Breath-Based Alcohol Detection in Smart Helmets: A Microcontroller-Driven Safety Solution

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Abstract: **-** Drink and drive detection is of interest because it may prevent accidents that are primarily caused by excessive alcohol consumption. There is currently a lot of research being done to develop detection techniques for alcohol limits that cause unconsciousness and impair human ability to walk, work, and comprehend. Utilizing the importance of electronics and automotive parts, components, and concepts is the main way that the research is accomplished. There are many different types of devices, such as various MQ series sensors and devices that read facial expressions. Among these, the MQ-3 Sensor, which measures the amount of alcohol in people, has demonstrated promise in the field of electronics. This article outlines a system and apparatus known as an alcohol sensor device that measures a person's alcohol intake. This device measures the concentration of alcohol, and if it exceeds a certain threshold, the car's ignition mechanism is stopped, meaning it won't start. We can prevent accidents caused by drinking and driving by using the aforementioned device. As everyone knows, driving while intoxicated is extremely risky. People won't be able to control their behavior and will react slowly. When operating a vehicle while intoxicated, drivers are unable to handle emergency situations. According to a 2008 World Health Organization study, drunk driving is a contributing factor in between 50% and 60% of traffic accidents. The primary cause of the deadly car accident has been identified as drunk driving.

Keywords: *Alcohol Sensor, Alcohol Detector; LCD: MQ3*

I. Introduction:

India has one of the largest numbers of road accidents in the world, and most of these involve two-wheelers. Some causes of road accidents include riding without helmets, drunk driving, and delays in medical assistance following accidents. Despite there being strict traffic regulation, most riders don't follow helmet usage and drive drunkenly. Besides, the delayed response to medical emergencies increases the severity of accidents. We have designed an intelligent Smart Helmet, integrating the latest technologies in order to improve road safety for two-wheeler riders. The helmet compels the rider to wear it before switching on the bike, thus making wearing a helmet compulsory and preventing head injuries. If the helmet is not put on, the bike won't start. The helmet will also detect the alcohol consumption of the rider through the detection of blood alcohol level. If alcohol is detected beyond permissible limits, the bike won't start, and a buzzer will sound to alert the rider. Further, a message will be sent to RTO for taking further action against the rider. Thus, this feature helps in reducing accidents caused due to drunk driving. In case an accident occurs, the accelerometer inbuilt in the helmet detects the sudden impact of the accident. Its GPS and GSM module send location coordinates immediately after detecting an accident to nearby ambulance services or hospitals. Thus, it helps in providing quick medical response. Most fatalities are caused due to loss of time in providing emergency services. In future versions, the Smart Helmet could be upgraded with an over-speeding warning system when the rider exceeds the speed limit, further helping to ensure safe driving. This helmet enforces safety measures and provides quick responses in case of emergencies to save lives and reduce fatalities due to road accidents. The alarming prevalence of road accidents from drunk driving has spurred the need for innovative solutions to improve road safety. Every year, innumerable people lose their lives and massive damage is incurred as a result of the recklessness on the part of intoxicated drivers. To mitigate this problem, technological developments point to promising directions in terms of intervention. A distinctive solution involves the integration of IoT into the safety mechanism for real-time monitoring. In this

regard, the Smart Helmet Alcohol Detection Engine Locking System shows as a proactive means of drunk driving countermeasures. By integrating the use of IoT technology, this system aims at preventing an inebriated individual from assuming control of a vehicle with the intent of reducing the possibility of accidents and, more importantly, saving lives. The major component of the system, the smart helmet, is integrated with a sensor that detects alcohol, a microcontroller unit, and modules for IoT connectivity.

II. Literature Survey:

Studies on alcohol detection systems widely employ MQ – series semiconductor sensors, particularly MQ – 3 and MQ – 135, because of their high sensitivity to ethanol vapour. Prior works, including those by Singh & Kumar (2015) and Throat & Kulkami (2016), have shown that these sensors accurately measure breath alcohol levels and are easily integrated with microcontrollers such as Arduino or PIC. Most of these systems use threshold – based logic to disable vehicle ignition if unsafe alcohol levels are detected, often supported by visual or audio alerts to increase user awareness.

