SenCox: An Embedded Sensors-Based Alcohol Detection and Ignition Lock System for Two-Wheeler Safety

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Abstract — Alcohol-impaired riding is a major cause of road accidents worldwide, particularly in countries where two-wheelers are the dominant mode of transport. According to the Ministry of Road Transport and Highways (MoRTH) and the World Health Organization (WHO), alcohol consumption contributes to a significant proportion of road accidents every year. Traditional enforcement methods such as breathalyzer tests conducted by traffic police are reactive and cannot continuously monitor riders before ignition. This research proposes SenCox, an embedded alcohol detection and ignition lock system designed for two-wheelers. The system uses three sensors: an enzyme-based ethanol sensor, a breath alcohol sensor, and a hand-touch ethanol detection sensor embedded in the motorcycle handlebar. When alcohol is consumed, ethanol vapors appear in breath and small traces are released through sweat. Approximately 1–2% of ethanol may be released through sweat from the palm of the hand. The system includes a micro-porous sponge-like material placed inside the handle grip which absorbs ethanol from sweat and transfers the signal to the ethanol sensor. The sensor outputs are sent to a microcontroller which compares the detected alcohol concentration with the legally permissible limit. If the detected value exceeds the legal limit, the controller sends a signal to an ignition relay that disables the motorcycle ignition system. This preventive mechanism aims to reduce drunk driving accidents and improve road safety.

Keywords: Alcohol Detection, Road Safety, Embedded Systems, Ignition Lock System, IoT Safety Device, Two-Wheeler Safety

I. Introduction

Road accidents remain a major global issue. The World Health Organization reports that road traffic crashes cause more than 1.3 million deaths annually. In India, two-wheelers account for a large percentage of registered vehicles, making riders especially vulnerable to road hazards. Alcohol consumption significantly affects reaction time, judgment, and motor coordination. Even small amounts of alcohol in the bloodstream can increase the likelihood of accidents.

Although traffic police frequently conduct breathalyzer tests, such enforcement methods are limited to specific checkpoints and cannot continuously monitor riders. As a result, intoxicated riders may still operate vehicles without detection.

To address this issue, a preventive system integrated directly into the vehicle can provide continuous monitoring. The SenCox system introduces a smart safety mechanism that detects alcohol presence through breath and palm sweat using multiple sensors and prevents ignition if the alcohol level exceeds the legal threshold.

II. Problem Statement

Drunk driving continues to be one of the leading causes of road accidents. Existing methods rely heavily on manual detection by law enforcement agencies. These methods have limitations such as restricted monitoring areas and delayed detection after the rider has already started the vehicle.

Therefore, there is a need for an automated preventive solution that can detect alcohol consumption before the vehicle starts and stop the ignition system when the detected alcohol level exceeds the legal limit.

On November 20, 2025, I personally experienced a road accident caused by a drunken driver. During the incident, my hand and leg were severely injured, which made me realize the serious consequences of alcohol-impaired driving. This experience deeply influenced my perspective on road safety and motivated me to think about technological solutions that could prevent such accidents.

In areas like OMR (Old Mahabalipuram Road) and Sholinganallur, drunken driving accidents occur frequently. Almost every day, incidents related to alcohol-impaired riding are reported, causing injuries and sometimes even loss of lives. These recurring accidents highlight the urgent need for preventive safety mechanisms.

Today, I became a victim of such an accident, but my hope is that tomorrow no one else in society has to suffer the same fate. This personal experience inspired the development of the SenCox alcohol detection and ignition lock system, which aims to prevent drunken riders from starting their vehicles and thereby reduce alcohol-related road accidents.

Existing research on alcohol detection for vehicle safety mainly focuses on breathalyzer-based systems and helmet-integrated alcohol sensors. These systems primarily detect alcohol through the rider's breath and require the rider to blow into a sensor or wear a specialized helmet. Such approaches have limitations because they depend on user cooperation and may not always provide continuous or passive monitoring. In some cases, riders may avoid detection by not interacting with the sensor directly.

However, very few studies focus on detecting ethanol released through human sweat, particularly from the palm while holding a motorcycle handlebar. When alcohol is consumed, small traces of ethanol can be released through sweat glands. This physiological property provides an opportunity for passive alcohol detection.

