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IOT BASED OF SMART AND SAFETY HELMET FOR RIDERS

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Abstract: The Smart Helmet System is an embedded and IoT-based safety solution designed to enhance two-wheeler rider protection and accident prevention. The system integrates multiple sensors and communication modules with a microcontroller-based architecture to ensure real-time monitoring and intelligent decision-making. The core of the system is a microcontroller (such as Arduino Uno), which interfaces with various modules including an alcohol sensor (MQ-3), a GPS module for location tracking, and for wireless communication. A helmet-wearing detection mechanism (using an IR sensor or pressure switch) ensures that the ignition system is enabled only when the rider wears the helmet. The alcohol detection subsystem continuously monitors the rider's breath alcohol concentration. If the measured value exceeds a predefined threshold, the control algorithm disables the ignition system, thereby preventing the vehicle from starting. The GPS module provides real-time geolocation data (latitude and longitude), which is transmitted for tracking and emergency response. The Blynk app displays parameters such as helmet status, alcohol detection level, and live GPS location (latitude and longitude). Additionally, a solar energy harvesting unit is incorporated to supplement power requirements, improving energy efficiency and system sustainability. The system operates through a rule-based control algorithm implemented in Embedded C, ensuring low latency and reliable performance. By combining sensor fusion, wireless communication, and automation, the Smart Helmet system offers a robust and scalable approach to improving road safety and reducing accident risks.

Keywords:
- Smart helmet system,
- Internet of Things (IoT),
- embedded systems,
- Arduino Uno,
- MQ-3 alcohol sensor,
- GPS tracking,
- ignition interlock,
- rider safety,
- solar energy harvesting.

I. INTRODUCTION

The rapid advancement of Internet of Things (iot) technology has significantly transformed the way devices interact and communicate in real-time environments. Iot enables smart connectivity between physical devices, allowing them to collect, process, and exchange data efficiently. In recent years, this technology has been widely adopted in various sectors such as healthcare, transportation, and smart systems. One of the major areas where iot plays a crucial role is in enhancing road safety. With the increasing number of two-wheeler accidents, there is a growing need for intelligent safety solutions. Traditional helmets provide only physical protection and lack advanced safety features. To overcome this limitation, the concept of a smart helmet has been introduced. The iot-based smart and safety helmet integrates embedded systems, sensors, and communication modules to improve rider safety. It uses sensors such as alcohol sensors and helmet detection sensors to monitor the rider's condition.

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Figure.1: The IoT-based smart and safety helmet

The system ensures that the rider is wearing the helmet properly before starting the vehicle. Additionally, it detects alcohol consumption and prevents vehicle ignition if unsafe conditions are identified. This helps in reducing accidents caused by negligence and drunk driving. The inclusion of GPS technology enables real-time location tracking of the rider, which is useful during emergencies. Wireless communication modules allow the system to send alerts and updates to users through mobile applications. The integration of platforms like Blynk makes the system user-friendly and easy to monitor remotely. Furthermore, the use of solar energy provides a sustainable power source, ensuring continuous operation. Overall, this project demonstrates how iot and embedded systems can be effectively combined to develop a smart safety solution. The iot-based smart helmet not only enhances rider protection but also promotes responsible driving behaviour. It serves as an innovative approach to reduce road accidents and improve emergency response systems, making it highly beneficial for modern transportation safety.

LITERATURE REVIEW

Rajput, R., & Singh, S. (2019),[1] in International Journal of Engineering Research & Technology, proposed a smart helmet system for accident detection and notification. The system used impact sensors and GSM modules to send alert messages to emergency contacts. However, it lacked real-time GPS tracking and advanced IoT integration.

Kumar, K., & Varma, S. (2018),[2] published in International Journal of Innovative Research in Science Engineering and Technology, developed an IoT-based smart helmet using GSM and GPS technologies. Their system enabled real-time location tracking and emergency communication but did not include safety features like alcohol detection.

