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Design a Smart Helmet with Multi-Fusion Sensor for Accident Detection

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ABSTRACT

Road safety remains a critical concern, especially with non-compliance in helmet usage and driving under the influence of alcohol, both of which significantly contribute to accidents and fatalities. Head injuries are a leading cause of death in road mishaps, often due to the negligence of wearing helmets. Additionally, alcohol consumption impairs cognitive abilities, slows reflexes, and affects judgment, making driving extremely dangerous. In high-traffic regions like India, drunk driving further intensifies the severity of road accidents. To mitigate these risks, we propose an intelligent helmet system equipped with an alcohol detection sensor and a helmet compliance sensor. This system ensures that the vehicle can only start when the driver is wearing a helmet and is not intoxicated. The system transmits real-time data using the Blynk Android application, allowing remote monitoring and enforcement of safety protocols. By leveraging IoT-based monitoring and real-time enforcement, the proposed system significantly reduces accident rates and enhances road safety.

Keywords— *Smart Helmet, Drunk Driving, Road Safety, Alcohol Detection, IoT-based Safety System, Helmet Compliance, Traffic Accident Prevention.*

I. INTRODUCTION

A traffic accident is defined as any vehicle accident occurring on a public highway (i.e. originating on, terminating on, or involving a vehicle partially on the highway). These accidents therefore include collisions between vehicles and animals, vehicles and pedestrians, or vehicles and fixed obstacles. In higher-income countries, road traffic accidents are already among the top ten leading causes of disease burden in 1998 as measured in DALYs (disability-adjusted life years). In less developed countries, road traffic accidents were the most significant cause of injuries, ranking eleventh among the most important causes of lost years of healthy life. In Indian road system, widening of the road is not an alternative solution to avoid traffic in such a cities. The problems with state drunk driving control systems can be solved in many ways. The most effective will follow several principles: They will invest authority and responsibility in people and organizations at all levels, local to national, because drunken driving control requires action at all levels. They will operate in the public eye, using the media to report on problems and solutions, because ultimate decisions on priorities and resources to control drunk driving must have public support. They will not promise instant solutions based on a single action but rather will take steady steps towards long-term improvement. And they will establish mechanisms for identifying and solving problems rather than attempting to apply one-size-fits-all methods.

II. LITERATURE REVIEW AND RELATED WORKS

Application of electronics in the automobile field is very much popular now. Because of the low prices and various varieties available in the market people prefer motorbikes to buy over 4 wheelers. Hence Road Safety becomes a major issue of concern. Therefore it becomes necessary to implement such a technique which is not easy to bypass the basic rule of wearing helmet and to avoid drunken driving. Here we designed a system which checks the two conditions before turning ON the engine of the bike. Our system includes an alcohol sensor and a helmet sensing switch. A switch is used to detect whether the biker is wearing a helmet. An alcohol sensor is used to detect if the biker is drunk, and the output is fed to the MCU. Both the switch and the alcohol sensor are fitted in the helmet. If any of the two conditions are violated, the engine will not turn ON. Alcohol sensor MQ3 is used here for detecting the alcohol concentration present in the driver's breath. The sensor provides an analog resistive output based on the alcohol concentration. The MCU is the microcontroller unit, which controls all the functions of other blocks in this system. The MCU takes or reads data from the sensors and controls all the functions of the whole system by manipulating these data. The alcohol sensor is connected to the MCU through an interfacing circuit, and the helmet sensing switch is directly connected to the MCU. The MCU receives data from these sensors and gives a digital output corresponding to the output of sensors to the encoder only if the two conditions are satisfied.

III. SYSTEM ARCHITECTURE

The existing system does not involve the real-time monitoring. Also, the systems developed mainly concentrates on the four-wheelers as MVEDR **(**Motor Vehicle Event Device Recorder**)**.

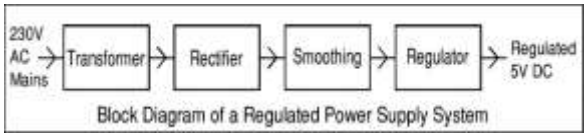
Which records the events before the collision thereby reconstructing the events before the collision. The car black box records the speed, acceleration, breaking and other important actions before collision.

3.1 Transformer

Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC.Step-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage (230V in UK) to a safer low voltage.

Turns ratio=Vp/Vs=Nn/Ns and Power out=Power in

Vs*Is=Vp * Ip



Block Diagram of a Regulated Power Supply System

The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the two coils; instead they are linked by an alternating magnetic field created in the soft-iron core of the transformer. The two lines in the middle of the circuit symbol represent the core. Transformers waste very little power so the power out is (almost) equal to the power in. Note that as voltage is stepped down current is stepped up.The ratio of the number of turns on each coil, called the turn's ratio, determines the ratio of the voltages. A step-down transformer has a large number of turns on its primary (input) coil which is connected to the high voltage mains supply, and a small number of turns on its secondary (output) coil to give a low output voltage.

