitoring to increase traffic safety. In order to speed up emergency reaction times during incidents, the system concentrates on real-time data transmission and location tracking. The method shows how wearable technology and distant monitoring systems may communicate effectively. Despite the fact that the suggested framework improves rider safety monitoring, the embedded control platform's low computational capacity limits system performance. Other research examine similar GPS-GSM communication architecture-based location tracking and rider monitoring systems. [5], [6].

C. Sneha A. M. et al. (2024)

In order to increase rider safety, this study presents an IoT-enabled smart helmet that detects dangerous riding situations prior to vehicle operation and ensures helmet usage compliance. The suggested approach emphasizes how crucial wearable IoT devices are to upholding traffic safety laws and enhancing rider behavior monitoring. The study shows that connectivity-based monitoring systems increase rider compliance. However, the lack of sophisticated motion analysis techniques limits the ability to detect accidents. Related study investigates machine learning-based methods for more precise accident detection. [8].

D. R. Kumar et al. (2023)

This study suggests an automated emergency notification system in conjunction with motion and vibration analysis for accident detection. Through communication networks, the system detects unusual motion patterns and notifies designated contacts. The suggested method shows that real-time accident monitoring in intelligent transportation systems is feasible. However, in the event of abrupt braking or other road disturbances, the technique can produce false alarms. Previous studies have addressed motion-based accident detection frameworks and alarm methods to increase reliability and decrease false positives. [10], [11].

E. Akbar M. et al. (2024) Akbar M. et al. (2024)

By identifying alcohol intake and limiting vehicle operating when impaired, this study aims to prevent drunk driving. In order to improve rider safety and lower the probability of alcohol-related accidents, the suggested system combines sensing technology with vehicle control mechanisms. The method effectively detects drunk riders and stops cars from igniting in dangerous situations. Nevertheless, the study mainly focuses on alcohol detection and excludes other safety aspects like real-time location tracking or accident monitoring. Extended smart helmet frameworks that integrate alcohol detection with communication-based tracking and emergency alarm systems have been proposed by other research projects. [13], [14].

F. S. Patel et al. (2022)

A communication-based emergency alert system that automatically sends accident location data to predetermined contacts is presented in the study. The study emphasizes how crucial real-time communication is to speeding up reaction times during traffic accidents. The suggested solution effectively uses wireless communication technologies to demonstrate automatic alarm transmission. However, rather than putting preventive safety measures in place, the framework primarily concentrates on post-accident reaction. Related research discusses advanced IoT-based accident reporting systems that include cloud-based monitoring and data processing. [16].

G. J. Lee et al. (2023)

In order to analyze rider motion patterns, this study suggests an intelligent accident detection framework based on machine learning approaches. To differentiate between typical riding conditions and possible accident scenarios, the system employs sensor data classification. When compared to traditional threshold-based detection systems, the suggested method increases accident detection accuracy. However, because machine learning techniques involve computation, the implementation raises system complexity and costs. Related studies have also addressed intelligent embedded safety frameworks and similar IoT-enabled helmet solutions. [11], [17].

H. K. Sharma et al. (2021)

This study presents an Internet of Things (IoT)-based smart helmet system that uses real-time monitoring and communication technologies to improve rider safety. The study shows how well wearable technology can send safety alerts and accident alerts. Emergency communication and monitoring capabilities are greatly enhanced by the incorporation of IoT connectivity. However, the study highlights issues with high energy consumption and short battery life, which may interfere with wearable safety devices' ability to function continuously. Other projects investigate similar IoT-based rider monitoring systems to increase effectiveness and communication dependability. [16].

I. R. Mehta et al. (2024)

The integrated smart helmet system presented in this study combines several safety features, including automated alert transmission, real-time monitoring, and accident detection. The suggested structure emphasizes how crucial it is to incorporate tracking, communication, and sensing technologies into a small wearable platform. The method shows how to improve rider safety through practical and economical design. However, prior research has already examined comparable integrated smart helmet systems, suggesting the need for more advancements in system intelligence and detection precision. [18].