IoT-based frameworks for detecting alcohol have been the focus of recent research. Studies by Sandeep et al. (2020) and Zaouk et al. (2021) incorporated wireless communication modules like GSM and IoT platforms to transmit alcohol-related violations in real time. By allowing authorities or emergency systems to receive immediate alerts, these solutions improve monitoring reliability and offer a proactive approach to preventing drunk-driving incidents.

Smart helmet designs in the literature focus on improving rider safety through sensor – based enforcement. Works such as Sharma et al. (2021) highlight the use of pressure switches, infrared sensors, and conductive contacts to ensure the helmet is worn correctly before ignition is enabled. Several studies also integrate alcohol sensors within the helmet structure, enabling early detection of intoxication and reducing risks associated with unsafe riding behaviour.

A significant portion of research addresses real-time accident detection using accelerometers and vibration sensors. Research by Singh & Chauhan (2020) and Rao & Prasad (2019) shows that abnormal tilt or sudden impacts can be precisely detected and connected to GPS and GSM modules to automatically send emergency alerts. Consensus in the literature suggests that an effective and affordable smart helmet system that improves two-wheeler rider safety combines alcohol detection, helmet verification, accident sensing, and wireless communication.

III. Methodology:

The helmet and bike unit of the suggested system incorporates several safety-focused modules. Each module operates using threshold-based decision logic governed by an Arduino microcontroller. Helmet-wear verification, alcohol detection, accident identification, and emergency notification are all part of the overall methodology. Every sensor's data is continuously monitored, and any dangerous situation prompts an instant reaction, such as message transmission, alert generation, or ignition locking. Each major component's operational methodology is described in detail in this section.

(a) Mechanism for Detecting Helmets:

In order to prevent the rider from starting the vehicle without wearing a helmet, the helmet detection module is installed. The helmet has an embedded conductive switch or infrared sensor to detect correct placement. The sensor shuts off the circuit and notifies the microcontroller when the rider puts on the helmet. The microcontroller then activates the relay that is attached to the ignition system. The relay stays open if the helmet is not worn, which stops the engine from starting. This straightforward but efficient method greatly lowers the risk of head injuries while enforcing safety regulations.

(b) Mechanism for Alcohol Detection:

The MQ-3 gas sensor, which is placed close to the rider's mouth, is used by the alcohol detection unit. When the rider exhales, the sensor detects ethanol vapours, transforms them into an electrical output, and transmits the data to the microcontroller. If the alcohol concentration surpasses the predetermined threshold, the controller instantly disables ignition through the relay module; additionally, the system activates a buzzer to warn the rider and sends an automated message to the RTO via GSM to prevent intoxicated people from operating the vehicle.

(c) Accident Detection & Emergency Alert

An accident is detected using a 3-axis accelerometer mounted inside the helmet. The sensor continuously monitors motion, tilt, and impact. If the measured acceleration crosses a critical threshold—indicating a fall or collision—the microcontroller identifies it as an emergency event. The system then activates the GPS module to capture real-time coordinates and sends an alert message to emergency contacts or nearby hospitals via GSM. This timely information can significantly reduce response time and improve the rider's chances of survival.

(d) Working Flow of the Smart Helmet System

First, the system checks to see if the rider has properly donned the helmet. Appropriate helmet placement is detected by an infrared or pressure sensor. The ignition circuit stays open and the engine cannot start if the rider is not wearing the helmet. The system moves on to the next validation step—alcohol detection—after the helmet is firmly put on. When the MQ-3 sensor detects more alcohol in the rider's breath than is allowed, the system disables the ignition relay and prevents the car from starting.

The system turns on the ignition and initializes all other sensors once the rider passes both tests (wearing a helmet and being free of alcohol). Several safety parameters are continuously monitored throughout the ride. The obstacle sensor looks for any objects in the vicinity that could cause a collision. A temperature sensor looks at engine heat to identify overheating conditions, and a speed sensor keeps track of whether the rider goes over the set safe speed limit.

The system instantly initiates an alert mechanism if it detects any dangerous condition, such as an obstruction, excessive speeding, or an overheating engine. The rider can take corrective action after being alerted by a buzzer or display message. This real-time alerting aids in preventing collisions brought on by rider behaviour, mechanical malfunctions, or environmental hazards. Throughout the trip, the system maintains this monitoring loop and promptly notifies users when a risk is identified. The Smart Helmet system is an effective safety companion for two-wheeler users because it guarantees that the rider is always informed and protected.