3.2 Vehicle Unit

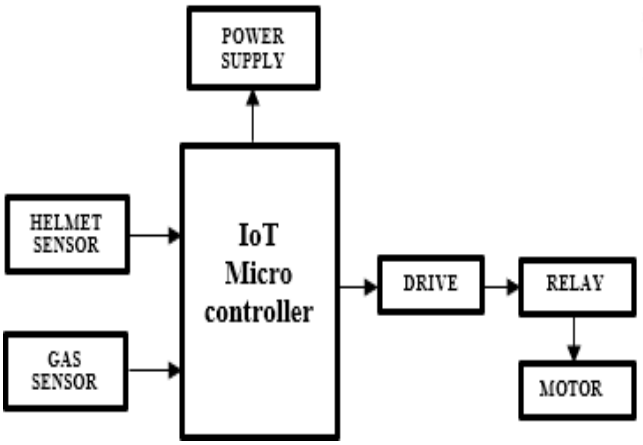


Fig 1 : block Diagram For Smart Helmet

IV. MANAGEMENT OF PRODUCT DESCRIPTION

4.1 Alcohol Detection Sensor (MQ3)

Gas sensors play a vital role in monitoring air quality and detecting harmful substances in various applications, including industrial safety and automotive security. In this project, the MQ3 sensor is used to detect alcohol in the rider's breath. It operates by measuring resistance changes upon exposure to alcohol vapors and produces an analog output proportional to alcohol concentration. The microcontroller processes this data and disables the vehicle's ignition if the detected level exceeds a predefined threshold, ensuring intoxicated riders cannot operate the vehicle.

4.2 Helmet Detection Switch

The helmet detection switch ensures that the rider is wearing a helmet before the vehicle can be started. This electromechanical component operates based on contact, where it gets activated only when the rider properly wears the helmet. If the helmet is not detected, the circuit remains incomplete, preventing the ignition from turning on. This simple yet effective solution enforces helmet compliance, significantly improving road safety.

4.3 Gas Sensor

In current technology scenario, monitoring of gases produced is very important. From home appliances such as air conditioners to electric chimneys and safety systems at industries monitoring of gases is very crucial. Gas sensors spontaneously react to the gas present, thus keeping the system updated about any alterations that occur in the concentration of molecules at gaseous state. The gas sensor module consists of a steel exoskeleton under which a sensing element is housed.

4.4 Limit Switch

In electronics, a switch is an electrical component that can break an electrical circuit, interrupting the current or diverting it from one conductor to another. The most familiar form of switch is a manually operated electromechanical device with one or more sets of electrical contacts. Each set of contacts can be in one of two states: either 'closed' meaning the contacts are touching and electricity can flow between them, or 'open', meaning the contacts are separated and non conducting.

4.5 IoT Module (NodeMCU)

NodeMCU, based on the ESP8266 Wi-Fi module, facilitates real-time data transmission for the smart helmet system. It enables wireless connectivity between the helmet sensors and the vehicle system, allowing data to be monitored via the Blynk application. Law enforcement agencies and family members can receive instant notifications if helmet usage is violated or alcohol is detected. This IoT integration strengthens road safety measures by ensuring continuous

monitoring.

