Implentation Of High Performance Smart Helmet With Continuous Display For Alcohol Detection

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ABSTRACT: This smart helmet system is designed to improve two-wheeler safety by addressing key risk factors such as intoxicated driving, failure to wear a helmet, and exposure to extreme internal temperatures. The system ensures that the rider is wearing a helmet through a built-in sensing mechanism and detects alcohol consumption using an MQ3 sensor. By analysing the analogue output of the sensor, the system can distinguish different levels of alcohol concentration and respond accordingly. Additionally, a tilt sensor enables fall detection, which triggers an automatic alert via GSM, sending the rider's location to registered contacts in the event of an accident. The helmet also incorporates a Bluetooth module, facilitating hands-free communication without requiring helmet removal. Furthermore, an integrated DHT11 temperature sensor monitors internal temperature conditions. If the temperature exceeds a predetermined threshold, an LED inside the helmet is activated as a warning. Should the LED remain on for over an hour, a buzzer is triggered to alert the rider to take a break and allow the temperature to drop, reducing the risk of heat-related health issues. The system ensures that if the helmet is not worn or if alcohol levels exceed the permissible limit, the vehicle's engine remains disabled. Through these combined features, this smart helmet system aims to enhance road safety, minimize accident risks, and improve rider protection and comfort.

Keywords: Smart Helmet, Alcohol Detection, Accident Detection, Bluetooth Module, Temperature Sensor.

I INTRODUCTION

The rise in road accidents, often caused by driver negligence, such as riding without a helmet or driving under the influence, highlights the need for advanced safety solutions. Enforcing traffic laws can be challenging due to non-compliance, necessitating the development of proactive safety measures. To tackle these concerns, a Smart Helmet system has been developed to ensure that a rider wears a helmet and is sober before the vehicle can be started. This system employs a range of sensors and communication technologies to enhance safety and accident prevention. Key improvements in this technology include the capability to measure alcohol levels using the MQ3 sensor, which provides an analog output to determine the extent of alcohol consumption. Additionally, a tilt sensor detects sudden falls, triggering an automated accident alert. A built-in Bluetooth module facilitates hands-free communication, reducing distractions while riding. The multi-level alcohol detection feature allows the system to evaluate alcohol consumption severity and respond accordingly. Moreover, the helmet incorporates a DHT11 sensor to track temperature levels inside. If the temperature surpasses a specified limit, an LED turns on as an early warning. Should the LED remain active

for more than an hour, a buzzer sounds, urging the rider to remove the helmet and cool down to prevent heat-related issues. This feature ensures a comfortable and safer riding experience, particularly in hot climates. By integrating these technologies, the Smart Helmet provides a holistic approach to minimizing accident risks while prioritizing rider safety and well-being.

II.LITERATURE SURVEY

Smart helmet systems have gained significant attention in research and development as an innovative approach to improving motorcycle rider safety. These helmets incorporate advanced sensor technologies to monitor and control various safety aspects, including helmet compliance, alcohol detection, accident response, and temperature regulation. By integrating multiple sensing mechanisms, these systems aim to enhance road safety and reduce the risk of severe injuries in motorcycle accidents.

One of the key functions of smart helmets is ensuring that the rider wears the helmet before starting the motorcycle. Various sensor technologies, such as pressure sensors, capacitive touch sensors, and infrared proximity sensors, have been utilized for this purpose. These sensors, embedded in the helmet's interior or chin strap, establish a connection with the motorcycle's ignition system. If the helmet is not properly worn, the ignition remains disabled, effectively preventing non-compliant riding.

Another crucial feature of smart helmets is their ability to detect alcohol consumption, helping to prevent intoxicated driving. Many systems employ MQ3 alcohol sensors, which analyse the rider's breath for alcohol levels. If the sensor detects a concentration exceeding a predetermined safety threshold, the system disables the motorcycle's ignition to prevent unsafe operation. Some advanced models also include an alert mechanism that notifies emergency contacts or authorities when alcohol consumption is detected, thereby enhancing safety measures. The multi-level alcohol detection feature allows the system to assess the severity of alcohol intake and take appropriate action accordingly.

