

Alcohol and Accident Detection with Sharing of Mobile Notification Along Location Using Smart Helmet System

Aditya Jadhav^{1*}, Aditya Vaidya¹, Yash Thakur¹, Yash Mhatre¹, Sharayu Patil²

Abstract

This study presents the design and implementation of a smart helmet equipped with advanced sensor technology to enhance the safety of motorcycle riders. The smart helmet integrates various sensors including the MQ3 gas sensor for detecting harmful gases, vibration sensor for impact detection, and GPS Neo6m module for location tracking. Additionally, it incorporates an Arduino microcontroller for data processing and control, a Namo buzzer for audible alerts, an LED bulb for visual warnings, and a SIM800L module for real-time communication. The MQ3 sensor continuously monitors for detecting alcohol levels in the rider's vicinity. The vibration sensor is designed to detect abrupt impacts or collisions, prompting instant alerts to notify nearby vehicles or emergency services. Additionally, the GPS module facilitates accurate location tracking, ensuring swift responses during accidents or emergencies. The Arduino microcontroller processes the sensor data and coordinates the functionality of the helmet's safety features. Upon detecting potential dangers, the buzzer emits audible alerts, while the LED bulb provides visual warnings to the rider. Furthermore, the SIM800L module facilitates communication by sending SMS alerts to pre-defined contacts or transmitting location data to emergency responders. The integration of these components into a single smart helmet offers comprehensive safety features, providing riders with enhanced protection against accidents, environmental hazards, and emergencies. The proposed system not only promotes rider safety but also contributes to the advancement of wearable technology for improved road safety in the motorcycle community.

Keywords: Vibration sensor, Arduino nano microcontroller, alcohol detection sensor, accident detection sensor, SMS notifications, GPS, GSM

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INTRODUCTION

Motorcycle riding presents exhilarating freedom and convenience but is accompanied by inherent risks, contributing to a significant number of accidents and casualties annually. To address these safety concerns, the integration of innovative technologies into motorcycle helmets has garnered increasing attention, paving the way for the development of “smart helmets”. These helmets, equipped with advanced sensor technologies, microcontrollers, and communication modules, aim to detect potential hazards, and provide real-time alerts to enhance rider safety [1].

This study focuses on the design and implementation of a prototype smart helmet, leveraging cutting-edge sensor technology tailored to the unique challenges faced by motorcycle riders.

Notably, the smart helmet features a suite of sensors, including the MQ3 alcohol sensor, vibration sensor, and GPS Neo6m module, each serving distinct safety functions. While the MQ3 sensor is primarily utilized for alcohol detection in the rider's vicinity, alerting them to potential impairment risks, the vibration sensor remains instrumental in identifying sudden impacts or collisions, triggering immediate alerts to nearby vehicles or emergency services. Complementing these functionalities, the GPS module enables precise location tracking, facilitating rapid response in the event of accidents or emergencies [2].

At the heart of the smart helmet lies the Arduino microcontroller, which efficiently processes sensor data, orchestrates safety features, and manages communication modules. Upon detecting potential dangers, the microcontroller activates the appropriate response mechanisms, such as the Namo buzzer for audible alerts and the LED bulb for visual warnings, ensuring timely notification to the rider. Furthermore, the SIM800L module enables seamless communication by transmitting SMS alerts to predefined contacts or relaying precise location data to emergency responders [3].

OBJECTIVES

- Design and develop a prototype smart helmet integrating advanced sensor technologies.
- Implement an MQ3 alcohol sensor for detecting alcohol levels in the rider's vicinity.
- Incorporate a vibration sensor for real-time detection of impacts or collisions.
- Incorporate a GPS Neo6m module to enable accurate location tracking and facilitate coordinated emergency response efforts.
- Utilize an Arduino microcontroller to process sensor data and control safety features.

METHODOLOGY

Existing System

Existing systems in the domain of smart helmets and motorcycle safety encompass a diverse array of technologies tailored to enhance rider comfort, convenience, and most importantly, safety.

Many contemporary helmets include integrated communication systems, often leveraging Bluetooth technology for hands-free communication, enabling riders to make phone calls, listen to music, or communicate with fellow riders without helmet removal or external device use. Additionally, helmet-mounted cameras have become a prevalent feature, favored by motorcycle enthusiasts for documenting rides, capturing scenic views, and providing evidence in accident scenarios. Equipped with high-definition video recording capabilities, wide-angle lenses, and stabilization technology, helmet-mounted cameras offer riders a means to capture and share their experiences on the road [4]. Additionally, heads-up display (HUD) helmets have gained traction in recent years. HUD helmets feature transparent display screens that project relevant information directly into the rider's field of view. This information may include speed, navigation instructions, incoming calls, or warnings about nearby hazards, enhancing situational awareness while minimizing distractions.

Impact detection systems represent another significant advancement in motorcycle helmet technology. These systems utilize accelerometers and gyroscopes to detect abrupt alterations in acceleration or rotation, signaling a potential crash event. Upon detecting a crash, these systems can automatically alert emergency contacts or initiate emergency response protocols, potentially saving lives in critical situations.

Proposed System

The proposed smart helmet integrates advanced sensor technology and communication modules to enhance motorcycle rider safety. Key features include an MQ3 alcohol sensor for detecting alcohol levels in the rider's vicinity, a vibration sensor for impact detection, and a GPS Neo6m module for precise location tracking. An Arduino microcontroller processes sensor data and coordinates safety features, activating audible alerts via a Namo buzzer and visual warnings using an LED bulb.

Additionally, a SIM800L module enables communication by sending SMS alerts to predefined contacts or transmitting location data to emergency responders [5].

This comprehensive system aims to mitigate risks associated with alcohol impairment, collisions, and emergencies, offering riders real-time awareness and facilitating swift response in critical situations. By integrating these functionalities into a single wearable device, the proposed smart helmet enhances rider safety and contributes to the advancement of motorcycle safety technology.

LITERATURE SURVEY

We have read different research papers, manuals, and documents that are related to this project idea. These are some pieces of literature that are useful to recognize different ways or strategies to build and implement this project.