J. R. S. Chavan (2023)

This study suggests a real-time rider monitoring and accident detection system that transmits emergency alerts via embedded IoT technology. By automatically transmitting location data to emergency contacts, the system speeds up accident reaction times. For applications involving road safety, the suggested framework exhibits effective monitoring and communication capabilities. Nevertheless, the architecture is not integrated with sophisticated cloud-based analytics and remote monitoring systems. In order to improve system robustness and safety, related studies have addressed security and communication reliability issues in vehicular IoT networks. [20].

III. METHODOLOGY

The proposed Smart Helmet is designed using an ESP32 microcontroller as the central processing unit, owing to its high processing capabilities and low power consumption. MQ-3 sensor is placed inside helmet to monitor alcohol concentration in rider's breath. If the concentration is found to exceed predefined threshold, the ignition switch is disabled using a relay module, thus preventing the rider from riding the vehicle in an intoxicated state. Accident detection is also possible using an MPU6050 sensor, which is used in conjunction with an accelerometer and gyroscope to monitor any sudden changes in the acceleration and orientation of the helmet. Once the accident is detected, the real-time latitude and longitude coordinates are sent from the GPS module, and these are then sent to emergency contacts using a GSM module in the form of an SMS containing a Google Map link.

A. System Architecture:

The purpose behind this is to ensure the rider's safety by requiring them to wear a helmet, not riding while drunk, tracking the rider in real time, and providing immediate emergency services in case of any accident. The process starts with the detection of helmet usage. The system monitors the usage of the helmet by the rider. The process does not proceed to the next step unless the usage of the helmet is confirmed. The rider's breath is checked using the alcohol detection module, which consists of an alcohol sensor. If the consumption of alcohol is more than the threshold limit, the technology immediately starts the ignition lock mechanism, which does not allow the car to start. If the consumption is below the threshold limit, the ignition is switched on. As soon as the ignition is switched on, the GPS live tracking module is activated, which tracks the location in real time while traveling. The system will then look for anomalous conditions to assess if an accident has occurred. If the system does not detect an accident, it will stay at the monitoring state and keep monitoring the vehicle. If an accident occurs, the system will immediately activate the emergency response system. The alarm message will be sent to the emergency contacts via the GSM module based on the current GPS location of the rider. The ignition will also be locked to prevent further hazards from occurring.

B. Alcohol Detection and Ignition Control Mechanism:

The alcohol detection unit plays a critical role in accident prevention. The MQ-3 alcohol sensor operates on the principle of change in resistance of a sensitive semiconductor material when exposed to alcohol vapors. The sensor is positioned inside the helmet near the rider's mouth to ensure accurate breath analysis. During system initialization, the sensor undergoes a warm-up and calibration phase to stabilize its output. A threshold alcohol concentration is experimentally determined based on ambient conditions and sensor characteristics. The ESP32 continuously monitors the analog voltage output from the MQ-3 sensor. If the detected alcohol level exceeds the calibrated threshold, the ESP32 activates the relay module to

disconnect the vehicle's ignition circuit. As a result, the engine cannot be started, ensuring proactive prevention of alcohol-impaired riding. A warning indication can also be provided to alert the rider

C. Accident Detection Algorithm

For accident detection, an MPU6050 accelerometer and gyroscope sensor module is used. The sensor continuously detects changes in acceleration along the X, Y, and Z axes and also detects changes in angular positions. Under normal circumstances, the detected accelerations are within a predetermined range. However, during an accident, there is usually an abrupt change in acceleration. To detect this change, a threshold-based approach is integrated into the ESP32 microcontroller. The system is able to detect changes in acceleration and angular velocity beyond predetermined limits. The accident is therefore detected and classified as an accident. The system has also been designed to avoid false alarms resulting from road humps and braking. The system includes a short delay during accident detection and considers multiple parameters before classifying an accident. Once an accident is detected, emergency procedures are initiated.