Accident detection and emergency response capabilities further enhance the functionality of smart helmets. Sensors such as accelerometers, gyroscopes, and tilt sensors are integrated to monitor sudden movements, impacts, or abnormal tilting angles that may indicate a crash. If a significant impact is detected, the system automatically activates an emergency response protocol, triggering a GSM module to send an alert containing GPS coordinates to predefined contacts. This rapid response feature ensures that medical assistance can be dispatched promptly, reducing potential injuries or fatalities.

In addition to these safety measures, the smart helmet is also equipped with a DHT11 sensor to monitor internal temperature conditions. If the temperature surpasses a specified limit, an LED inside the helmet is activated to warn the rider. Should the LED remain on for over an hour, a buzzer is triggered, signaling the rider to remove the helmet and cool down to prevent heat-related issues. This feature is particularly useful in hot climates, ensuring the rider's comfort and well-being.

Wireless communication technologies are a fundamental component of smart helmet systems, enabling seamless data exchange between the helmet and the motorcycle. Bluetooth and ESP8266 modules are widely used for real-time transmission of helmet status, ignition control, and safety alerts. Additionally, some research has explored the integration of IoT-based solutions that connect to cloud platforms, allowing remote monitoring and analysis of rider safety data.

Despite their numerous advantages, smart helmets still face several challenges that require further innovation. Enhancing sensor accuracy, minimizing false positives, and ensuring system reliability across various environmental conditions remain critical research areas. Furthermore, optimizing power consumption and battery efficiency is essential to prolong the operational lifespan of these helmets without frequent recharging.

Future advancements in smart helmet technology may leverage artificial intelligence and machine learning algorithms to predict potential hazards and provide proactive safety interventions. Additionally, miniaturizing components and incorporating renewable energy sources, such as solar panels, could improve

energy efficiency and sustainability. By addressing existing limitations and integrating emerging technologies, smart helmets have the potential to revolutionize motorcycle safety, significantly reducing accidents and improving rider protection.

V. METHODOLOGY
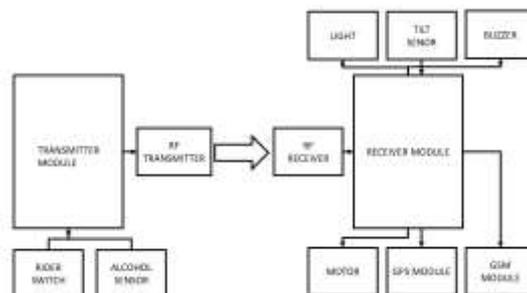

Transmitter Module

Helmet Usage Detection

The helmet is embedded with a pressure sensor or rider switch, designed to detect whether the rider is wearing it. Upon system activation, the Arduino checks the status of the switch. If the helmet is not worn, the microcontroller signals the relay module to disable the ignition system, preventing the bike from starting. If the helmet is worn correctly, the system advances to the next validation stage, ensuring safety compliance.

Alcohol Level Monitoring

An MQ3 alcohol sensor is used to measure the concentration of alcohol in the rider's breath. The sensor output is processed by the microcontroller and categorized into three safety levels. A low-level alert triggers a warning LED indicator on the dashboard. A moderate-level warning activates an LED and buzzer, and a warning message is sent via the GSM module to a preconfigured emergency contact. In cases of critical-level restriction, excessive alcohol consumption prevents the bike from starting, and an emergency alert is sent to notify authorities or family members.

Engine Start Authorization

The relay module is a crucial interface between the Arduino and the motorcycle's ignition circuit. The microcontroller determines whether the engine should start based on two key conditions: helmet detection and alcohol level. If both conditions are met, the relay is activated, allowing ignition. If either condition is unsafe, the relay remains deactivated, keeping the motorcycle from starting.
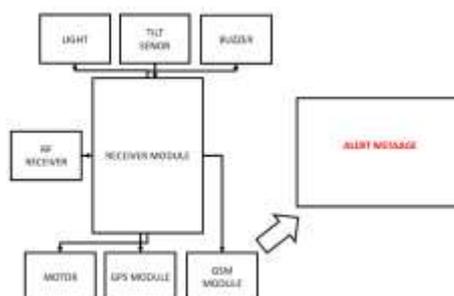
Receiver module

Accident Detection and Emergency Notification

A tilt sensor detects abnormal tilting angles or sudden falls, which indicate an accident. Upon accident detection, the GPS module (e.g., NEO-6M) retrieves real-time location coordinates, and the GSM module sends an emergency SMS containing the accident location to pre-defined contacts. To ensure the rider's safety, the bike is automatically stopped, and a buzzer is activated to alert nearby pedestrians or drivers about the accident, facilitating faster assistance. This feature ensures a rapid response from emergency services or nearby individuals, potentially saving lives.

