Design and Implementation of In-Vehicle Alcohol Detection and Speed Control System

Ugochi A. Okengwu and Aminat A. Taiwo

Abstract — This study presented an effective method for reducing the rise in the number of road accidents instigated by drivers’ excessive alcohol consumption on Nigerian roadways. Although speed restrictions and other preventative measures have been introduced, traffic accidents continue to occur daily. Over speeding, rash driving and drunk driving are all major contributors to motor vehicle accidents. To introduce this concept, this study has built an IOT-based in-vehicle alcohol detection and speed control system using the Arduino Nano microcontroller connected to the alcohol sensor, LCD display, and DC motor with the Bluetooth Low Energy (BLE) Application and Blynk Cloud Server for remote control and monitoring. This system uses the MQ-3 sensor to continuously monitor the blood alcohol concentration (BAC) and detect the presence of alcohol during breathing. This system can continuously monitor the alcohol content of the driver’s breathing by installing a sensor in the steering wheel. This device was capable of detecting excessive speed and was programmed to alert with an SMS. After testing, it was determined that the suggested system met the standards for starting a car’s engine. If the driver's breath alcohol level is discovered to be greater than the prescribed level (BAC) of 0.5 mg/mL, relevant individuals and authorities will be notified through GSM. The experimental results indicate that the alcohol sensor can respond rapidly when alcohol is detected and also operate for an extended period.

Keywords — Accident, Alcohol Detection, Arduino, IOTs, Speed Control.

I. INTRODUCTION

The issue of safety has always been one of the most serious human issues. Countries frequently establish legislation forbidding particular human practices or behaviors to protect public safety, cut health-care expenses, and gain greater control over one's health [1]. There has been a rising tendency toward the overuse and abuse of alcohol in recent years, which coincides with the growth in drug-related problems around the world. Obtaining accurate information on alcohol consumption and misuse in Nigeria and globally is difficult. Death related to alcohol consumption has been reported to be over ten thousand yearly in several countries around the world. Furthermore, alcohol is suspected to be a contributing factor in more than half of all road and workplace injuries in such countries, resulting in a large number of injuries, and damage to property each year. Drunk drivers are not the only ones who cause traffic accidents. They can also occur when people drive excessively quickly, which is a factor in a large number of fatal car accidents.

Drinking and driving is a major cause of road accidents all over the world. According to Shrushti [2], three people are killed in an alcohol-related highway crash every two hours. Driving under the influence of alcohol is still the most serious issue confronting the general public in the United States. It is a well-known fact that when you drink alcohol, your driving skills are affected, and your risk of getting into an accident goes up a lot. As reported by Welcome and Pereverzov [3], alcohol use is a contributing factor in about half of all road traffic accidents in Nigeria. It is typical to observe drivers consume alcoholic beverages at rest stations as these areas are densely populated with establishments that offer both licensed and locally produced alcoholic beverages [4]. The authors, Ogazi and Edison [4], claim that many commercial drivers in Nigeria use alcoholic beverages while driving long distances.

According to the Nigerian Bureau of Statistics, 11,363 reported street accidents in 2016. Even though the research said that speeding was the primary reason for these accidents, it can be reasonably assumed that a large portion of the incidents would have been caused by the un-stability of drivers’ conditions as a result of drinking alcohol before getting behind the wheel. According to research published by the World Health Organization in 2008, drunk driving is responsible for roughly half of all vehicle accidents. According to data collected by the World Health Organization on street traffic passing, 1.25 million traffic passes were documented globally in 2013, with poor and middle-income countries experiencing higher casualty rates per 100,000 population (24.1 and 18.4 separately). Business car drivers in Nigeria acknowledged consuming alcoholic beverages while on the job, according to data collected from various sources. That the vast majority of drivers, particularly commercial and aggressive truck drivers, indulge in drunk driving, which can result in an accident, is demonstrated below. Any amount of blood alcohol fixation (BAC) above the legal limit in Nigeria is deemed illegal. The country's legal limit for BAC is 0.5 g/100 mL [5].

The Arduino processor always uses the information from the liquor sensor to check for drunk driving and activates a bolt on the vehicle. In India, over 10,000 activity fatalities were directly linked to drivers who had higher blood alcohol levels than allowed in 2009. Numerous accidents occur because of the driver's carelessness. Many drivers drink and drive, which is illegal. Such drivers are a danger to society.
and should be apprehended as soon as possible. Although the country has laws in place to prevent drunk driving, its practical application is still being worked on and is sometimes even questionable. Today we observe that accidents of vehicles are coming widely in which a lot of people died and millions of properties are destroyed in similar. In Nigeria, hardly a day goes by without an accident living people injured, and sometimes leading to loss of lives and properties destroyed. The causes of these accidents are estimated as the problem of overloading, speed, illegal road use, inefficient for driving, and alcohol consumption. Among these, alcohol consumption is most and highly estimated as the reason for car accidents [6] with over speed accounting for the next in line. Some drivers use alcohol on their journey, especially they take beer for refreshment and at lunchtime. This may bring them to serious accidents because alcohol in nature can affect perception, vehicle control, and the internal nervous system.