D. Location Acquisition and Emergency Alert System

Once this accident is detected, it triggers the GPS module, which retrieves the current geographical location of the rider. The GPS receiver receives satellite signals and retrieves the coordinates of the rider's current location. The coordinates are processed using ESP32 and are converted into a clickable Google Map link. The GSM module is then utilized to send this data to emergency contacts using SMS. The SMS includes details of accident notifications and accurate location details, which can be easily identified to provide assistance in case of an accident. This is because the rider is unconscious and unable to ask for assistance.

E. Power Management and System Reliability

The Smart Helmet system is powered by a rechargeable battery that is optimized for wearable electronic devices. Voltage regulators are used to regulate the supply voltage for all devices, thereby protecting them from supply voltage fluctuations and overcurrent conditions. The ESP32's deep sleep and low power modes are used to reduce power consumption during idle states. Modules such as GPS and GSM are used only during emergency conditions, thereby increasing the battery life. Also, proper electrical isolation is maintained for the sensor and communication devices, thereby increasing the reliability of the system.

F. Operational Flow

The flow of operation of the Smart Helmet system is as follows: For normal operation, alcohol detection and accident monitoring are executed in parallel. Once there is a detection of alcohol, ignition control is enforced. Once there is an accident, emergency response is executed over all other processes. This flow of operation provides preventive safety as well as

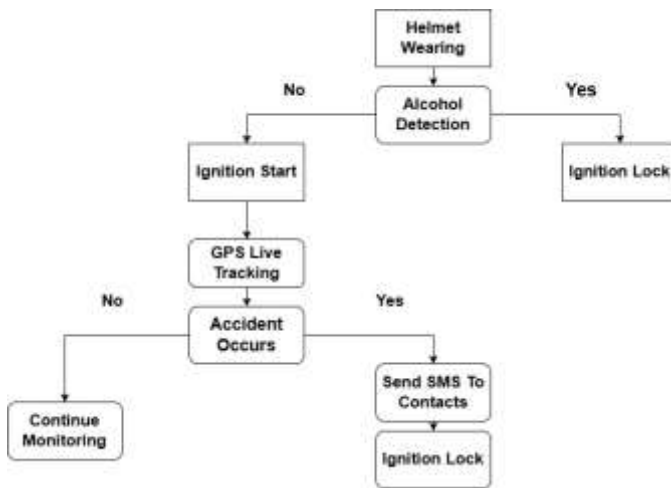


Fig. 1. process flow

assistance during an accident. The flow is smooth and does not require any input from the user, thereby increasing safety and usability.

IV. RESULTS AND DISCUSSION

Arduino IDE software was used to write, compile, and upload the embedded program into the ESP32 microcontroller for the successful operation of the IoT-based Smart Helmet system. The developed system enhances rider safety by preventing drunk driving and providing quick emergency assistance during accidents. The MPU6050 sensor, which continuously tracks abrupt changes in acceleration and orientation, was used to implement the accident detection feature. The system identified a potential accident when it detected an abrupt impact or abnormal tilt that exceeded the threshold value. Following detection, the GPS module obtained the rider's current location coordinates. Following that, an SMS alert containing these coordinates was sent to predetermined emergency contacts via the communication module. According to the test results, the alert message with the location information was successfully sent a few seconds after the accident was discovered.

The MQ-3 alcohol sensor effectively detected alcohol levels in the rider's breath. When the alcohol concentration exceeded the permissible limit, the system automatically activated the relay module to lock the ignition, thereby preventing the rider from starting the vehicle under drunk conditions. This feature helps reduce accidents caused by alcohol consumption. The helmet detection sensor ensured that the vehicle could operate only when the helmet was properly worn. The MPU6050 accelerometer continuously monitored sudden impacts and successfully detected accident conditions.