IoT Based Smart Helmet

Various studies have explored the integration of advanced sensor technologies, communication modules, and heads-up display systems into motorcycle helmets to enhance rider safety. These technologies aim to provide real-time information about environmental conditions, potential hazards, and vehicle performance to riders, thereby improving their situational awareness and reducing the risk of accidents [6].

Design and Implementation of an Intelligent Motorcycle Helmet for Large Vehicle Approach Intimation

Research has focused on the development and implementation of impact detection systems using accelerometers and gyroscopes to detect crashes and trigger emergency response mechanisms. These systems have shown promising results in reducing emergency response times and improving outcomes for injured riders [7].

Smart Helmet with a Built-in Drowsiness and Alcohol Detection

Studies have investigated the integration of alcohol detection sensors, such as the MQ3 sensor, into motorcycle helmets to prevent alcohol-impaired riding. These systems aim to detect alcohol levels in the rider's vicinity and provide alerts or inhibit the ignition system to discourage riding while intoxicated [8].

Smart Helmet

Literature has examined the effectiveness of Bluetooth-enabled communication systems in motorcycle helmets for hands-free communication, navigation assistance, and music playback. These systems offer riders the convenience of staying connected while riding, enhancing communication with passengers or fellow riders [9].

Smart Helmet to Start the Motorbike and to Prevent Accidents

Research has explored the benefits of helmet-mounted cameras for recording rides, documenting road conditions, and providing evidence in legal proceedings. Helmet cameras offer riders a means to capture and share their experiences while promoting accountability and safety on the road [10].

BLOCK DIAGRAM

In this section we are going to know about the flow of the smart helmet. Figure 1 provides a concise visual representation of key components and interaction within this system [11]. This Block Diagram includes following components:

1. *Smart helmet*: It is the central component that integrates various functionalities into a single wearable device, including accident detection, location tracking, and alert messaging. It acts as the primary interface for the user.
2. *Sensor integration*: It includes various sensors like accelerometers, MQ3, GPS and GMS. It monitors movements, impacts, location information, alcohol level, etc.
3. *Alcohol detection system*: This module is responsible for detecting alcohol levels in the user's breath or vicinity. This can include alcohol gas sensor MQ3.

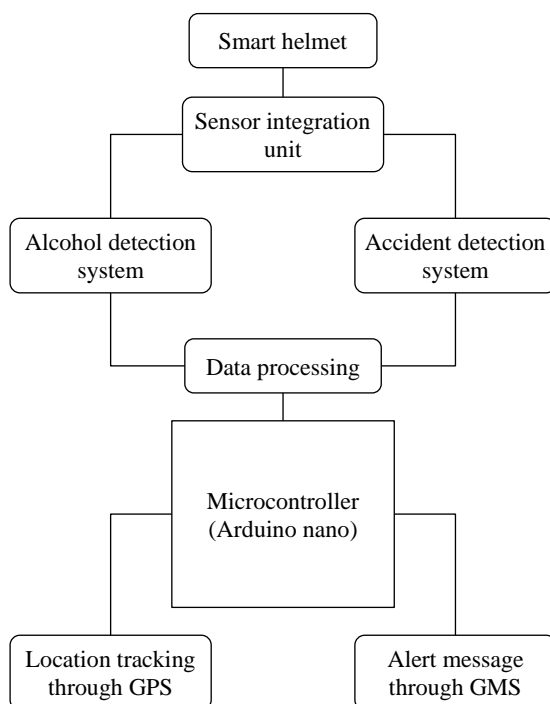


Figure 1. Flowchart of the smart helmet.

4. *Accident detection:* The module is responsible for detecting accidents or impacts. It relies on various sensors to determine if an accident has occurred.
5. *Data processing:* This unit involves processing the location data, possibly performing calculations or conversions, and determining how to use the location information.
6. *Microcontroller:* It is the brain of the system, typically an embedded platform like Arduino and Raspberry Pi. It used to process data from sensors and make decisions based on predefined criteria or algorithm.
7. *Location tracking module:* This module is responsible for tracking the helmet's location. This module gets activated when accident gets detected and sends location of rider to the registered mobile number.
8. *Alert message system:* The alert system may use the location information to trigger alerts or notifications based on predefined criteria, such as notifying emergency contacts or updating the user about their location. This module combines the features of accident detection, location tracking, alcohol detection, and alert messaging into one cohesive unit.

FLOWCHART

This flowchart illustrates the sequence of actions in a Smart Helmet system when an accident or alcohol consumption is detected. In case of an accident, the system dispatches an alert containing the exact location. If alcohol is detected, it sends an additional alert. Otherwise, it continues monitoring the user's activity as shown in Figure 2.

1. The flowchart starts with the user wearing the Smart Helmet, which powers on. And if the helmet is on then it will go on next step that is "Sensor Integration", or else it will stop.
2. The "Sensor Integration" initializes sensors, including accident detection and alcohol detection sensors.
3. First, the system will check whether the rider is consuming alcohol or not. If yes, then the system will automatically send an alert message along with his/her precise location on registered contacts using GPS technology. Or else the system will continue and go on next step that is accident detection.
4. After checking alcohol consumption level of the rider, the system checks for an accident by analyzing sensor data. If an accident is detected, it proceeds to send an alert and then determines the precise location using GPS or other location tracking technology.

