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Design and Fabrication of Smart-Safety Helmet Tracking System for Two-Wheeler Riders

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ABSTRACT :

The Design and Fabrication of Smart-Safety Helmet Tracking System for Two-Wheeler Riders aims to improve rider safety using smart sensors and communication technology. Two-wheeler riders face risks such as alcohol consumption, drowsiness, accidents and delayed emergency assistance. The proposed system uses an ESP32 microcontroller to integrate multiple safety features. The MQ-3 sensor detects alcohol vapour, while the eye-blink sensor monitors drowsiness and activates a buzzer when prolonged eye closure occurs. The MPU6050 sensor detects sudden changes in movement that may indicate an accident. When an accident is detected, the NEO-6M GPS module collects the rider's location coordinates. The SIM800L GSM module sends an emergency SMS with the location details to a predefined contact. A temperature sensor also monitors the surrounding temperature during the journey. All the sensors work together to monitor the rider's safety and provide timely alerts. Overall, this project aims to make two-wheeler riding safer through an intelligent and affordable safety system.

Keywords: Smart Helmet, Road Safety, Accident Detection, Arduino Uno, MPU6050 Sensor, GPS Module, GSM Module,Emergency Alert System, Gas Detection, Rider Safety.

Introduction :

Two-wheelers are widely used because they are easy to handle, affordable and convenient for daily travel. However, riders often face risks such as alcohol consumption, drowsiness and unexpected road accidents. In many cases, delays in getting emergency help can make the situation worse. To reduce these risks, this project introduces a smart safety helmet using an ESP32 microcontroller. An MQ-3 sensor detects alcohol vapour, while an eye-blink sensor monitors the rider's eye movements. If the rider shows signs of drowsiness, a buzzer gives an immediate warning. The MPU6050 sensor helps identify sudden movements that may indicate an accident. The GPS and GSM modules work together to find the rider's location and send an emergency SMS to a saved contact. A temperature sensor is also used to monitor the surrounding temperature. Overall, this project aims to make two-wheeler journeys safer and help riders receive emergency assistance when needed.



Smart-Safety Helmet Tracking System for Two-Wheeler Riders

Literature Survey :

IOT Based Smart Helmet and Accident Identification System

The methodology of the proposed system involves integrating multiple sensors with an Arduino-based control system for rider safety and accident detection. An IR sensor detects helmet usage, while an MQ-3 sensor detects alcohol in the rider's breath and prevents the motorcycle from starting under unsafe conditions.

A Smart Helmet Ensuring Safety of Bike Riders

The proposed system methodology involves the development of a smart helmet using an Arduino Uno as the main controller, along with GPS, GSM, vibration sensor, speed sensor, RF transmitter and receiver, emergency button, battery pack, and Arduino Nano.The vibration sensor is used to detect accidents, and when an accident occurs, the Arduino processes the sensor signal and activates the GSM module to send an emergency call and SMS containing the rider's exact location through a Google Maps link.

Smart Helmet Ignition System: A Solution to Ensure Bike and Pillion Rider Safety

The proposed methodology consists of two main modules: the Helmet Module and the Bike Module. The Helmet Module uses an HC-SR04 ultrasonic sensor to detect whether the driver and pillion rider are wearing their helmets, while a microcontroller processes the sensor information. An HC-12 wireless communication module transmits the helmet status to the Bike Module.

Bike Rider's Safety Using Helmet

The methodology of the proposed system focuses on improving the safety of two-wheeler riders through multiple safety features. The system consists of two sections, one mounted on the helmet and the other on the motorcycle. PIR and IR sensors are used to authenticate whether the rider is wearing the helmet properly. An MQ-3 alcohol sensor detects alcohol in the rider's breath before the motorcycle is started.