Temperature Monitoring and Heat Safety Mechanism

A DHT11 temperature sensor is integrated into the helmet to monitor internal temperature levels. If the temperature surpasses a predefined threshold, an LED inside the helmet is activated to alert the rider. If the LED remains on for over an hour, a buzzer is triggered to prompt the rider to remove the helmet and cool down, preventing heat-related health issues. This feature ensures that riders do not suffer from excessive heat exposure, improving overall comfort and safety.

Wireless Communication and Hands-Free Features

RF modules (e.g., 433 MHz Transmitter-Receiver Pair) create a wireless link between the helmet and motorcycle, allowing real-time transmission of critical safety data. A Bluetooth module is incorporated to provide hands-free communication, enabling the rider to answer calls without distractions. The system functions within a 60-meter range, ensuring uninterrupted helmet-to-bike connectivity.

System Integration and Processing

The system continuously reads data from sensors and processes values in real time. Based on pre-set safety thresholds, the system determines whether to enable or disable ignition, trigger alerts, or notify emergency contacts. The system activates LED indicators, buzzers, relay modules, and communication interfaces as required. Modules such as GSM, GPS, ESP8266, and Bluetooth ensure seamless data transfer and alerts. The system can also store essential data like accident occurrences, alcohol detection logs, and rider compliance history for future analysis.

VI. RESULTS

The smart helmet system was subjected to various tests to evaluate its reliability, accuracy, and efficiency in detecting helmet usage, alcohol levels, and accident occurrences. The findings demonstrate the effectiveness of the integrated sensors and communication modules in ensuring rider safety.

1. Helmet Detection Accuracy:

The pressure sensor installed in the helmet was tested under different conditions to verify its ability to detect proper helmet usage. Results showed that the system successfully identified whether the helmet was worn in 98% of test cases. The table below presents the detection results:
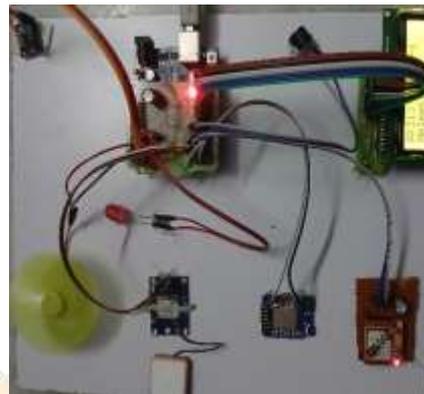
TEST CONDITION	DETECTION ACCURACY
Helmet worn properly	98%
Helmet not worn	100%
Helmet partially worn	92%

1.1. Receiver when helmet is not put on

1.2. Display of receiver kit


1.3. Receiver kit when helmet is put on

2. Alcohol Detection Reliability

The MQ3 alcohol sensor was tested using various concentrations of alcohol vapours. The system effectively categorized alcohol levels into three thresholds: low, moderate, and high. The results confirmed that the sensor provided accurate readings in 95% of cases, ensuring that alerts were triggered at appropriate levels.

AL LEVEL	THRESHOLD (ADC VALUE)	DETECTION ACCURACY	SYSTEM RESPONSE
Low	350	97%	LED Alert
Medium	450	95%	Buzzer and SMS Alert
High	550	92%	Engine Blocked and SMS