Patel, M., & Shah, D. (2017),[3] in International Journal of Advanced Research in Computer and Communication Engineering, introduced an accident detection and smart rescue system using IoT. The system focused on rapid emergency response by sending alerts to rescue teams, but it lacked preventive mechanisms for accident avoidance.

Shaikh, S., & Khan, A. (2020),[4] published in International Journal of Scientific Research in Engineering and Management, designed a smart helmet with alcohol detection and bike control system. The system prevented the engine from starting when alcohol was detected, enhancing rider safety, but it did not support GPS tracking or cloud-based monitoring.

The World Health Organization (2021),[5] report highlights that road traffic accidents are a major global concern and emphasizes the importance of safety systems like helmets to reduce fatalities.

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The National Highway Traffic Safety Administration (2020),[6] report stresses the significance of helmet usage and advanced safety technologies in reducing motorcycle-related deaths and injuries.

METHODOLOGY

The Smart Helmet System is an embedded and IoT-based safety solution developed to enhance the protection of two-wheeler riders. It integrates multiple sensors, communication modules, and control mechanisms to ensure safe riding conditions and real-time monitoring. The system combines both hardware and software components to detect helmet usage, monitor alcohol levels, track location, and provide alerts during emergency situations. The core unit of the system is a microcontroller such as Arduino or ESP8266, which coordinates all operations and processes the data obtained from different sensors. The helmet is equipped with a wear detection sensor, such as an IR or pressure sensor, which verifies whether the rider is wearing the helmet. If the helmet is not detected, the system restricts the ignition of the vehicle, thereby enforcing safety compliance. An alcohol detection sensor (MQ-3) is also integrated to measure the alcohol level in the rider's breath. If the detected value exceeds a predefined safe limit, the system prevents the engine from starting, reducing the risk of accidents caused by drunk driving. A GPS module is incorporated to continuously track the rider's location by providing real-time latitude and longitude data. This information is transmitted to a mobile application using an IoT platform such as Blynk, allowing users to monitor the rider's location remotely. The system also includes a buzzer that generates audible alerts during emergency conditions to attract nearby attention. To ensure uninterrupted operation, the helmet is powered by a battery supported by a solar panel, which provides an efficient and renewable energy source. The system architecture consists of four main blocks: input, processing, communication, and output. The GPS module acts as the input unit, supplying location data to the ESP8266 microcontroller, which serves as the processing unit. The communication block utilizes the inbuilt Wi-Fi module of ESP8266 to transmit data to the Blynk application. The output block includes the buzzer and mobile application, which provide alerts and display real-time information to the user. The hardware components are interconnected effectively to ensure smooth operation. The ESP8266 (NodeMCU) acts as the central controller and manages Wi-Fi communication. The GPS module is connected using software serial pins, while the buzzer is connected to a digital output pin. A battery-based power supply with solar backup is used to maintain portability and continuous functionality. The software implementation is carried out using Arduino IDE with embedded C programming. Essential libraries such as ESP8266WiFi, Blynk, TinyGPS++, and Software Serial are used for connectivity and data processing. The program initializes all components, establishes a Wi-Fi connection, and continuously communicates with the Blynk server to update real-time data. The working process begins when the system is powered ON, followed by the ESP8266 connecting to the Wi-Fi network. The GPS module starts receiving satellite signals and transmits data in NMEA format. This data is decoded using the TinyGPS++ library to extract latitude and longitude values, which are then sent to the Blynk application. The user can monitor these coordinates through the mobile interface in real time. The IoT communication is established using Blynk virtual pins, where V1 and V2 are used for latitude and longitude, V3 and V4 are used for control inputs, and V5 indicates system status. The system allows users to trigger emergency alerts or manually activate the buzzer through the application. During emergency situations, a notification containing the rider's location and a Google Maps link is sent to the user. The buzzer alert mechanism plays a vital role in safety by generating audible signals during critical conditions, helping to attract attention. The control logic uses variables such as pin1, pin2, and State to manage system operations, prevent repeated alerts, and ensure proper functioning of the alert mechanism. The power supply system includes a rechargeable battery and a solar panel, ensuring reliable operation even in the absence of direct charging. Proper circuit connections with common grounding and voltage regulation are maintained to achieve stable performance. Finally, the system is tested and validated under various conditions, including GPS accuracy, Wi-Fi connectivity, alert response, and real-time monitoring through the Blynk application. The successful testing confirms that the Smart Helmet System operates efficiently and reliably, making it a practical solution for improving rider safety.