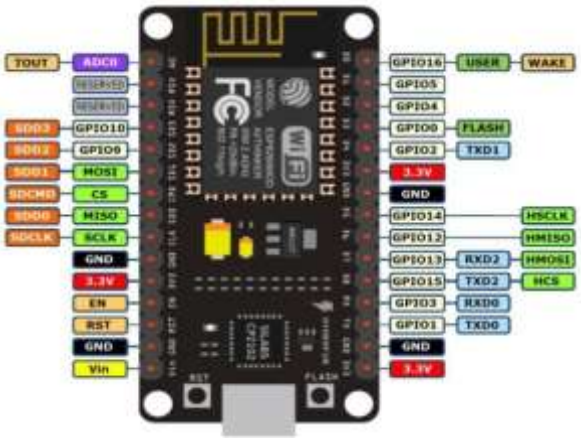


Fig. 2: NodeMCU ESP8266 development

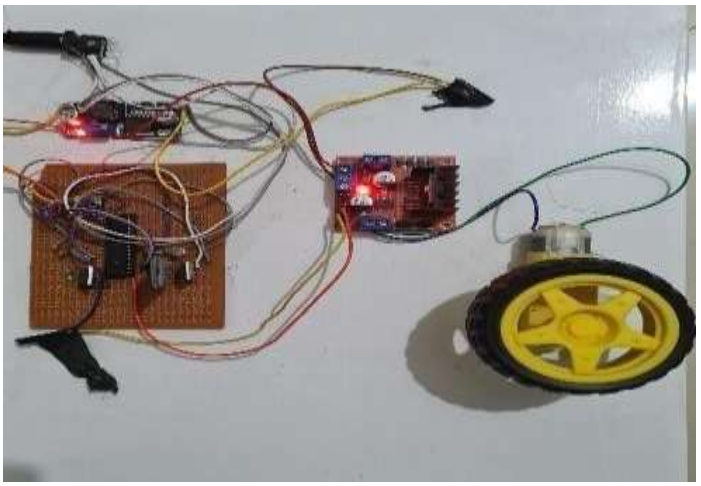


Fig. 3: Smart Helmet System - Bike Unit Integration

4.4 GPS Module neo 6m module

The gps neo 6m module can be communicate with any microcontroller with the UART protocol in this project this module will be connect to the arduino with the UART protocol and use rx and tx pin to connect the system.There is a library which can help to callibrate the sensor with the coding.Some common applications for the NEO-6M GPS module include navigation systems, geotagging, tracking devices, and unmanned aerial vehicles (UAVs). It is important to note that the module requires a clear view of the sky to receive GPS signals, and may not work well indoors or in areas with poor satellite coverage.

V. FUNCTIONALITY

In this system, we use ATmega328P microcontroller which acts as brain of the system, because the entire system program instruction stored in it. Here we have two sections in which one is at the helmet and the other is at the vehicle. The helmet section has IR sensor which gives the information about the status of whether the helmet is occupied or not, also we have sensors like gyroscopeand to know the status of accident. The location of accident area along SMS or either call have done by the GSM module we have. Allthe data fetched from the helmet section is transferred through RF technology and reception take place at the vehicle section. The datais also update to cloud so that we are able to either control or monitor the respective system using IOT. It is already mentioned that theproject is divided into two units namely helmet and bike. In helmet unit, also called the transmitter unit the force sensing resistor is placed on inside upper part of the helmet where actually head will touch with sensor surface.. And the battery and regular circuits were fixed onside the helmet. Secondary controller and RF transmitter circuit were also placed onside the helmet. Antenna is located outside the helmet. The receiver is placed in the bike. The RF receiver accepts all the data from the helmet (i.e. transmitter) unit. Depending on the conditions, if true, the ignition starts and bike moves. The GSM can continuously send the location information of the bike. If any accident occurs, the acoelomate sensor gets activated and sends the location information to the registered mobile number.

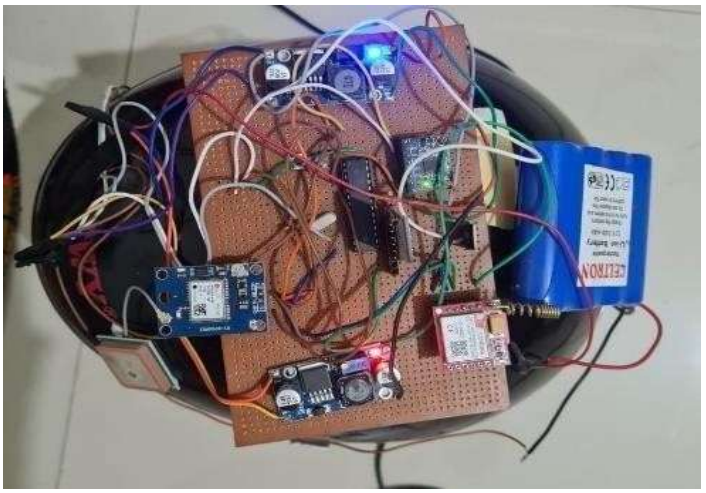


Fig. 4 : Smart Helmet System – Helmet Unit Output

Fig. 5:Emergency Message Alert System for Smart Helmet

VI. CONCLUSION

The proposed smart helmet system demonstrates a significant advancement in promoting road safety by addressing two major issues: helmet non-compliance and alcohol-impaired driving. Through the integration of a helmet sensor and a gas sensor, the system effectively enforces safety protocols, ensuring that vehicles are only operational when the driver is wearing a helmet and is free from alcohol influence. The real-time monitoring capabilities via the Blynk Android application further enhance the system's reliability by providing immediate feedback and continuous data tracking.The system's successful test results indicate its potential to drastically reduce accidents and fatalities caused by non-compliance with helmet laws and drunk driving. While the technology shows promise, challenges such as ensuring sensor accuracy, system affordability, and user comfort must be addressed to achieve widespread adoption. In summary, the smart helmet system represents a crucial step towards improving road safety, with the potential to save lives and make roadways safer for all. With further development and the support of public awareness campaigns, this system could play a transformative role in reducing traffic-related injuries and fatalities.

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