Design and Implementation of an Embedded Smart Helmet for Alcohol Detection and Ignition Interlock

The helmet module consists of an MQ-3 alcohol sensor, helmet wear detection switch, Arduino microcontroller, RF transmitter, and power supply. The MQ-3 sensor continuously detects alcohol vapors from the rider's breath and produces an analog output. The Arduino reads this signal through its ADC and compares the value with a predefined alcohol threshold

Smart Helmet for Rider Protection and Location Tracking

An MQ-3 alcohol sensor is placed inside the helmet to detect alcohol in the rider's breath. If the alcohol level exceeds the predefined threshold, a relay module disables the vehicle ignition. An MPU6050 accelerometer and gyroscope continuously monitor the rider's acceleration and helmet orientation. Sudden changes in acceleration or abnormal tilting are used to identify an accident.

Accident Prevention Using IOT Based Smart Helmet

The proposed smart helmet system uses IoT technology and multiple sensors to improve two-wheeler rider safety. An Arduino Uno microcontroller is used to collect and process data from the alcohol,

vibration, temperature, MEMS, and IR sensors. The alcohol sensor is placed near the rider's mouth to detect alcohol vapour and prevent the bike from starting when the rider is intoxicated. The vibration sensor and MEMS sensor are used to identify abnormal movements, helmet tilting, and possible accidents.

Smart Helmet with Rider Safety System

The proposed Smart Helmet with Rider Safety System is designed to improve both rider safety and two- wheeler security using an intelligent microcontroller-based system. The system consists of two main modules: a helmet module and a bike module. The helmet module uses an IR sensor to detect whether the rider is wearing the helmet and an MQ-3 alcohol sensor to detect alcohol consumption. These signals are processed by an Arduino/ATmega328-based controller and transmitted wirelessly to the bike module through an RF transmitter and receiver.

Smart Safety Helmet for Bike Riders Using IOT

The methodology described in the paper involves developing an IoT-based smart safety helmet using FSR, MQ-3 alcohol, and vibrating sensors integrated with NodeMCU. The FSR sensor detects whether the rider is wearing the helmet, while the MQ-3 sensor checks for alcohol consumption. The vehicle ignition is enabled only when both safety conditions are satisfied. A vibrating sensor detects accident-related vibrations by comparing the measured value with a predefined threshold. When an accident is detected, NodeMCU communicates with the cloud platform (Ubidots) to obtain the rider's location, and the latitude and longitude are sent to saved mobile numbers or email.

Two Wheeler Design and Fabrication to Prevent Trible Riders and Accidents

The proposed smart two-wheeler system integrates three main safety and energy-generation modules: an inbuilt helmet detection system, a triple-rider prevention system, and a thermoelectric power-generation system. A Raspberry Pi with a night-vision camera captures the rider's image and uses image processing with TensorFlow to detect whether the rider is wearing a helmet; if a helmet is not detected, a relay cuts off the engine ignition. A

strain/piezoelectric sensor placed near the bike's tank detects the load caused by more than two riders and sends the measured value to an Arduino, which compares it with a programmed threshold and activates a relay to stop the engine when the threshold is exceeded.

Methodology:

The methodology of the Smart Safety Helmet Tracking System for Two-Wheeler Riders involves hardware setup, circuit connections, programming, sensor integration and testing. Initially, the ESP32 microcontroller is selected as the main controller, and all the required components, including the MQ-3 alcohol sensor, eye-blink sensor, MPU6050 accelerometer and gyroscope, NEO-6M GPS module, SIM800L GSM module, DHT11 temperature and humidity sensor, and buzzer, are assembled. The sensors and modules are connected to the ESP32 according to their operating requirements. The program is developed using the Arduino IDE to read sensor values and control the complete system.
After completing the hardware connections, each sensor is tested individually to ensure proper operation. The MQ-3 sensor is used to detect alcohol vapour near the rider's mouth. When the detected value crosses the predefined threshold, the system activates a warning.