Components

ESP 8266

The ESP8266 is a low-cost Wi-Fi enabled microcontroller widely used in Internet of Things (IoT) applications. It combines a microprocessor and an inbuilt Wi-Fi module, allowing devices to connect directly to the internet without

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additional hardware.

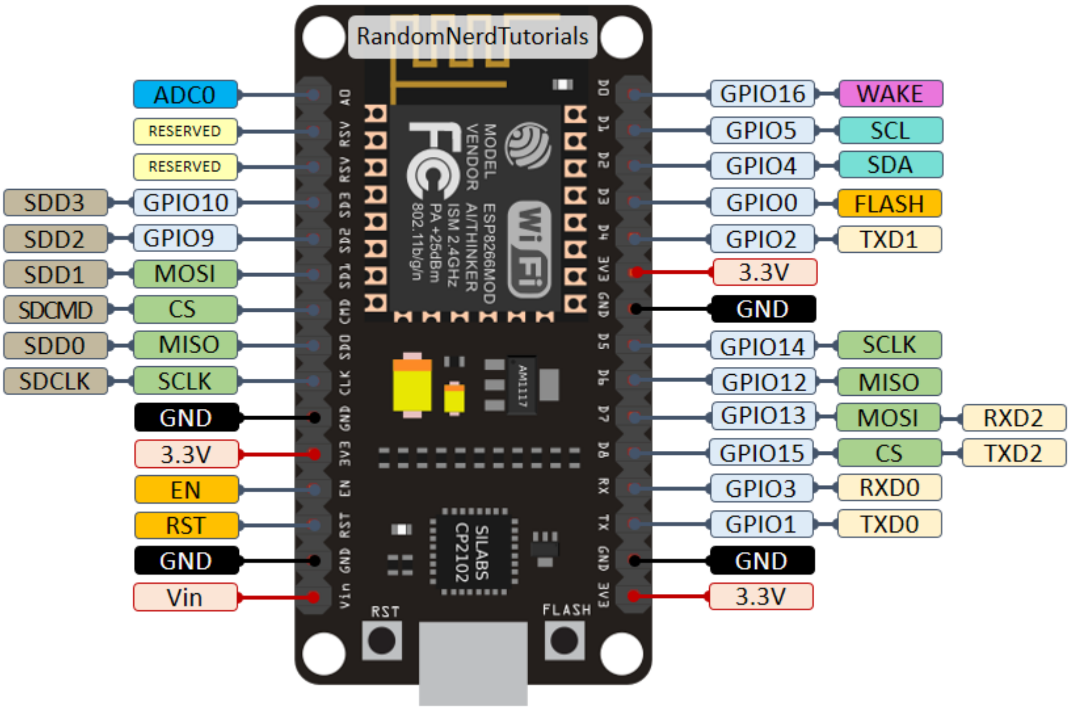

Figure.2: ESP 8266

The ESP8266 can be easily programmed using Arduino IDE with embedded C language, making it suitable for beginners and developers. It supports serial communication and can interface with various sensors and modules for real-time data processing. Due to its compact size, low power consumption, and efficient performance, it is ideal for embedded systems such as smart helmet applications.

GPS Module

The GPS module is used for real-time location tracking in the system. It provides essential location data such as latitude and longitude coordinates. The module continuously receives signals from satellites to determine the exact position. It communicates with the ESP8266 microcontroller using serial communication. This makes it highly useful for emergency location sharing and monitoring purposes.