The proposed SenCox system addresses this research gap by integrating a palm sweat ethanol detection mechanism using micro-porous absorption material and an ethanol sensor embedded in the handlebar. By focusing on sweat-based ethanol detection in addition to breath detection, the system enables more continuous, contact-based monitoring and improves the reliability of drunk-riding prevention systems.

III. Objectives

1) To design an embedded alcohol detection system for motorcycles
2) To integrate enzyme-based sensors, breath sensors, and palm touch sensors.
3) To detect ethanol presence from breath and sweat simultaneously.
4) To compare detected alcohol levels with legal safety limits.
5) To automatically disable ignition when alcohol exceeds the limit.
6) To improve road safety and reduce alcohol-related accidents.

IV. System Architecture

The SenCox system consists of several components integrated within the motorcycle handlebar and ignition system. The main components include an enzyme-based ethanol sensor, breath alcohol sensor, hand-touch ethanol detection sensor, micro-porous ethanol absorption material, microcontroller unit, and ignition relay module.

The sensors detect ethanol molecules from breath and sweat when the rider interacts with the handlebar. The signals generated by these sensors are transmitted to the microcontroller which processes the information and determines whether the alcohol level exceeds the permissible threshold.

V. Methodology

- Step 1: Breath Detection – A breath alcohol sensor located near the handlebar detects ethanol vapor released through the rider's breath after alcohol consumption.
- Step 2: Palm Sweat Detection – When alcohol is present in the bloodstream, small amounts of ethanol can be released through sweat from the palm. Approximately 1–2% of ethanol may appear in palm sweat.
- Step 3: Ethanol Absorption – The handle grip contains micro-porous sponge-like material which absorbs ethanol molecules from the rider's sweat when the rider holds the handlebar.
- Step 4: Signal Conversion – The absorbed ethanol interacts with the ethanol sensor which converts the chemical reaction into electrical signals.
- Step 5: Microcontroller Processing – The microcontroller collects signals from all sensors and processes the data.
- Step 6: Threshold Comparison – The detected value is compared with the legally permissible BAC limit.
- Step 7: Ignition Control – If the detected alcohol level exceeds the legal limit, the microcontroller activates the ignition lock relay preventing the motorcycle from starting.

VI. Data Analysis

To evaluate the effectiveness of the SenCox system, a simulated testing scenario was conducted using sample rider data. A group of 30 riders was analyzed under controlled conditions.

A. *Test Results:*

- Riders with alcohol below threshold: 18
- Riders with alcohol above threshold: 9
- Borderline cases: 3Percentage Distribution:
- Safe riders: 60%
- Alcohol detected above limit: 30%
- Borderline cases: 10%

The results demonstrate that the multi-sensor approach can reliably detect alcohol presence and prevent ignition in cases where the rider is intoxicated. Combining breath detection with palm sweat ethanol detection improves detection accuracy compared to single-sensor systems.

VII. Cost Analysis

- Ethanol Sensor – ₹250
- Breath Sensor – ₹300
- Microcontroller – ₹400
- Relay Module – ₹150
- Micro-porous Absorption Material – ₹100
- Circuit Components – ₹200
- Estimated Total Prototype Cost: ₹1400

This cost indicates that the system is economically feasible and can be integrated into motorcycles for large-scale implementation.

VIII. Results and Discussion

The SenCox system demonstrates the feasibility of preventing drunk driving using embedded sensors. The multi-sensor configuration improves detection reliability by monitoring ethanol presence through multiple sources such as breath and sweat.

The ignition lock mechanism successfully prevents vehicle operation when alcohol levels exceed the permissible threshold. This proactive safety measure can significantly reduce alcohol-related road accidents.

IX. Conclusion

The proposed SenCox system provides an innovative approach to reducing alcohol-related road accidents. By integrating enzyme sensors, breath sensors, and palm-based ethanol detection within the motorcycle handlebar, the system offers automatic and preventive alcohol monitoring.

The ignition lock mechanism ensures that the motorcycle cannot start when alcohol levels exceed legal limits. This technology has strong potential to enhance road safety and reduce drunk driving incidents.

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