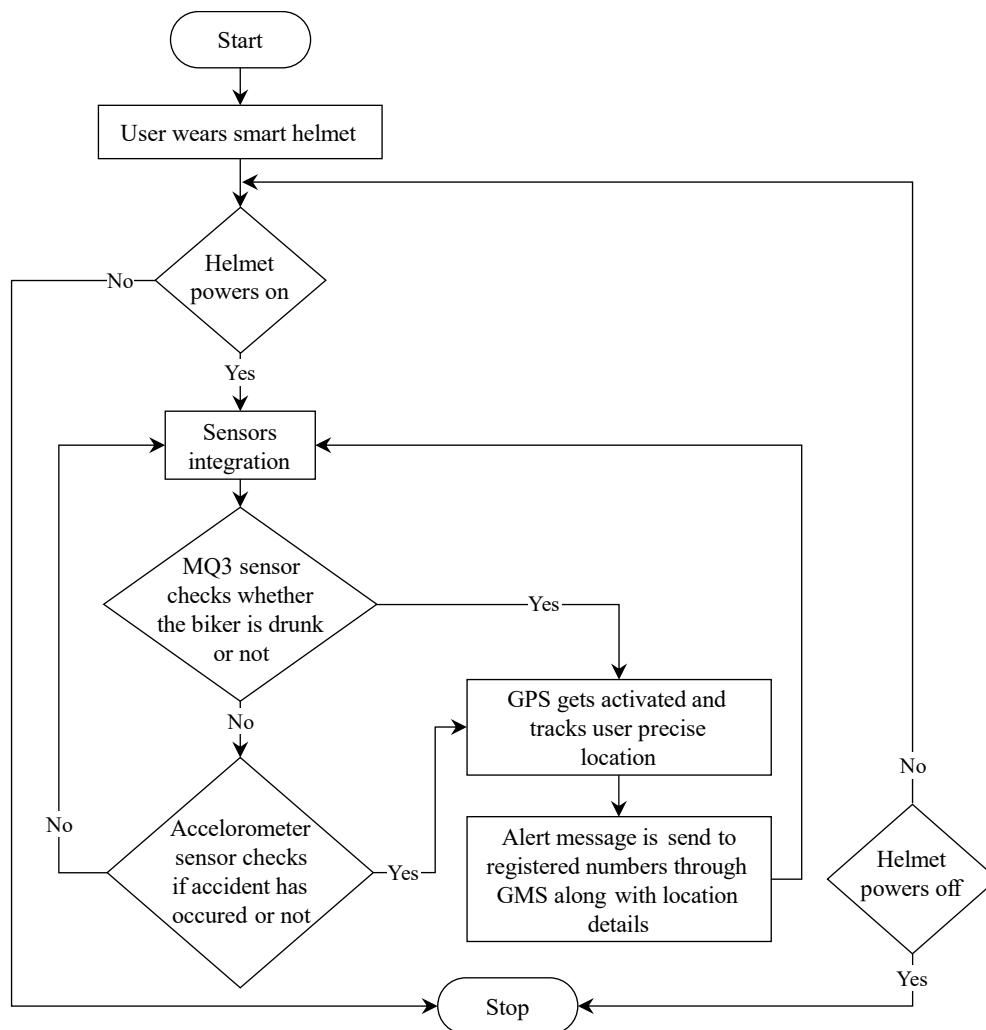


Figure 2. Alcohol detection smart helmet system.

5. If no accident is detected, the system continues monitoring the user's activity.
6. The flowchart will end when the Smart Helmet is powered off.

USE CASE DIAGRAM

A Use Case Diagram is a visual representation of the interactions between users, or A Use Case Diagram illustrates interactions between users or external systems and a software system as shown in Figure 3. It comprises actors, which represent users or systems, and use cases, which represent system functionalities. Relationships like associations, includes, and extends depict interactions and dependencies. It helps stakeholders grasp system functionalities and user interactions, aiding in effective communication and requirements analysis during software development. This diagram provides a clear overview of the functionalities of the Smart Helmet System from both the user's perspective and the system's capabilities, facilitating understanding and communication among stakeholders during the system's development process.

SEQUENCE DIAGRAM

A Sequence Diagram is a form of interaction diagram depicting the interactions among objects or components within a system across time (Figure 4). It delineates the sequence of messages exchanged among these entities to accomplish a particular functionality or scenario. Sequence diagrams provide valuable insights into the interaction flow among system objects, encompassing message exchange order, operational timing, and component relationships.

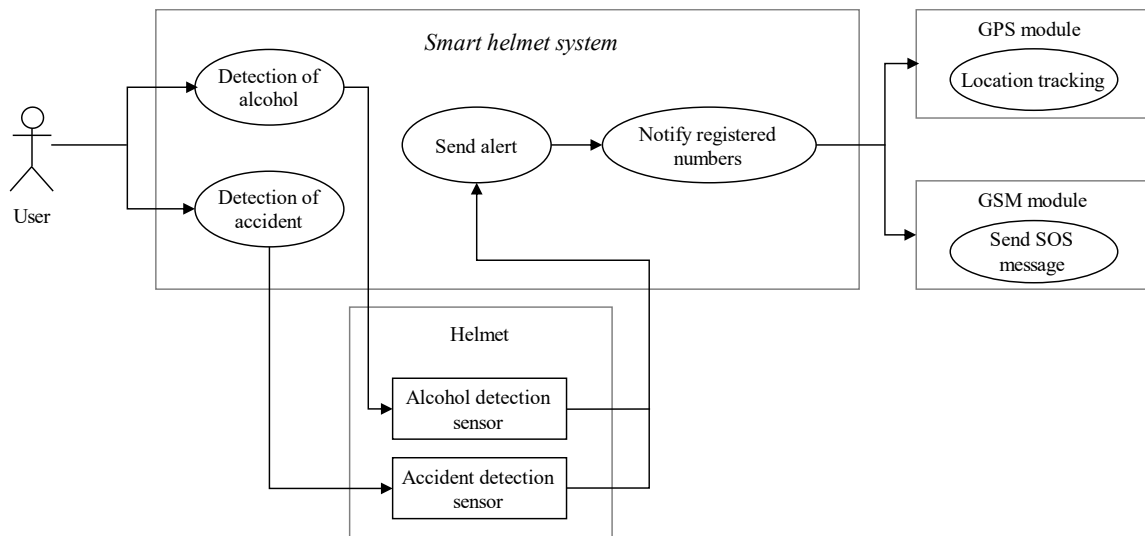


Figure 3. Visual representation interactions between users or external systems and a software system.

