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ORIGINAL RESEARCH ARTICLE

AN AUTOMATED PROTOTYPE SYSTEM FOR ALCOHOL LEVEL DETECTION IN DRUNK DRIVERS AND VEHICLE CONTROL

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ABSTRACT

Drunk driving is one of the principal contributors to road accidents in Nigeria. Passengers, other motorists and the driver's life are all at risk because of this behavior. The aim of this study is to develop a system that will automatically detects drunken drivers based on the proximity to the steering wheel and prohibits the car from been start. The method employed in this research is the use of an MQ-3 sensor to measure the level of alcohol in the driver's breath in the area around where the driver sits in a car and compare it to the Nigerian guidelines for acceptable blood alcohol concentration (BAC) levels. In addition, the alcohol sensor is protected from obstruction (coverage) by an MH infrared proximity sensor. Also, a red light alert is incorporated to sensitize the passenger whenever the driver is drunk. The result shows that the system performed satisfactorily. It prompt quicker reaction by prohibition of drunk drivers within a distance of 36 cm from the steering wheel from being able to start the car as well as sensitizes the passenger through blinking red light. It also prevent the systems sensor from been cover (obstruction) by drunk drivers within a distance of 5 cm. As a result, the system can be combined with the new technologies of modern vehicles to enforced don't drive when drunk rules which are often violated by drunk drivers.

1.0 Introduction

Modern-day traffic accidents are mostly caused by drunk driving. Drunk drivers are erratic and prone to making impulsive decisions that endanger everyone on the road, including themselves. Nigeria has passed laws making it unlawful for drivers to drink alcohol before or while driving a vehicle and has also designated law enforcement officials to conduct arrests and bring cases against violators (Emmanuel et al., 2017).

In 2016, the Nigerian Bureau of Statistics registered 11, 363 road accidents (Report, 2017). Although, speeding was cited as the main contributing factor in the report, it can be fairly concluded that the majority of events were brought on by drivers' erratic circumstances brought on by consuming alcohol before driving. A 2008 World Health Organization evaluation found that between 50 and 60 percent of road accidents are caused by drunk driving. Analysis shows that 67.2 percent of Nigerian drivers of commercial vehicles admitted to drinking during work days (Groot, 2018). This shows that the majority of drivers engage in drunk driving, which may lead to accidents, especially those operating commercial and heavy-duty vehicles (Mohamad et al., 2013).

Any blood alcohol concentration (BAC) test that is higher than the permissible level of 0.5 g/100 mL in Nigeria is considered illegal. The BAC measures the quantity of alcohol that is present in a certain volume of blood. Additionally, a blood alcohol level of 0.7 to 0.8 substantially impairs a driver's mental, physical, and sensory capacities (Ehikhamenor and Agwubike, 2007).

Many studies have been conducted to monitor and control alcoholic drinking (Jankhotkaew et al., 2023). Rahim and Hassan (2010) created an ignition switch device with a Breathalyzer capability. An LCD screen, an alcohol sensor, a microcontroller, and electronics for the ignition switch are all components of the system. After development, the system can detect the level of alcohol in a breath sample and display the proportion detected as a percentage of BAC on the LCD screen (Blood Alcohol Concentration). Comparatively to other versions, the sensor's sensitivity is likewise rather high. The sensor may detect other compounds and mistake them for alcohol, but its sensitivity to alcohol is substantially greater, making it an extremely accurate alcohol detection gadget.

A steering-wheel-integrated automatic alcohol detector was created by Kousikan and Sundaraj (2014). More infrared light may be absorbed by ethanol. Therefore, the authors make use of an IR sensor that is positioned on the steering. Continuous IR energy is sent via the sensor by an IR source, led-894. A relay circuit is turned on if the absorption of alcohol vapour stops the passage of infrared photons. The gasoline delivery system is under the supervision of this relay circuit, which also shuts off the engine's fuel supply. This causes the automobile to gently come to a stop. More infrared absorption happens at greater ethanol concentrations. When the sensor is coated with alcohol, it does not, however, disable the ignition system.

A system of alcohol detection and vehicle control was developed by Bhuta et al., (2020) using a hardware platform with Arduino at its core, an alcohol sensor mq3, a GPS module, and a GSM module, an effective approach is proposed for developing an intelligent vehicle system that would monitor different vehicle characteristics over a certain period of time and transmit this data to the base station. The suggested system would accomplish the duty of communicating with the access point using GPS, GSM, and control of multiple factors. Small volume and great dependability are advantages of the whole Control system. This system's future potential is to prevent accidents and provide helpful information on the involved car, hence lowering the number of accidents caused by drunk driving.

Al-Youif et al., (2018) presented a study titled "Alcohol detection for the automobile locking system." The prototype has successfully shown its capacity to detect and, therefore, identify a gas concentration. Although this is just a prototype, it might serve as the foundation for further improvised systems that combine more features, leading to improved systems that meet market demands and niches and enable customization. Additionally, the system may feature a wireless alerting system, an auditory alarm, or perhaps both at the same time, in addition to a visual indication.

An effective system of car accident prevention with an alcohol detector incorporated was developed by Mohamad et al., (2013). The primary controller is a PIC 16F876A, the input is an alcohol sensor, and there are three outputs: an LCD, an alarm system, and an ignition system. This technology will notify the motorist of their degree of intoxication by showing them the situation on an LCD screen. Additionally, a buzzer sound is produced to alert the driver of their state and to alert anybody around. The system's most important safety feature is that it prevents drivers who are severely intoxicated from operating a vehicle by deactivating the ignition.