This study is limited to the application of IoT to in-vehicle alcohol detection and speed control purposes. The project makes use of input devices such as alcohol sensors to detect the driver’s level of alcohol and output devices such as the motor driver helps control the speed and direction of the car. While the ESP 32 Development board (wi-fi chip) creates the connectivity between the car and the website (cloud Blynk). The BLE App provides a graphical user interface (GUI) for controlling the speed and direction of the car. This study is a tool geared towards reducing the cause of road accidents worldwide (either the driver is under the influence of alcohol or exceeded the speed limit).

II. MATERIALS AND METHODS

A. Materials

The project has two MCU, one for the control of the movements and one for the alcohol and speed detection, website upload, and the car shutdown. The Control MCU Components are Arduino Nano microcontroller, L298N dual H-bridge DC motor driver, AT-09 CC2541 BLE 4.0 Bluetooth module, Smart Car chassis with 4 sets of geared motor and wheels, Micro Servo, Jumper cables, Male/female Headers, Vero board.

The Monitoring MCU Components consist of Esp32 Development Board, Relay Switch, BD135 Transistor, Resistor, MQ3 Alcohol/Ethanol Gas Sensor, Optical Slot Motor Speed Sensor, GSM Module, and LCD Module. Other components used in this project include Battery (3.7v), Power Switch, Glue Gun, and Soldering Iron/Soldering Led.

B. Methods

The frame of the car and the geared motors were screwed together to form a firm body. The wheels as well as the speed encoder were then attached to the geared motors. The control and monitoring MCU circuit were soldered according to the circuit diagram and the necessary components were mounted on it. It was then placed on the car frame with the help of a glue gun. Jumper cables were then installed to and from every part involved. Similarly, the battery holders were placed on the car frame with the help of a glue gun. The output wires were connected in series connection so as to combine all 3.7v of the 4 batteries to give out 14.8v as shown in Fig. 1. The codes for each MCU were carefully developed and uploaded to their respective boards. Fig 2, Fig. 3, and Fig. 4 show the circuit diagram, architecture, and block diagram of the system.

C. Testing and Corrections

The entire system was tested if it suits the expected standards. Testing is done by certifying the requirements. i.e., whether the application is working based on the requirements. In addition to the Bluetooth Low Energy (BLE) app and Blynk Cloud Server-specific functionality, other scenarios one should test for to limit errors include:

- The application installs and launches correctly.
- The users can sign-up and log in.
- Text boxes and buttons function properly.
- Push notifications render correctly.

After this, some errors were discovered, and several corrections were made both on the circuits and the code.

![In-Process Car Coupling](image1.jpg)

![Circuit Diagram of Speed and Direction of Car](image2.jpg)
Fig. 3. Architecture of In-vehicle Alcohol and Speed Control Detection System.

Fig. 4. Block Diagram of the Design System.
III. RESULT

With the increase in the consumption of alcohol by vehicle drivers, there has been a hike in accidents being taken place. Even with the development of the latest technology to stop these, there are still cases of such happening. To avoid this, the concept implemented in this project was introduced. The MQ3 Alcohol Sensor and the 16 × 2 LCD Display are interfaced with Arduino Nano (ATMega 328P) Microcontroller. The MQ3 Sensor senses alcohol (consumed by the driver) and indicated the level of Alcohol content through the LCD Display present on the sensor board. The LCD display is used to display the results given by the MQ3 Sensor to the owner of the vehicle, and the Blynk cloud server gives real-time corresponding values to the respective authorities, while an SMS is sent once the alcohol level is above the recommended standard to a registered concerned person (family member). In this study, an alcohol level between 0 to 0.49 is normal while an alcohol level greater than or equal to 0.5 is considered as high. The system minimizes the risk factor of the driver, or anyone being injured.

Table II and Fig. 5 show the degree of intoxication and level of alcohol in selected drinks respectively. The highest level of alcohol was detected in Ethanol while the lowest level is Heineken.

![Fig. 5. Level of Alcohol detected in the selected drink.](image)

<table>
<thead>
<tr>
<th>TABLE I: CONCENTRATION LEVEL OF SELECTED ALCOHOLIC DRINKS</th>
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<tbody>
<tr>
<td>Different Alcohol Drinks</td>
</tr>
<tr>
<td>----------------------------</td>
</tr>
<tr>
<td>Heineken</td>
</tr>
<tr>
<td>Action bitters</td>
</tr>
<tr>
<td>Smirnoff</td>
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<tr>
<td>Ethanol</td>
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<td>Vodka</td>
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![Fig. 6. A prototype of the complete system before packaging.](image)