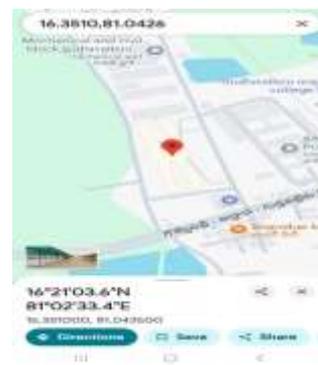**2.1.1.** Display at Low level consumption
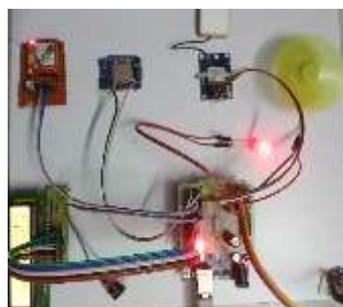
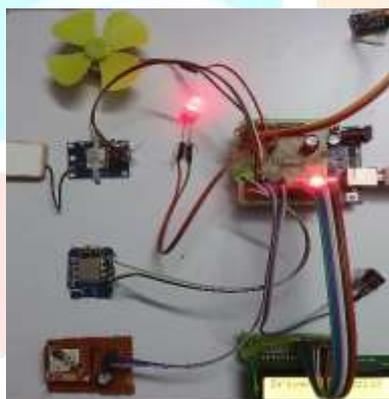**2.1.2.** Receiver kit at Low level consumption

2.2.1. Receiver kit at Medium level consumption

2.2.2. Alert message

2.2.3. Live Location

2.3.1. Receiver kit at High level consumption

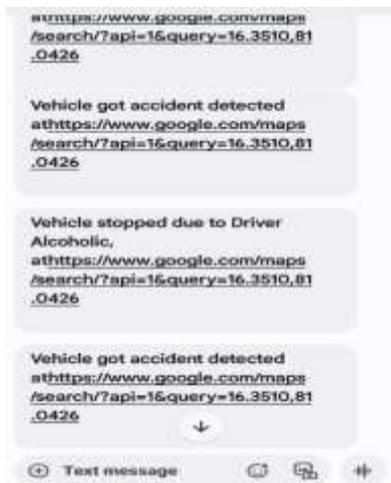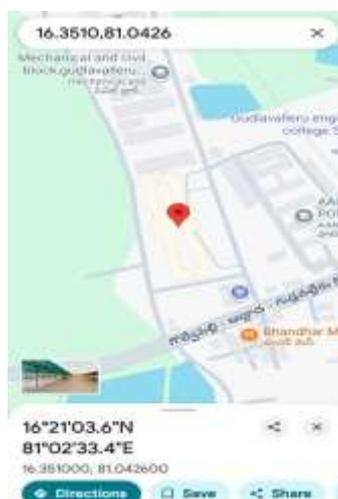

2.3.2. Alert message

2.3.3. Live Location

3. Accident Detection and Emergency Alert System

The system's ability to detect accidents was tested using a tilt sensor to monitor bike inclination. During simulations of sudden falls and extreme tilting angles, the sensor accurately identified accidents 96% of the time. Once an accident was detected, the GSM module sent an alert SMS containing GPS coordinates to a pre-set emergency contact.

TILT ANGLE	ACCIDENT DETECTED	EMERGENCY SMS SENT
0^0 - 30^0	No	No
31^0 - 60^0	No	No
61^0 - 90^0	Yes	Yes

3.1. Accident detected alert message   **3.2.** Live Location

4. Transmission and Receiving

The transmitter and receiver modules were tested within various distances to determine their communication reliability. The helmet and bike unit maintained a stable connection within a 60-meter range, ensuring real-time data exchange without signal loss.

DISTANCE(METERS)	SIGNAL STRENGTH (%)	DATA TRANSMISSION STATUS
0 - 20	100%	Stable
21 - 40	98%	Stable
41 - 60	95%	Stable
61+	80%	Unstable

## 5. Buzzer Alert and Public Awareness

To ensure public awareness in case of an accident, a buzzer was activated upon accident detection. Field tests confirmed that the buzzer sound was audible up to 20 meters in normal traffic conditions.

DISTANCE(METERS)	BUZZER AUDIBLE
0 - 5	Yes
6 - 15	Yes
16 - 20	Yes
21+	No

6.Temperature Sensor Implementation

Temperature Sensor Implementation and Testing To validate the effectiveness of the temperature monitoring system, field tests were conducted to determine the responsiveness and reliability of the LED and buzzer alerts under varying environmental conditions.