Whenever an accident occurred, the GPS module (NEO-6M) obtained the rider's exact location coordinates. Immediately, the GSM module (SIM800/SIM900) sent SMS alert messages containing the accident location to predefined emer-



Fig. 2. Hardware Configuratio

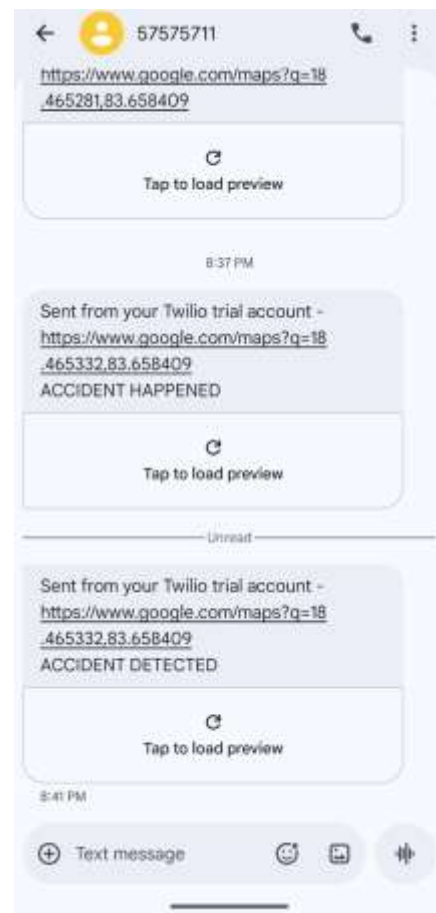


Fig. 3. Alert via SMS and location sharing

gency contacts and relatives. This rapid alert system ensures that family members and emergency responders are informed without delay, enabling faster medical support. Overall, the results confirm that the smart helmet system provides reliable accident detection, automatic ignition control during drunk driving, and instant emergency communication, making it an effective solution for improving road safety.

V. COMPARATIVE ANALYSIS

TABLE I
COMPARISON WITH EXISTING METHODS

Reference Implemented	No. Of Components Used	Cost	Objectives
[1]	3	2500	1
[2]	4	3650	2
[3]	3	2200	2
[4]	3	2200	1
[5]	2	1500	1
[6]	3	2400	2
[7]	3	1700	2
[8]	2	1200	1
[9]	4	2600	2
[10]	5	3700	2
[Proposed System]	7	4700	3

VI. CONCLUSION

The suggested Smart Helmet System has the potential to provide an effective means of improving the safety of two-wheeler riders. This technology has the capability to immediately send emergency alerts with the rider's location to pre-defined contacts and correctly identify accident scenarios. The timely response of the technology ensures the rider will receive help immediately, which is critical during emergency situations. The technology has managed to remain cost-effective while displaying robust performance with high accuracy in identifying abnormal conditions. Considering all these factors, the suggested smart helmet system has the potential to be an effective means of improving traffic safety.

REFERENCES

[1] H. C. Impana, M. Hamsaveni, and H. T. Chethana, "A review on smart helmet for accident detection using IoT," *EAI Endorsed Transactions on Internet of Things*, vol. 5, no. 20, p. e3, Oct. 2019, doi: 10.4108/eai.13-7-2018.164559.

[2] S. A. A. Shah, M. Faheem, and A. Raza, "IoT-based smart helmet for accident detection and emergency notification," *IEEE Internet of Things Journal*, vol. 8, no. 5, pp. 3548–3556, Mar. 2021, doi: 10.1109/JIOT.2020.3028891.

[3] M. A. Hossain, M. M. Rahman, and M. R. Islam, "Design and implementation of an intelligent helmet for motorcycle riders," *IEEE Access*, vol. 9, pp. 117785–117795, 2021, doi: 10.1109/ACCESS.2021.3107162.

[4] P. A. Varshini, "Smart helmet for accident detection and alert using IoT, GPS, and alcohol sensing," *International Journal of Scientific Research and Engineering Development (IJSRED)*, vol. 8, no. 4, pp. 118–122, July 2025.