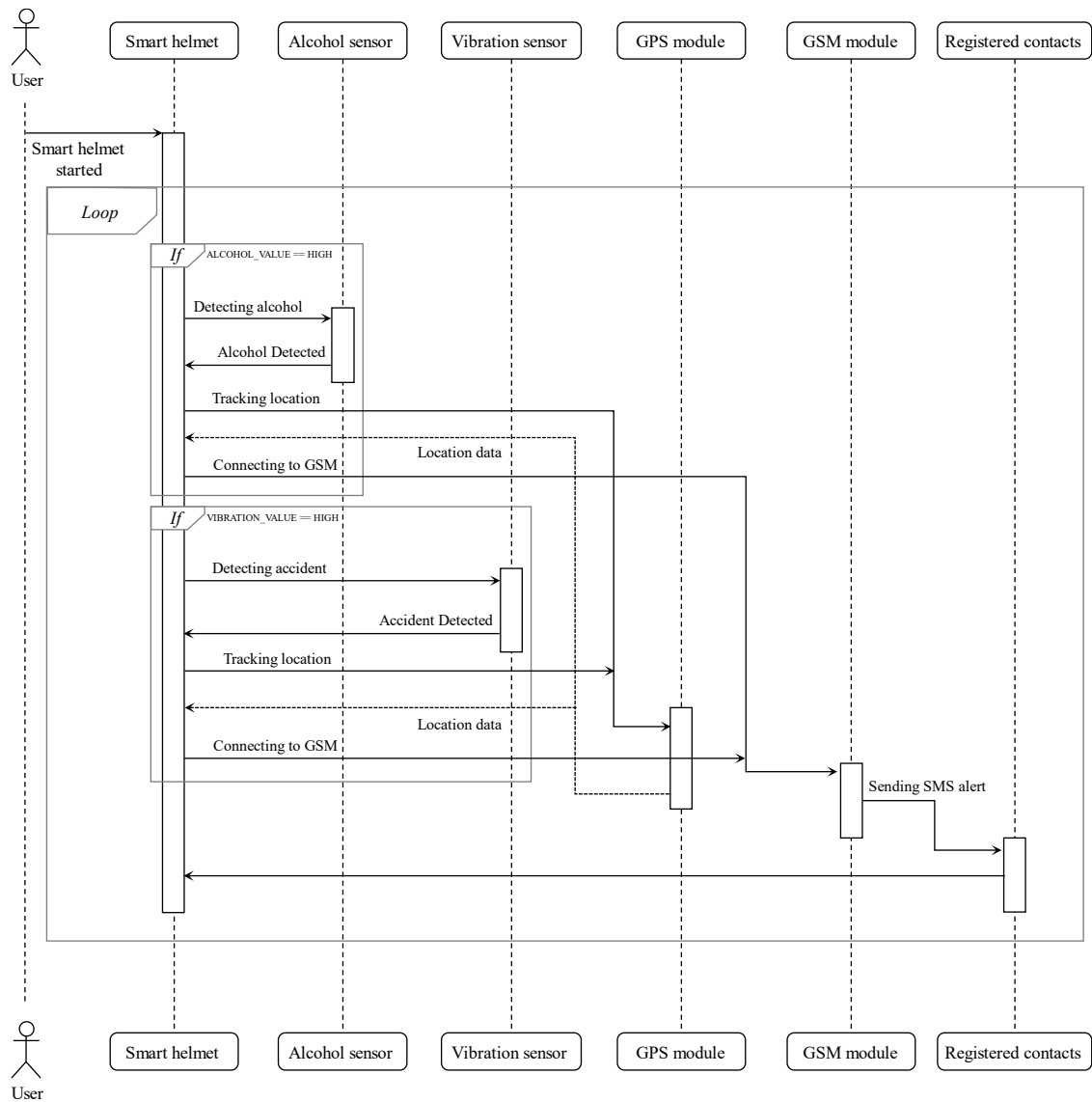


Figure 4. Sequence diagram.

ARCHITECTURE DIAGRAM

An Architecture Diagram, also known as a system architecture diagram or high-level architecture diagram, provides a conceptual overview of the structure, components, and interactions of a system or application. It depicts the architectural structure of the system, outlining its principal components, their interconnections, and their collaborative interactions to achieve the system's functionalities. The Architecture Diagram serves as a blueprint for designing, implementing, and deploying the Smart Helmet system, providing stakeholders with a clear understanding of its structure, functionality, and integration points within the broader ecosystem of wearable technology and IoT devices (Figure 5).

HARDWARE DESCRIPTION

Arduino Nano

In this project, the Arduino Nano microcontroller serves as the central processing unit, coordinating the functionality of various sensors and safety features integrated into the smart helmet as shown in Figure 6. Programmed with algorithms for data processing and control, the Arduino Nano interfaces with sensors such as the MQ3 alcohol sensor, vibration sensor, and GPS Neo6m module.

GPS Module (NEO-6m GPS)

Integrate the GPS Neo-6M module into a smart helmet for accurate location tracking and navigation. Utilize its support for GPS, GLONASS, and Galileo satellite systems for real-time location data, enhancing safety and convenience (Figure 7).

GSM Module (SIM-800)

It enables users to initiate and receive phone calls directly through the helmet, offering a hands-free communication solution. The module can send and receive text messages, which could be useful for notifications, alerts, or simple communication. When combined with a GPS module, it can provide location tracking services. This could be crucial for applications like navigation, emergency response, or tracking the position of users (Figure 8).