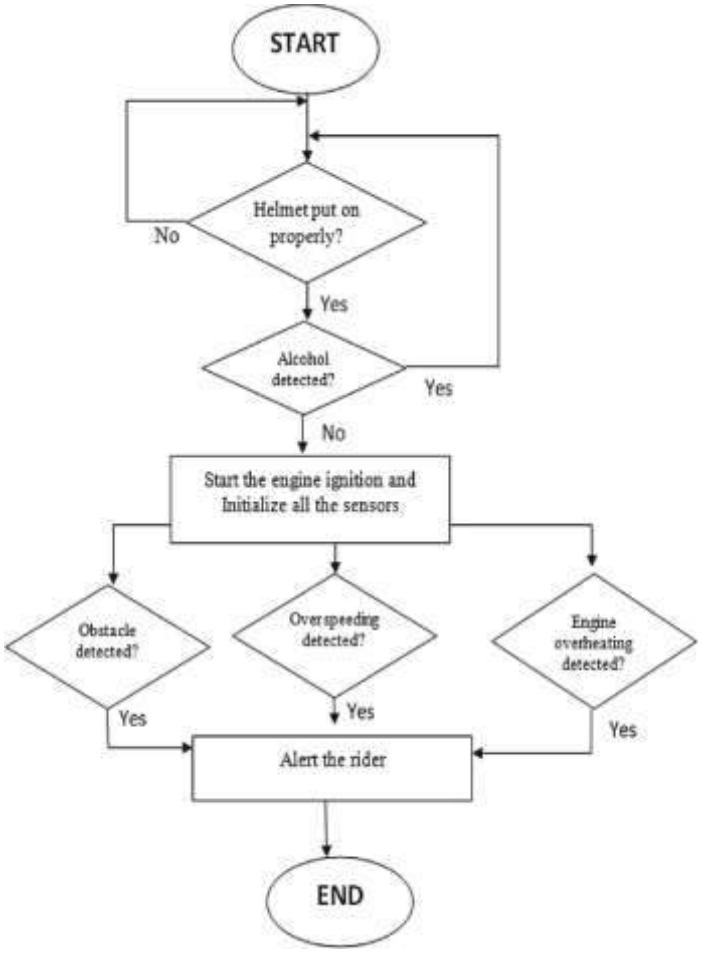

Fig.1. Block diagram

IV. Result And Discussion:

The developed Smart Helmet prototype was successfully assembled and tested, as shown in the project setup. The system integrates an MQ – 3 alcohol sensor inside the helmet, an Arduino Uno microcontroller, a relay – based ignition control unit, and supporting electronic modules mounted on a wooden base. During testing, the helmet – wear detection worked accurately; the ignition circuit remained open when the helmet was not worn and activated only when proper helmet placement was detected, demonstrating reliable safety enforcement.

The alcohol detection mechanism also performed consistently. When the rider's breath contained no alcohol, the MQ – 3 sensor output remained below the programmed threshold, enabling the ignition relay and allowing the motor to run normally. When alcohol was introduced near the sensor, the output voltage exceeded the permissible limit, immediately cutting off the ignition and preventing the motor from operating.

This real – time response confirms that the system effectively restricts intoxicated riders from starting the vehicle.

Overall, the individual nodules – helmet detection, alcohol sensing, ignition locking, and power control – worked together smoothly without signal delay or malfunction. The project demonstrated stable operation under repeated trials, showing that a compact, low – cost system built using readily available sensors and microcontroller hardware can deliver practical and reliable safety functionality. The experimental results validate the feasibility of implementing such a system in a real two – wheeler environments to reduce accident risks caused by not wearing helmets and driving under the influence of alcohol.

V. Conclusion:

The Smart Helmet alcohol detection and ignition control system was successfully designed, implemented, and tested. The prototype consistently ensured that the vehicle could be operated only when the rider wore the helmet and did not consume alcohol. By combining an MQ – 3 sensor for breath analysis with a microcontroller – based ignition lock, the system effectively prevents unsafe riding behaviours. The reliable performance of the hardware during testing confirms that this approach can significantly enhance two – wheeler safety.

Given its low cost, easy integration, and accurate operation, the system is suitable for real – world applications and can be extended with additional features such as GPS tracking, accident detection, and wireless communication modules. The successful output of this project highlights its potential to reduce road accidents and promote responsible riding habits.

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