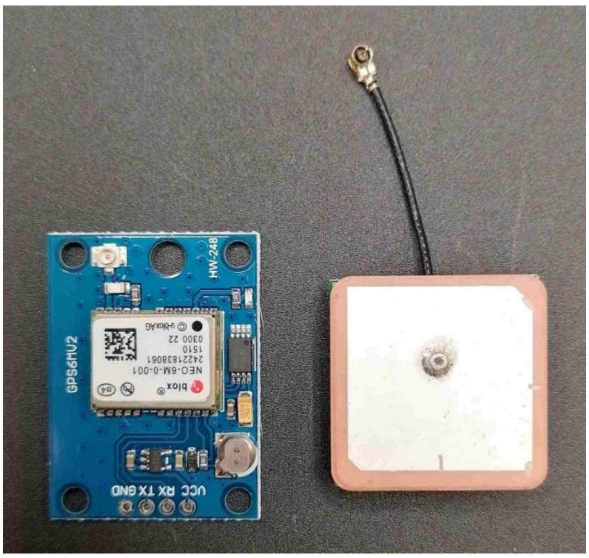

Figure.3: **GPS Module**

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Buzzer

The buzzer acts as an important alert system in the smart helmet. It produces a sound whenever an emergency situation is triggered or when a manual alert is activated by the user.

Figure.4: **Buzzer**

This immediate audio signal helps in drawing attention to critical situations. It is useful in notifying nearby people about accidents or unsafe conditions. Additionally, the buzzer serves as a warning indicator to enhance overall safety and awareness.

DC MOTOR WITH WHEEL

The DC motor with wheel is used to provide motion in the system. It converts electrical energy into mechanical rotation to drive the wheel. The motor enables controlled movement based on input signals from the controller. It ensures smooth and efficient operation of the mechanism. This component is essential for mobility and demonstrates practical motion control in the system.

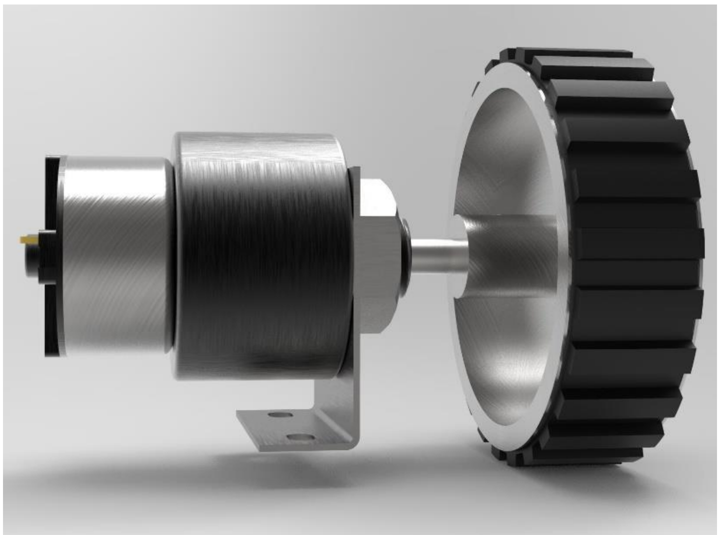

Figure.5: DC MOTOR WITH WHEEL

3S BATTERY PACK (LI-ION) WITH HOLDER

The 3S Li-ion battery pack with holder is used as the main power source for the system. It consists of three lithium-ion cells connected in series to provide higher voltage output.

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Figure.6: **3S BATTERY PACK (LI-ION) WITH HOLDER**

The holder ensures secure placement and easy replacement of the batteries. It supplies stable and reliable power to all electronic components. This battery pack enhances portability and ensures continuous system operation.

Power Switches

Figure.7: SWITCH (ON/OFF)

The rocker switch is used to control the power supply in the system. It allows the user to easily turn the device ON or OFF. The switch operates by pressing one side to complete or break the circuit. It is simple, reliable, and user-friendly in operation. This component ensures safe and convenient control of electrical flow.

MQ-3 ALCOHOL DETECTING SENSOR

The MQ-3 alcohol sensor is used to detect the presence of alcohol in the rider’s breath. It operates based on changes in resistance when exposed to alcohol vapors.