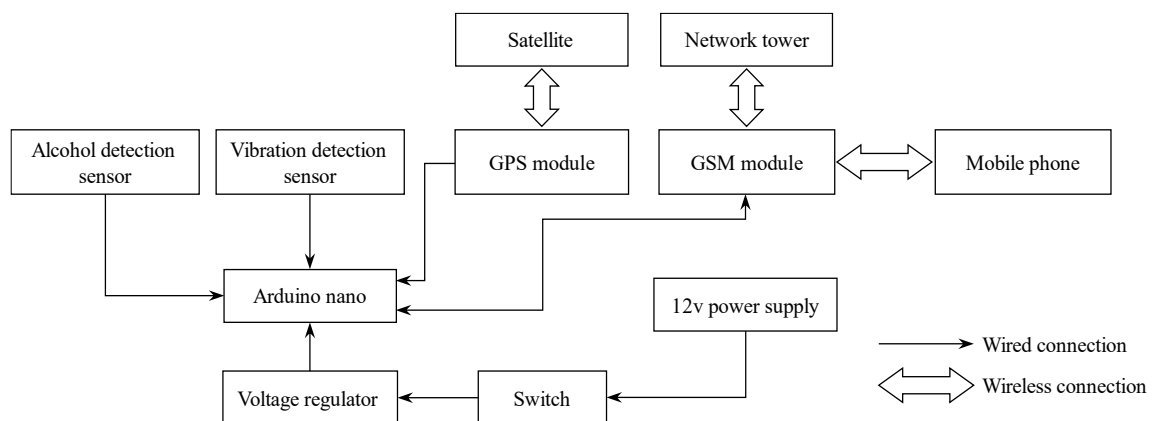


Figure 5. Architecture diagram for designing, implementing, and deploying the smart helmet system.



Figure 6. Arduino Nano.



Figure 7. NEO-6m GPS.



Figure 8. SIM-800.

Alcohol Sensor (MQ-3)

Integrate the MQ-3 alcohol sensor into the smart helmet to detect alcohol levels in the vicinity. Enhance safety by alerting the wearer if alcohol is detected nearby, reducing the risk of accidents caused by impaired individuals (Figure 9).

Vibration Sensor (SW-420)

Incorporate the SW-420 vibration sensor into the smart helmet for detecting movement or impact. Enhance safety by alerting the wearer of sudden shocks or collisions, potentially preventing accidents or injury (Figure 10).

Breadboard

A breadboard serves as a flexible electronic prototyping instrument utilized by engineers and hobbyists for constructing and evaluating electronic circuits sans soldering (Figure 11). It features a rectangular plastic board with an array of holes arranged in a grid pattern, interconnected by conductive metal strips positioned beneath the surface.

PCB Board

It plays a pivotal role in electronic devices, functioning as a foundation for interconnecting diverse electronic components. PCBs are composed of a non-conductive substrate material (often fiberglass) with conductive pathways etched or printed onto the surface to create the necessary connections between components (Figure 12).

Buzzer

Buzzer is a component that emits sound to provide alerts and feedback to the wearer. It can warn about safety hazards, indicate incoming communication, assist with navigation, confirm actions, and alert about system status (Figure 13).



Figure 9. Alcohol sensor (MQ-3).

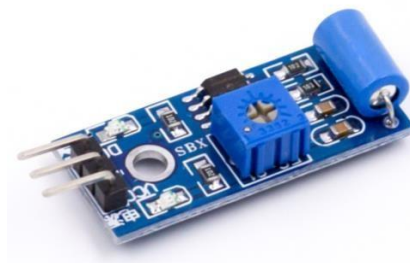


Figure 10. Vibration sensor (SW-420).

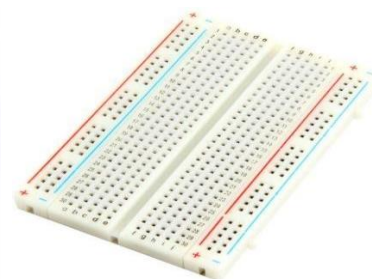


Figure 11. Breadboard.

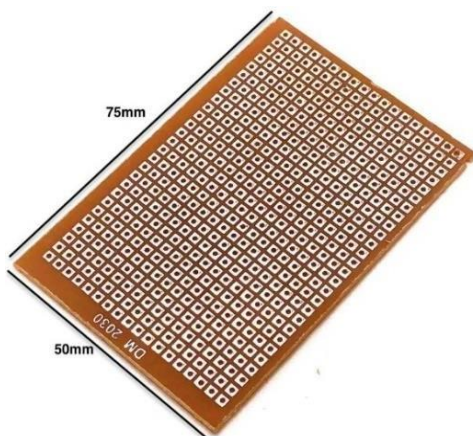


Figure 12. PCB board.



Figure 13. Buzzer.

Jumping Wires

“Jumping wires” commonly denote short wires employed to establish electrical connections between two points on a circuit board or electronic component. They are often used as a quick fix or workaround when a permanent connection is needed but cannot be made through the regular circuitry due to design constraints, errors, or modifications (Figures 14 and 15).

Toggle Switch

A “toggle on-off switch” is a specific type of toggle switch commonly used to control the power supply to electrical devices (Figure 16).

Voltage Regulator (7805)

The 7805 voltage regulator is an integrated circuit engineered to uphold a consistent output voltage amidst fluctuations in input voltage and load. Specifically, the 7805 functions as a positive voltage regulator, guaranteeing a steady +5 V output, rendering it widely favored for powering diverse electronic components and circuits (Figure 17).

Traditional Helmet

A traditional helmet is a safety headgear with a hard outer shell and an impact-absorbing liner, designed to protect the head during activities like cycling, motorcycling, and construction work. It offers fundamental head protection against impacts and falls (Figure 18).



Figure 14. Jumping wires.



Figure 15. Circuit board or electronic component.



Figure 16. Toggle switch.

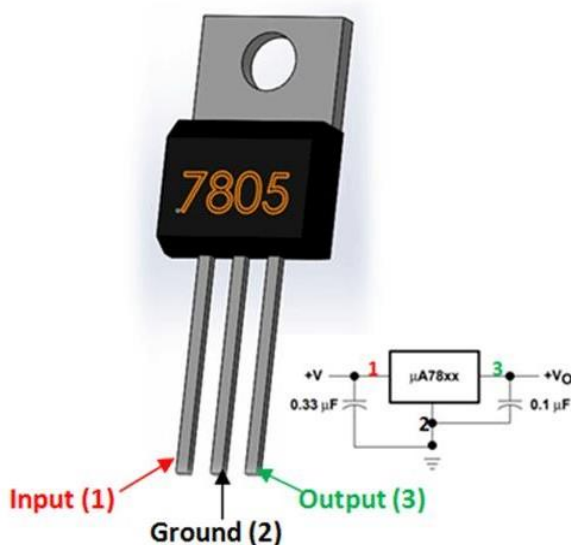


Figure 17. Voltage regulator (7805).