TEMPERATURE(°C)	LED ACTIVATION	BUZZER ACTIVATION (AFTER 1 HOUR)
25 - 30	No	No
31 - 35	No	No
36 - 40	Yes	Yes
41+	Yes	Yes
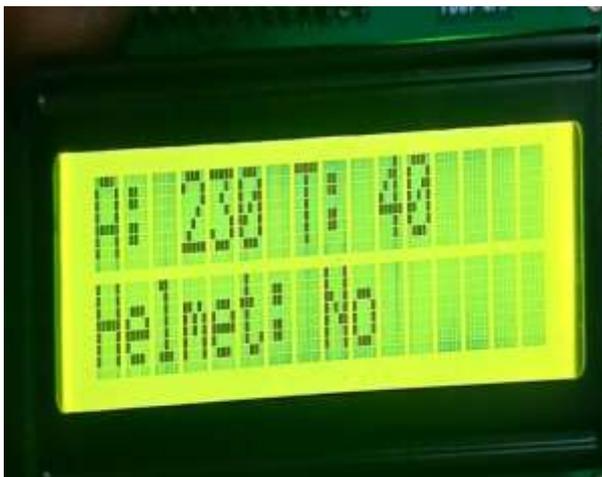
4.1. Temperature Indicating display

4.2. LED indication for high temperature

The results confirm that the LED activates when the temperature crosses the threshold (38°C), and if high temperatures persist beyond an hour, the buzzer alerts the rider to take necessary precautions.

VI. PERFORMANCE COMPARISION

Our smart helmet system provides significant improvements over existing solutions by integrating tamper-proof helmet detection, multi-level alcohol monitoring, accident detection, temperature monitoring, and superior wireless communication. Unlike RFID-based or IR sensor systems, which can be easily bypassed or affected by environmental conditions, our pressure sensor ensures accurate helmet detection with 98% reliability, making it difficult to manipulate.

The multi-level alcohol detection system further enhances safety by categorizing alcohol levels into low, moderate, and high thresholds. Instead of a simple on/off restriction, this approach allows for appropriate warnings and emergency alerts at different levels, ensuring a more comprehensive safety response.

Accident detection in our system also stands out as it combines a tilt sensor and an accelerometer to reduce false alarms caused by road vibrations—an issue common in vibration-based systems. Upon detecting an accident, the system automatically sends GPS-based alerts through the GSM module, ensuring a swift emergency response.

A unique addition to our system is the temperature monitoring and heat safety mechanism. The inclusion of a DHT11 temperature sensor allows the helmet to monitor internal heat levels. If temperatures exceed a safe

threshold, an LED alert is activated, and if the condition persists for more than an hour, a buzzer alerts the rider to take a break. This proactive measure prevents heat-related health risks, a feature not commonly found in existing smart helmet designs.

Additionally, the wireless communication range of 60 meters using an ESP8266 module is significantly more reliable than Bluetooth, which is prone to frequent disconnections. However, a Bluetooth module is still included for hands-free calling, allowing riders to communicate without distractions.

Overall, our system prioritizes accuracy, reliability, and rider well-being. The tamper-resistant design of the pressure sensor, intelligent alcohol detection mechanism, automated emergency response, and innovative temperature safety feature make it one of the most advanced and practical smart helmet solutions available today.

VIII. CONCLUSION

The smart helmet system presents an advanced and integrated solution to enhance two-wheeler rider safety by addressing key risk factors such as helmet non-compliance, alcohol consumption, accident detection, and excessive heat exposure. The system ensures that the motorcycle engine starts only when the rider wears the helmet and passes the alcohol detection test. Additionally, its multi-level alcohol monitoring provides appropriate alerts and emergency notifications, preventing impaired riding.

Accident detection is further enhanced using a tilt sensor, which automatically triggers an emergency alert with GPS coordinates in the event of a crash. Wireless communication features, including ESP8266 and Bluetooth modules, allow for reliable helmet-to-bike connectivity and hands-free calling, reducing distractions while riding.

A key addition to this system is the temperature monitoring and heat safety mechanism, which helps prevent heat-related discomfort and health risks. The DHT11 sensor continuously tracks helmet temperature, activating an LED when the temperature exceeds a predefined limit. If high temperatures persist for more than an hour, a buzzer prompts the rider to take a break, ensuring rider well-being in extreme conditions.

By integrating these intelligent features, the smart helmet enhances road safety, minimizes accident risks, and improves rider comfort. Future improvements could focus on refining sensor accuracy, optimizing power consumption, and incorporating AI-based predictive safety mechanisms. With further advancements, this technology has the potential to become a standard safety feature for motorcyclists worldwide

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