The Intelligent Safety Helmet with Monitoring and Prevention System

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***Abstract*— This smart helmet safety system for two-wheelers enhances rider safety by using a combination of basic electronics, sensors, and AI technology. The system is controlled by an Arduino Nano microcontroller, which manages various components to ensure safe vehicle operation. An alcohol sensor (MQ3) checks for alcohol consumption, and a helmet detection sensor (limit switch) ensures the rider is wearing a helmet. If either condition is not met, the vehicle will not start. An RFID reader scans the rider's license to verify authorization. A camera module with AI-based facial recognition further confirms the rider's identity and checks if they are 18 years or older, based on stored data. If the rider is underage or unauthorized, the ignition remains locked. In case of an accident, a vibration sensor detects the impact, and the GPS and GSM modules send the rider's location to emergency contacts. This system ensures safer rides and faster emergency response through smart automation.**

Keywords: face detection, Accident Prevention, Alcohol Detection, GSM, RF transceiver, RF receiver.

I. INTRODUCTION

RF Smart Helmet Ignition System with Enhanced Safety Features Road accidents are a significant global concern, often resulting in severe injuries and fatalities. A substantial portion of these accidents involve two-wheelers, and factors like drunk driving, underage riding, and the absence of timely post-crash assistance contribute significantly to the severity of the outcomes. To address these critical issues, this project proposes an RF Smart Helmet Ignition System that integrates multiple safety features: Alcohol Detection, Under 18+ Detection, and Crash Detection based on GSM and GPS. This system aims to enhance rider safety and prevent accidents by proactively addressing key risk factors and ensuring timely emergency response during crashes. By combining Radio Frequency Identification (RFID) for user identification and helmet verification, an alcohol sensor for preventing intoxicated riding, and GSM/GPS technology for crash detection and location tracking, this smart helmet system offers a comprehensive approach to motorcycle safety.

The core functionalities of the proposed system are:

- **RF-Based Ignition Control:** The system utilizes RFID technology to ensure that only authorized users wearing a designated smart helmet can start the motorcycle. This helps prevent theft and unauthorized use.
- **Alcohol Detection:** An alcohol sensor integrated into the helmet detects if the rider has consumed alcohol above a predefined limit. If alcohol is detected, the ignition system is disabled, preventing the rider from starting the vehicle.
- **Under 18+ Detection:** The RFID tag associated with the helmet can be linked to the rider's age. The system can be programmed to prevent ignition if the detected age is below the legal driving age.
- **Crash Detection:** An accelerometer within the helmet detects sudden impacts indicative of a crash.
- **GSM-Based Alert System:** Upon detecting a crash, the system automatically sends an SMS alert containing the rider's location to per-defined emergency contacts (e.g., family, friends, emergency services).
- **GPS-Based Location Tracking:** The integrated GPS module provides accurate location coordinates, which are included in the SMS alert, enabling quick and precise emergency response.

FINAL STAGE

1.System Integration:

Hardware Integration: Connecting all the sensors (RF receiver, alcohol sensor, potentially a weight/pressure sensor for under 18 detection, accelerometer/gyroscope for crash detection, GPS module, GSM module), micro-controllers (one in the helmet, one on the bike), and the ignition system. Ensuring proper wiring, power supply, and signal transmission between components.
Software Integration: Combining the code for each module (helmet detection, alcohol detection, age detection, crash detection, GPS tracking, GSM communication, and ignition control) into a cohesive program running on the micro-controllers. This involves managing data flow, communication protocols, and timing.

2. CALIBRATION AND TESTING:

Sensor Calibration: Fine-tuning the alcohol sensor for accurate readings, calibrating the vibration sensor for reliable crash detection, and ensuring accurate GPS readings.
Camera Calibration: Testing the under-18 and face detection (if implemented) to prevent ignition for underage riders.
Vibration Sensor: Simulating crashes to ensure the crash detection triggers, GPS coordinates are obtained, and an SMS is sent via GSM.