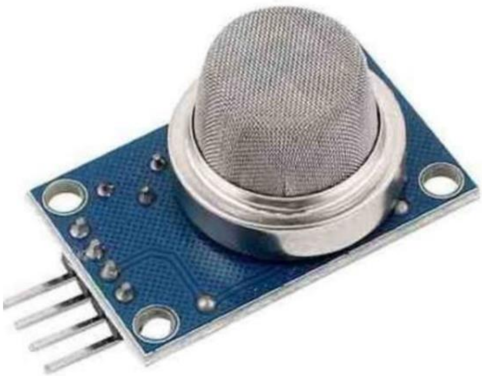

Figure.8: MQ-3 ALCOHOL DETECTING SENSOR

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The sensor provides an analog output that can be read by a microcontroller. It is highly sensitive and suitable for breath analysis applications. This component helps in preventing drunk driving by enabling safety mechanisms in the system.

Solar Pannel

The solar panel is used to generate electrical energy from sunlight. It converts solar energy into usable electrical power through photovoltaic cells. This power is used to charge the battery or run the system directly. It makes the system energy-efficient and environmentally friendly. The solar panel ensures continuous operation by utilizing renewable energy.

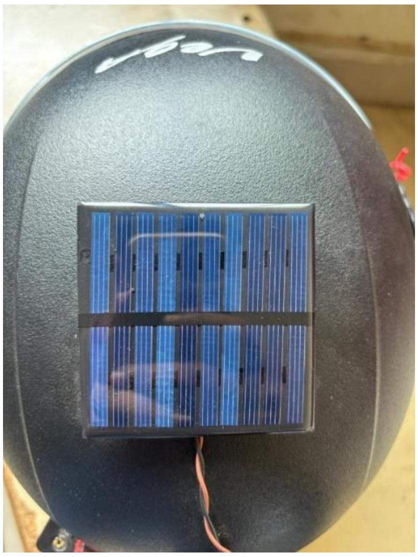
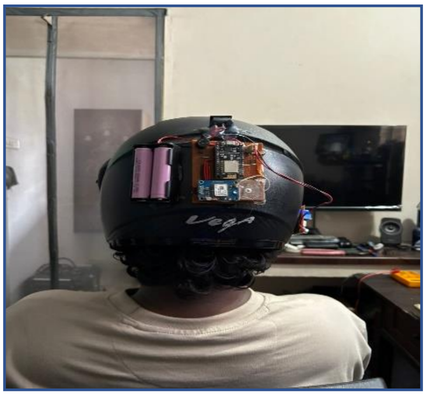


Figure.9: solar Pannel

RESULTS

The IoT-based smart and safety helmet was successfully designed, implemented, and tested under various conditions, showing reliable overall performance. The system effectively performed real-time GPS tracking by continuously capturing and transmitting latitude and longitude to the Blynk application. IoT communication using the ESP8266 remained stable, ensuring smooth data transfer and remote monitoring with minimal delay. The alert system functioned efficiently, generating notifications with location details and activating the buzzer during emergencies.



Manual control through the Blynk app worked accurately, allowing users to trigger alerts and monitor system status. The MQ-3 alcohol sensor successfully detected alcohol levels and initiated safety actions when thresholds were exceeded. The power supply system, supported by a rechargeable battery and solar panel, provided continuous and stable operation. All hardware components were well integrated and worked without major conflicts. However, minor limitations such as GPS dependency, Wi-Fi availability, and environmental factors affecting solar charging were observed. Overall, the system proved to be practical, efficient, and suitable for enhancing rider safety in real-world applications.

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CONCLUSION

The wear detection mechanism ensures that the vehicle can only be started when the rider is wearing the helmet by using IR or pressure sensors, thereby promoting safe riding habits and reducing the risk of head injuries. The MQ3 alcohol detection sensor adds an extra layer of safety by preventing the engine from starting if alcohol is detected, helping to reduce accidents caused by drunk driving. The integration of a GPS module enables real-time location tracking through the Blynk application, allowing users to monitor coordinates and receive alerts via Gmail for easy tracking and security. Additionally, the use of solar power makes the system energy-efficient and sustainable, reducing dependence on external charging sources while improving overall system reliability.

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