Figure 18. Traditional helmet.

WORKING AND IMPLEMENTATION

Working

Component Integration

1. Connect the Arduino Nano to the MQ3 Alcohol Sensor, Vibration Sensor (SW-420), Buzzer, GPS Neo-6M Module, and GSM 8001 Module.

Alcohol Detection

1. Continuously monitor the MQ3 sensor for alcohol levels.
2. If alcohol concentration surpasses a predefined threshold, activate the buzzer to warn the user.

Impact Detection

1. Utilize the vibration sensor to detect sudden movements or impacts.
2. Upon detecting a significant impact, trigger the GPS module to record the helmet's location.

Emergency Alert System

1. Integrate the GSM module to send emergency alerts.
2. Compose a message containing the GPS coordinates and predefined emergency message.
3. Send the message to predefined contacts via SMS or initiate a call for assistance.

Testing and Calibration

1. Conduct thorough testing to ensure all components function correctly.
2. Calibrate sensors and modules to optimize performance and minimize false alarms.
3. Test various scenarios, including alcohol detection, impact detection, and emergency alert functionalities.

Safety and Reliability

1. Ensure the helmet is durable, waterproof, and shock-resistant.
2. Secure components using reliable mounting methods to prevent disconnections.
3. Regular maintenance and inspection are necessary to ensure continued reliability.

By integrating these components and functionalities, the smart helmet can effectively enhance user safety by detecting alcohol levels, monitoring for accidents, and sending timely emergency alerts when required. Regular testing and maintenance ensure the helmet remains reliable in real-world situations.

Implementation

To implement the smart helmet, begin by integrating the alcohol sensor, accelerometer, GPS module, GSM module, LEDs, and buzzer with a microcontroller like Arduino. Develop firmware to read alcohol levels, monitor helmet movements for accidents, track GPS location, and send GSM notifications. Test the system thoroughly for accuracy and functionality, calibrating sensors as needed.

Design a user-friendly interface, possibly an LCD display or smartphone app, for feedback. Ensure the safety of the helmet by preserving its structural integrity and adhering to safety regulations. Educate users on proper usage and understanding of alerts.

Consistent maintenance and regular updates are imperative to uphold the system's reliability and efficacy. This concise approach ensures a streamlined implementation process, resulting in a smart helmet capable of detecting alcohol levels, accidents, and providing timely notifications to enhance user safety.

OUTPUT AND RESULT SCREENSHOTS

Proteus 8 Simulation

Unlock the power of circuit design with Proteus 8 Simulation: Seamlessly create, test, and visualize your electronic projects with industry-leading accuracy and ease (Figure 19).

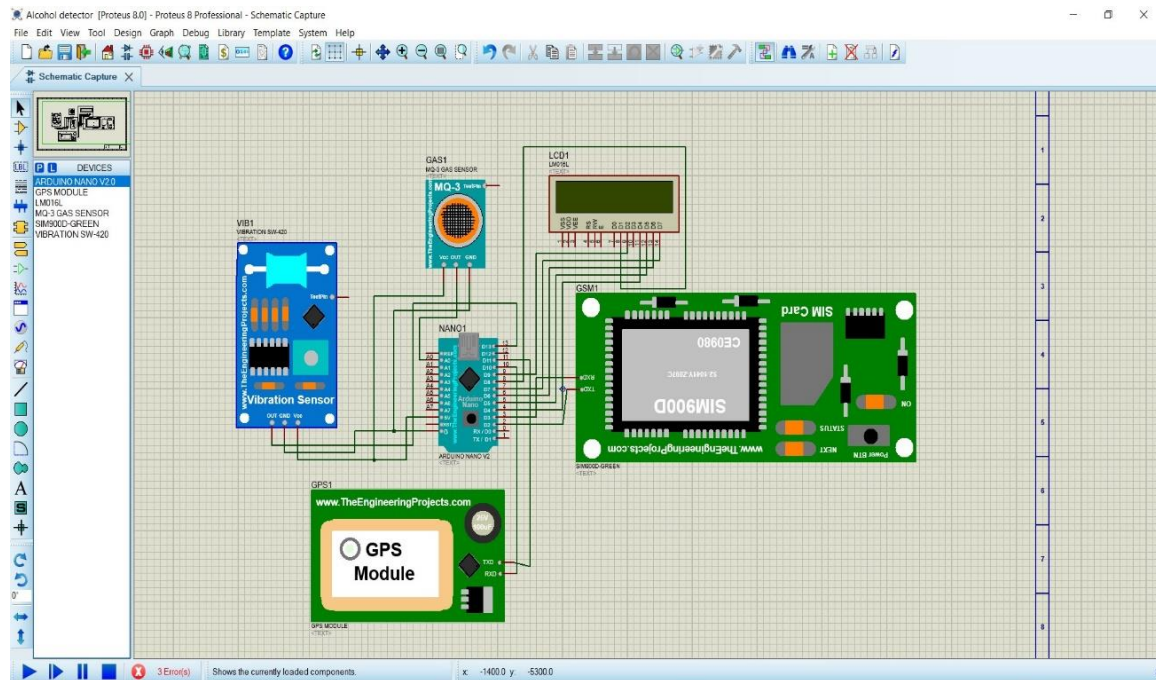


Figure 19. Proteus 8 Simulation.