Rf Transmitter & Receiver: Testing the range and reliability of the RF communication between the helmet and the bike.

This integrated system offers a significant step towards improving motorcycle safety by preventing accidents caused by impaired riding and ensuring rapid assistance in case of a crash. It leverages readily available and cost-effective technologies to create a practical and impact solution for riders and their families.

This introduction sets the stage for a more detailed exploration of the system's architecture, components, working principles, and potential benefits.

II. PROPOSED SYSTEM

The proposed system is an AI-powered smart safety solution for two-wheeler riders that actively prevents accidents by integrating real-time monitoring, automated authentication, and emergency response features. Unlike traditional safety measures, this system ensures that the vehicle starts only when all safety conditions are met. The system includes alcohol detection, which prevents the rider from operating the vehicle if intoxicated, and helmet verification, ensuring compliance before ignition. AI-driven facial recognition monitors rider drowsiness, issuing alerts if signs of fatigue are detected. Additionally, an RFID-based authentication mechanism ensures that only licensed riders can start the vehicle. In case of an accident, the system automatically detects the incident and transmits GPS coordinates via a GSM module to alert emergency contacts. By integrating AI, machine learning, RFID authentication, and IoT-based real-time tracking, the proposed system significantly enhances rider safety, reduces accident risks, and promotes responsible driving habits.

III. BLOCK DIAGRAM

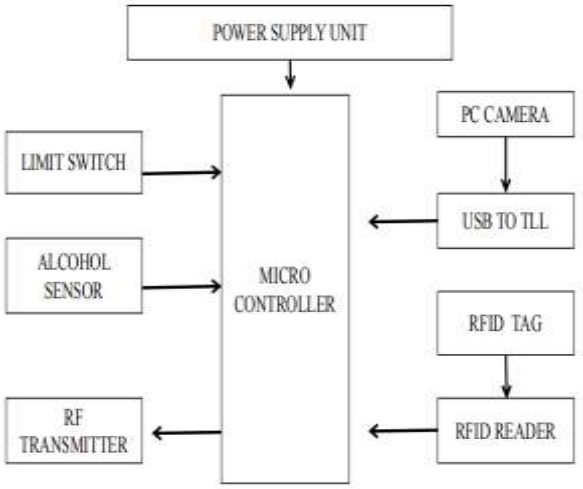

Figure 1; Transmitter unit block diagram

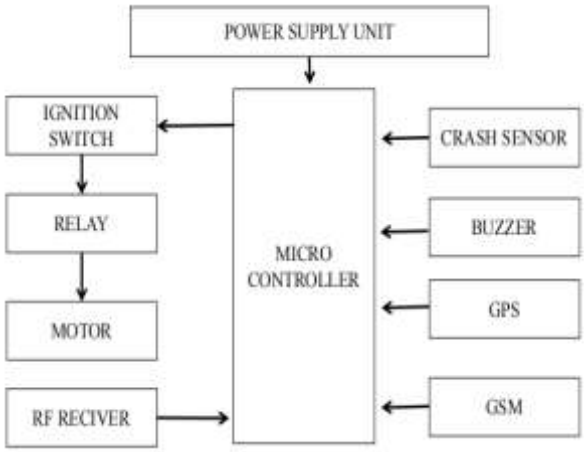

Figure 2; Reciver unit block diagram

IV. BLOCK DIAGRAM DESCRIPTION

The proposed smart helmet system integrates multiple components including a limit switch to detect helmet usage, an MQ3 alcohol sensor to measure breath alcohol concentration, a PC camera for AI-based facial recognition and age verification, an RFID system for rider authorization, and an NRF24L01 RF module for wireless communication between helmet and bike units. The Arduino Nano microcontroller serves as the central processor, interfacing with a NEO-6M GPS module for real-time tracking, a SIM800L GSM module for emergency SMS alerts, and a vibration-based crash sensor to detect accidents. Additional components such as a relay-controlled ignition switch, motor prototype, and buzzer are used to simulate engine control and provide safety alerts, ensuring the bike starts only when all predefined safety conditions are satisfied, thereby enhancing rider safety, preventing unauthorized access, and enabling rapid emergency response in the event of an accident.