[5] A. K. Gupta and P. K. Srivastava, "IoT-enabled smart helmet system for rider safety and monitoring," *International Journal of Advanced Computer Science and Applications*, vol. 13, no. 4, pp. 210–216, 2022.

[6] P. Verma and J. Bhatia, "Design and development of GPS-GSM based tracking system with Google map-based monitoring," *International Journal of Computer Science, Engineering and Applications*, vol. 3, no. 3, pp. 33–40, June 2013, doi: 10.5121/ijcsea.2013.3304.

[7] A. M. Sneha, et al., "IoT-based smart helmet for rider safety and alcohol consumption detection," *International Journal of Advanced Research in Computer and Communication Engineering*, vol. 13, no. 3, pp. 45–50, 2024.

[8] J. Lee, et al., "Machine learning-based accident detection using accelerometer and gyroscope sensors in smart helmets," *IEEE Access*, vol. 12, pp. 45821–45834, 2024.

[9] R. Kumar, et al., "Accelerometer-based accident detection system with GSM alert mechanism," *International Journal of Engineering and Advanced Technology*, vol. 12, no. 6, pp. 45–51, 2023.

[10] N. K. Suryadevara and S. C. Mukhopadhyay, "Wireless sensor network based vehicle accident detection and reporting system," *IEEE Sensors Journal*, vol. 15, no. 1, pp. 45–53, Jan. 2015, doi: 10.1109/JSEN.2014.2343214.

[11] T. V. S. Sai Kiran, B. Harish, and K. Venkatesh, "Accident detection and alert system using accelerometer and GSM module," *Procedia Computer Science*, vol. 85, pp. 570–577, 2016, doi: 10.1016/j.procs.2016.05.251.

[12] M. Akbar, et al., "Alcohol detection and ignition control system using MQ-series sensors in smart helmets," *International Journal of Scientific Research in Engineering and Technology*, vol. 9, no. 2, pp. 30–36, 2024.

[13] R. S. Chavan and S. S. Shinde, "Smart helmet with accident detection and alcohol sensing using GSM and GPS technology," *International Journal of Engineering Research Technology (IJERT)*, vol. 12, no. 6, pp. 812–816, 2023.

[14] S. R. Nandurkar and V. R. Thool, "Alcohol detection system in vehicles using MQ-3 sensor," *International Journal of Scientific Engineering Research*, vol. 8, no. 4, pp. 152–156, 2017.

[15] S. Patel, et al., "GPS and GSM based emergency alert system integrated in smart helmet," *International Journal of Recent Technology and Engineering (IJRTE)*, vol. 10, no. 5, pp. 102–107, 2022.

[16] V. R. Kiran, P. Rajalakshmi, and U. B. Desai, "Real-time accident detection and alert system using IoT and cloud computing," *IEEE Sensors Journal*, vol. 21, no. 3, pp. 3433–3441, Feb. 2021, doi: 10.1109/JSEN.2020.3021154.

[17] R. Mehta, et al., "Integrated smart helmet system with accident detection and real-time location tracking," *International Journal of Engineering Research and Applications (IJERA)*, vol. 14, no. 8, pp. 77–83, 2024.

[18] M. A. Hossain, M. M. Rahman, and M. R. Islam, "Design and implementation of an intelligent helmet for motorcycle riders," *IEEE Access*, vol. 9, pp. 117785–117795, 2021, doi: 10.1109/ACCESS.2021.3107162.

[19] K. M. A. Alheeti, A. Gruebler, and K. D. McDonald-Maier, "An intrusion detection system against malicious attacks on the communication network of driverless cars," *IEEE Access*, vol. 3, pp. 1939–1953, 2015, doi: 10.1109/ACCESS.2015.2476962.

[20] R. S. Chavan and S. S. Shinde, "Smart helmet with accident detection and alcohol sensing using GSM and GPS technology," *International Journal of Engineering Research Technology (IJERT)*, vol. 12, no. 6, pp. 812–816, 2023.