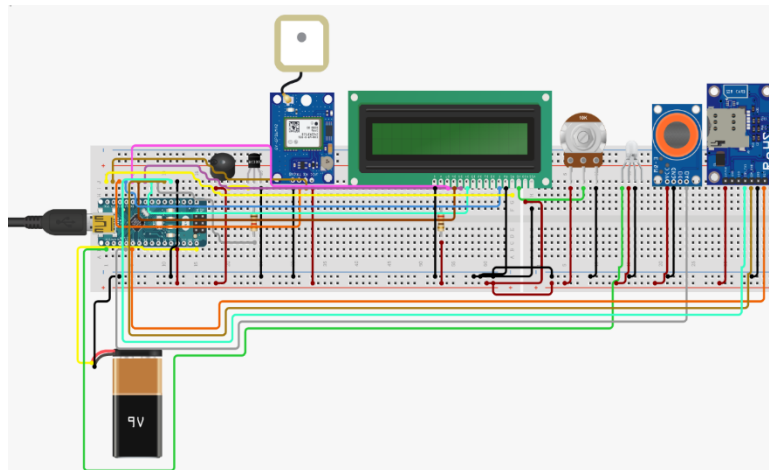


Figure 20. Bread board connections of the complete circuit.

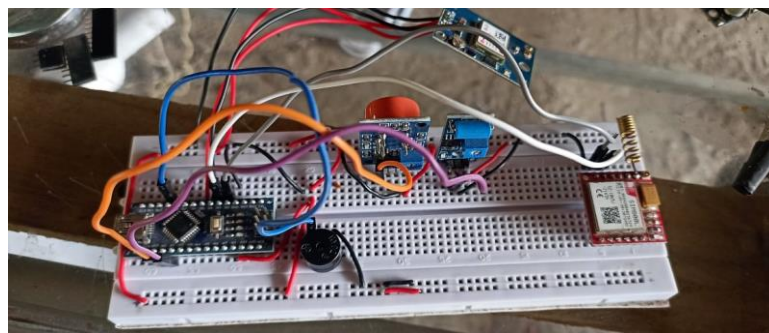


Figure 21. Breadboard connection.

Breadboard Connection

Ensure all components are firmly inserted into the breadboard, maintaining a clear and organized layout to avoid cross-connections and ensure reliable circuit functionality (Figures 20 and 21).

Final PCB Connection

Ensure all components are securely soldered, verify proper alignment of all pins, and double-check connections for continuity before powering up the board (Figure 22(a) and (b)).

Alert Message Notification

Immediate action required! Please check your system for critical updates (Figure 23).

Rider's Current Location on GMAP

Tracking real-time position for seamless navigation (Figures 24 and 25).

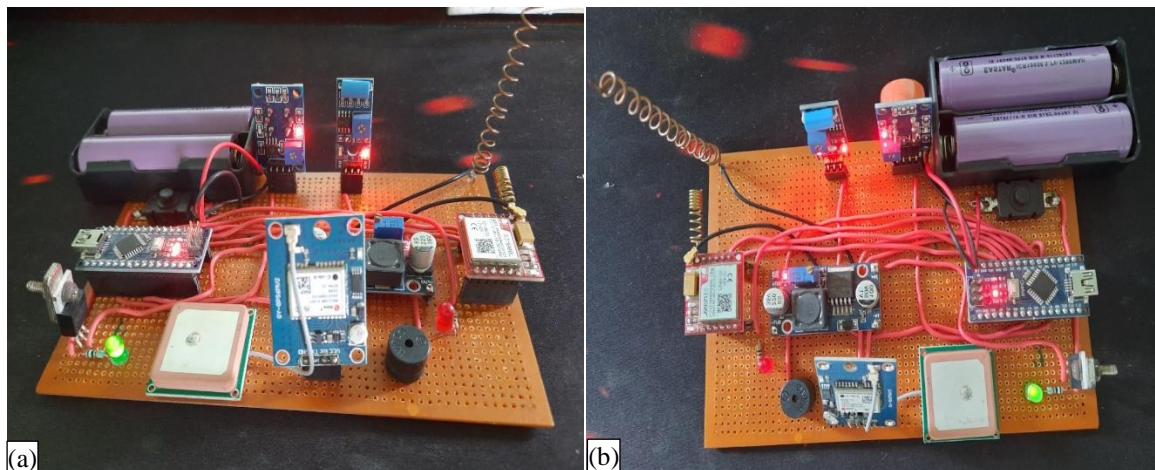


Figure 22. (a) Screenshot of final PCB connection (Front), (b) Screenshot of final PCB connection (Top).

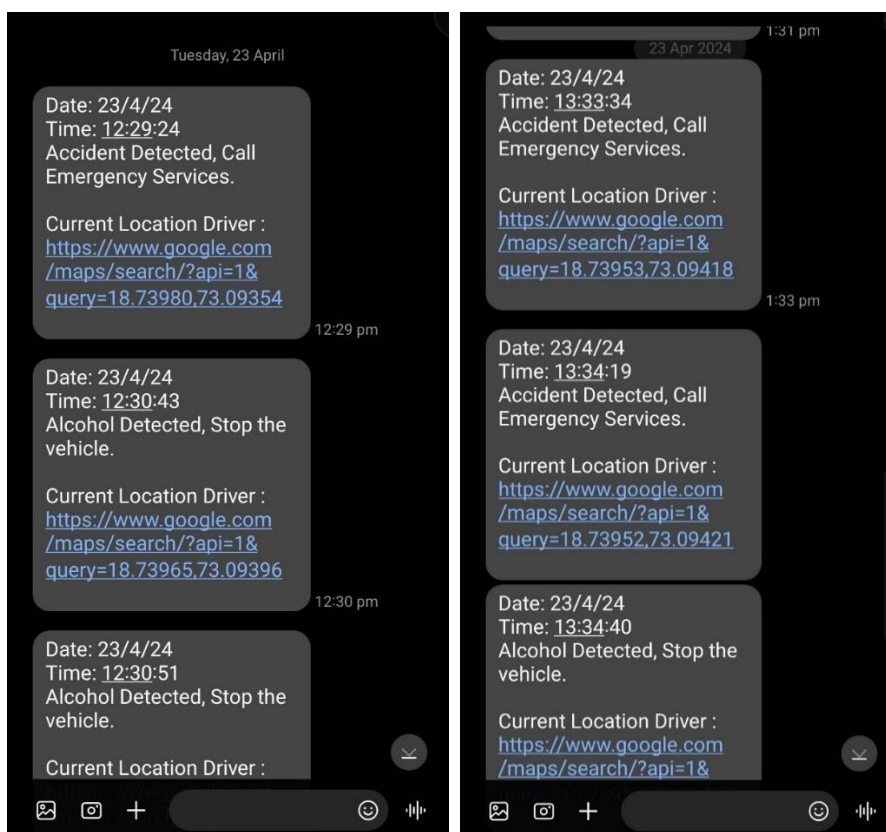


Figure 23. Alert message notification.