The eye-blink sensor monitors the rider's eye movements and identifies prolonged eye closure, indicating possible drowsiness. When drowsiness is detected, the buzzer produces an alert to warn the rider. The MPU6050 sensor continuously measures acceleration and angular movement to identify sudden changes that may indicate an accident. The accident detection threshold is set through testing with controlled movements to reduce false alerts.
When a possible accident is detected, the ESP32 communicates with the NEO-6M GPS module to obtain the rider's latitude and longitude coordinates. These location details are then sent through the SIM800L GSM module as an emergency SMS to a predefined contact. The DHT11 sensor is also used to monitor the surrounding temperature and humidity during the journey. Finally, all the components are properly arranged and fixed inside or on the helmet, and the complete system is tested under different conditions. Individual and combined testing is carried out to check alcohol detection, drowsiness alerts, accident detection, GPS tracking, emergency SMS communication and temperature monitoring. This methodology helps integrate all the safety features into a single system to improve rider safety and support timely emergency assistance.

Component	Specifications	Purpose
ESP32 Microcontroller	32-bit dual-core processor, up to 240 MHz, Wi-Fi and Bluetooth support	Main controller for sensor integration and system operation
MQ-3 Alcohol Sensor	5V operating voltage, alcohol vapour detection	Detects alcohol vapour near the rider
Eye-Blink Sensor	IR-based eye movement detection	Monitors eye blinking and prolonged eye closure
MPU6050 Sensor	3-axis accelerometer and 3-axis gyroscope, 3.3V operation	Detects sudden movement and possible accidents
NEO-6M GPS Module	GPS receiver, UART communication	Provides latitude and longitude coordinates
SIM800L GSM Module	Quad-band GSM/GPRS, 3.4–4.4V supply	Sends emergency SMS notifications
DHT11 Sensor	3.3–5V operation, temperature and humidity measurement	Monitors surrounding temperature and humidity
Buzzer	3–5V (depending on model)	Provides warning alerts
Power Supply	Battery with suitable voltage regulation	Supplies power to the complete system

Results & Discussion:

The Smart Safety Helmet Tracking System for Two-Wheeler Riders was developed by integrating the ESP32 microcontroller with different sensors and communication modules. The testing of the system showed that the MQ-3 sensor can detect alcohol vapour and provide a warning when the sensor reading crosses the predefined threshold. The eye-blink sensor monitors the rider's eye movements and activates the buzzer when prolonged eye closure is detected, helping to identify possible drowsiness. The MPU6050 sensor detects sudden changes in acceleration and movement that may indicate an accident. When a possible accident is detected, the NEO-6M GPS module obtains the rider's location coordinates, and the SIM800L GSM module sends an emergency SMS to a predefined contact. The DHT11 sensor also monitors the surrounding temperature and humidity. The combined operation of these components demonstrates how the system can monitor different safety conditions and provide timely warnings and emergency information. Overall, the proposed system provides an affordable approach to improving two-wheeler rider safety through sensor-based monitoring, GPS tracking and GSM communication. However, the accuracy of accident detection, GPS availability and SMS delivery depends on sensor calibration, signal conditions and proper power supply.

Conclusion :

The Smart Safety Helmet Tracking System for Two-Wheeler Riders is designed to improve rider safety by integrating different sensors and communication technologies. The system uses an ESP32 microcontroller to monitor alcohol vapour, rider drowsiness, possible accidents and surrounding temperature and humidity. The MQ-3 sensor detects alcohol vapour, while the eye-blink sensor identifies prolonged eye closure and provides a warning through the buzzer. The MPU6050 sensor helps detect sudden movements that may indicate an accident. In case of a possible accident, the GPS module collects the rider's location, and the GSM module sends an emergency SMS to a predefined contact. This helps reduce delays in sharing accident information and requesting assistance. Overall, the proposed system provides an affordable and intelligent approach to improving two-wheeler rider safety through continuous monitoring and emergency communication. In the future, the system can be improved by increasing detection accuracy, adding a mobile application and introducing advanced features for better rider protection.

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