The alcohol is detected by the sensor; it sends the signal to the Microprocessor which in turn displays the concentration of the alcohol consumed on the LCD to the driver. This takes place until the alcohol is above the threshold limit if no emergency the ignition stops but in an emergency situation, the driver is allowed to speed for safety purposes and send an SMS to concerned parties involved (i.e. authorities and family members) for appropriate safety measures as shown in fig. 7, 8 and 9 respectively. In instances where the driver is not intoxicated, the speed of the car is continuously monitored, and once above the threshold limit, if no emergency the ignition stops but in an emergency situation, the driver is allowed to speed to safety and an SMS is sent to concerned parties. Field testing was done specifically for the mobile data network and not in-house but by going out and using the app as a normal user. This testing is done ‘only’ after the whole app is developed, tested, and regressed (for bugs and test cases). It was basically done to verify the behavior of the system when the network has a 4G or 3G or 2G connection. Field testing verifies if the app is crashing under a slow network connection or if it is taking too long to load the information.

The speed of the motor car and the handler holding the foam is controlled by a mobile phone application called the

IV. DISCUSSION

To assess the system's accuracy, several alcoholic beverages were used to imitate the system's response to varying alcohol concentrations (Table I). Our system was tested with a breadboard, digital multimeter, LEDs, Arduino sketch IDE, and MQ3. Fig. 6 shows the system's final output. This project senses the presence of alcohol (consumed by the driver) in the vehicle, immediately sends the signal, and starts the blinking LED. The circuit can sense the alcohol level thus minimizing the chances of accidents.
BLE app. The Blue app uses a Bluetooth connection to control the motor car. A servo motor controls the handle containing a foam dipped in alcohol whenever the handler is controlled towards the alcohol sensor the alcohol level on the web page is observed to increase.

The Speed of the car and the alcohol level are displayed on a web page of the Blynk Cloud server as shown in Fig. 10.

This system has been designed to operate in three scenarios involving alcohol detection. In the first scenario, if the driver has consumed alcohol above the legal limit and then entered the car, the system is designed in such a way that whenever the driver starts or attempts to start the vehicle's engine, the MQ-3 alcohol sensor activates, begins sensing for alcohol, and performs its assigned function. The MQ-3 sensor detects alcohol as soon as the driver begins exhaling; it works by sensing the amount of alcohol in the driver's breath as he exhales.

The second scenario is that the motorist is agitated or wishes to unwind while driving and begins consuming alcohol (albeit this is not the best approach to unwind) while on the road. The technology is developed in such a way that it will continue to operate throughout the duration of the drive and will continuously monitor the driver's blood alcohol content. When the detected amount exceeds the specified legal limitations, the desired action is triggered.

The third scenario occurs when the driver is not intoxicated, and the vehicle's passengers begin consuming alcohol while on the road. It will not detect in that instance, as the system is integrated into the steering wheel and has a limited range of two meters. Not only does the device's position matter, but also the fellow-behavior passenger's (alcohol consumption), since he or she must guarantee that they do not enter the designated range that triggers the sensor's activation.

V. CONCLUSION

This research developed a system to detect the presence of alcohol in a driver's breath and reduce the potentially fatal consequences, as well as monitor the driver's speed limit. The Arduino Nano, ATMEGA328P microprocessor, and MQ-3 sensor were used to effectively develop and construct the system. The system's experimental assessment revealed that the alcohol sensor was capable of providing a quick reaction when alcohol was detected. The alcohol sensor's capacity to work over a lengthy period of time is also a characteristic of the proposed system. In comparison to other versions, the sensor's sensitivity is likewise rather high. Although the sensor may detect other drugs and mistake them for alcohol, its sensitivity to alcohol is far higher, making it an extremely reliable alcohol detector.

Following the end of the project, several technical and nontechnical difficulties linked to the project's design are
discovered. It was difficult to integrate the GPRS module into the system, as well as to use the Google Geolocation API. The API is not supported by the ESP32 MCU board utilized in this system.

The MQ3-based approach for measuring the alcohol content in blood, like any other system, is prone to malfunction and system failure. Similarly, if the driver is wearing a mask or has his mouth covered, the amount of breath he exhales will be inadequate to trigger the action. If the driver covers the sensor module with a handkerchief or a piece of fabric, the sensor module will not work correctly since the sensor's input is obstructed, enabling the car to start. The device will also be unable to work properly if the sensor's vents get blocked with dust/dirt or other impurities.

This study recommends the following proposals for future research and development to improve the system's design:

a. Connect the system to a GPRS wireless signal transmission unit so that the vehicle's position may be recorded and communicated along with an SMS alert to the authorities or family members if high levels are detected.
b. Integrating the system with a speech recognition system so that only the vehicle's owner is permitted to take a breath sample.
c. Incorporate a temperature and humidity sensor for condition correction.

APPENDIX

A. ALCOHOL LEVEL BELOW THE THRESHOLD VALUE

B. SMS NOTIFICATION OF: A. ALCOHOL LEVEL DETECTION, B. SPEED LEVEL DETECTION.
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CONFLICT OF INTEREST

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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