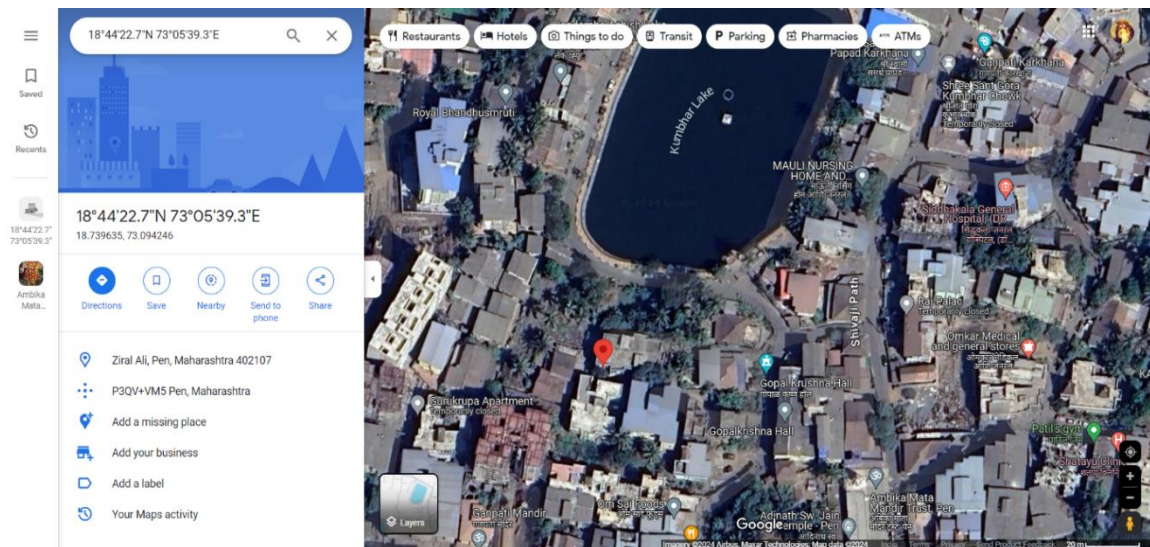


Figure 24. Rider's current location on GMAP (top view).

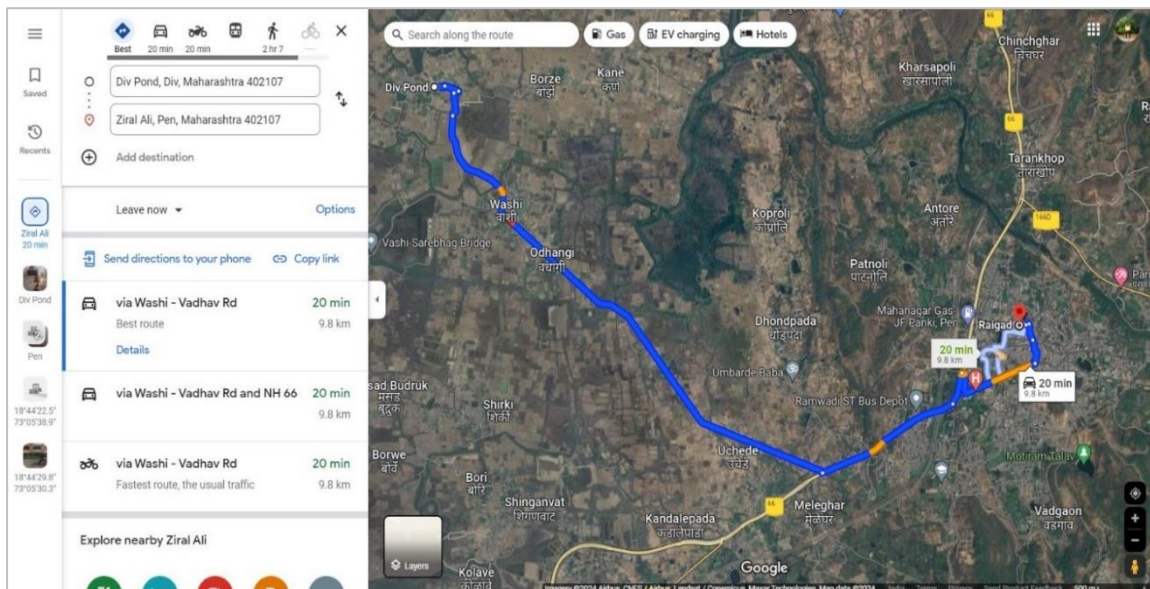


Figure 25. Rider's current location on GMAP (Route).

CONCLUSION

In conclusion, the development of the smart helmet integrating alcohol detection, accident sensing, GPS tracking, and GSM notifications represents a significant advancement in enhancing user safety. Through the integration of various hardware components and meticulous programming, the smart helmet provides a reliable solution for detecting alcohol levels and accidents, as well as tracking the user's location in real-time.

By prioritizing simplicity, accuracy, and user-friendliness, the project ensures that users can easily understand and utilize the features of the smart helmet. Moreover, compliance with safety regulations and continuous maintenance guarantee the helmet's effectiveness and reliability over time.

Ultimately, the smart helmet serves as a proactive measure to mitigate risks associated with alcohol consumption and accidents, thereby promoting a safer environment for users. With further advancements and refinements, this technology has the potential to significantly impact road safety and improve overall well-being.

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