V. METHODOLOGY

- **HELMET WEAR DETECTION**
  A limit switch is placed inside the helmet.
  When the rider wears the helmet, the switch is pressed, sending a signal to the microcontroller to confirm helmet usage.
  If the helmet is not worn, the bike ignition is disabled.
- **ALCOHOL DETECTION**
  An MQ3 alcohol sensor is placed near the mouth area inside the helmet.
  It checks the rider's breath for alcohol content.
  If alcohol is detected above the safe threshold, the microcontroller blocks the ignition system.
- **RIDER AUTHENTICATION (RFID + FACE RECOGNITION)**
  The rider scans their RFID card/tag, which is linked to their license.
  The RFID reader sends the ID to the microcontroller for verification.
  A camera module captures the rider's face and runs AI-based facial recognition.
  The face is matched with a pre-stored database, and the rider's age is verified (must be 18+).
  If the rider is unauthorized or underage, the system denies ignition.
- **BIKE IGNITION CONTROL**
  After all safety checks (helmet, alcohol, identity), the microcontroller activates a relay module.
  The relay powers the ignition switch, allowing the motor to run.
- **ACCIDENT DETECTION**
  A crash sensor (vibration sensor or accelerometer) is used to detect sudden impacts or falls.
  If an accident is detected, it triggers the alert system.
- **LOCATION TRACKING AND EMERGENCY ALERT**
  A GPS module fetches the real-time location of the rider.
  A GSM module sends an SMS alert with the GPS coordinates to emergency contacts (like family or emergency services).
- **WIRELESS COMMUNICATION BETWEEN HELMET AND BIKE**
  An RF transmitter (in the helmet) and an RF receiver (on the bike) ensure real-time data transfer between the two units.
  This helps in monitoring helmet use and sensor values wirelessly.

VI. RESULT

The Intelligent Safety System for two-wheeler riders is designed to improve road safety using real-time monitoring and automated safety features. It includes a helmet detection sensor and an alcohol sensor to ensure the rider is wearing a helmet and is not under the influence of alcohol. A facial recognition system verifies if the rider is authorized, while RFID authentication allows only licensed users to start the vehicle. In case of an accident, a crash sensor detects the impact, and a GSM module sends the rider's GPS location to emergency contacts. The system also uses IoT connectivity to provide live data for remote safety monitoring. Despite minor challenges like sensor calibration and network delays, this AI- and IoT-based solution offers a smart, proactive approach to safer and more responsible riding.

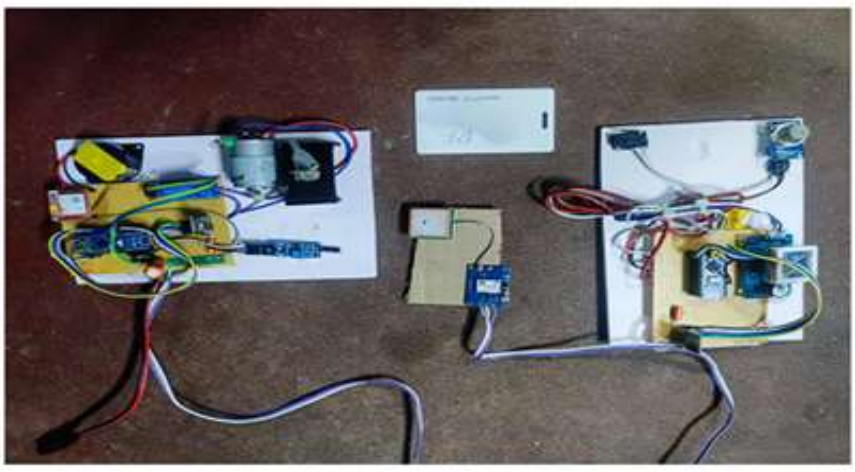

Figure 3; final prototype

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