Although several types of research have been conducted on strategies to decrease road accidents caused by drunk driving, the aim of this study is to develop a system that will automatically detects drunken drivers based on the proximity to the steering wheel and prohibits the car from been start.

2. Materials and Methods

The design and implementation of the automated alcohol detection system prototype model for intoxicated drivers and vehicle control included integrating several modules and components. The power supply unit, switching unit, and sensor unit are the three main components of the system. Figure 1 depicts a Block Schematic of an alcohol detection system.

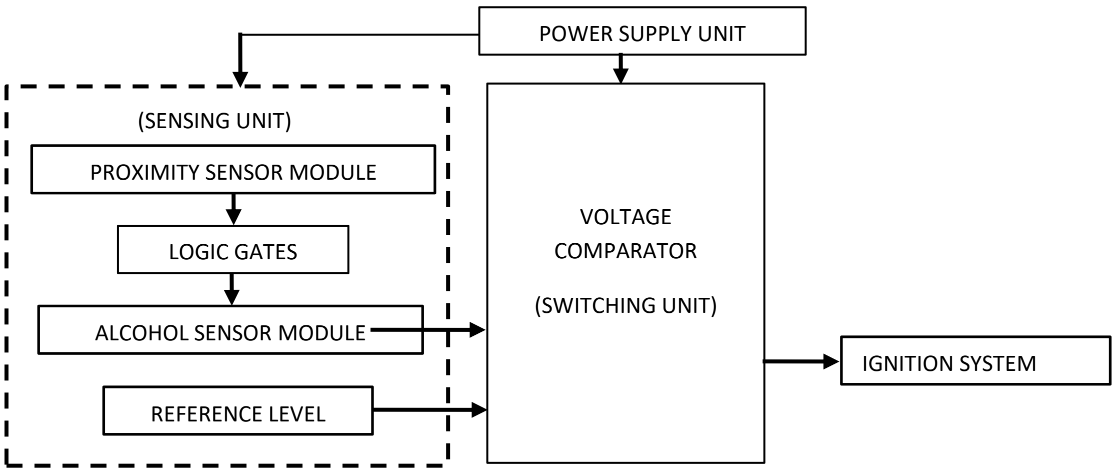

Figure 1: Block Schematic of the System

The power supply unit's circuit diagram is seen in Figure 2. C_1 and C_2 are 0.1 F and 100 F respectively

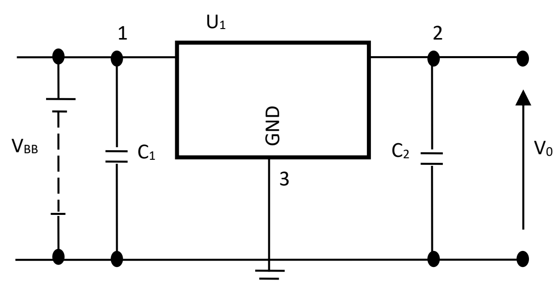

Figure 2: Circuit Diagram of the Power Supply unit

The MQ-3 alcohol gas sensor module is a type of alcohol sensor adopted because it is a low-cost semiconductor sensor that works with Breathalyzers and can detect alcohol concentrations between 0.05 mg/L and 10 mg/L (Tapadar et al., 2018). The device is compatible with TTL and runs on 5 V and 150 mA. Additionally, it has a quick reaction time and a high level of alcohol sensitivity. The photograph and the circuit diagram of the MQ-3 alcohol gas sensor are shown in Figures 3 and 4, respectively.

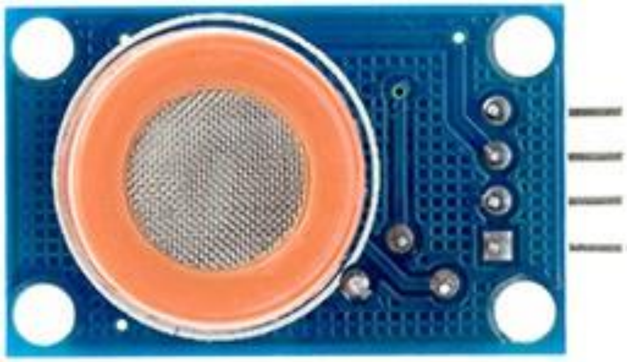

Figure 3: The photograph of the MQ-3 Alcohol Gas Sensor (Component-101, 2020)

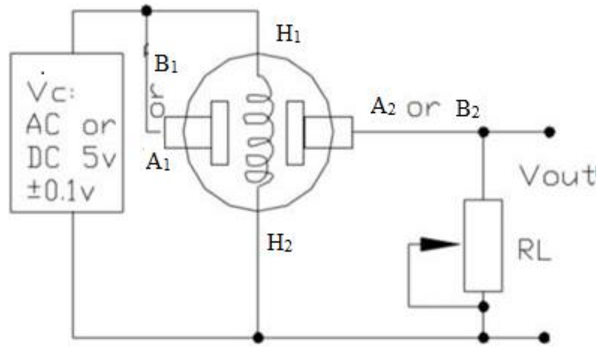

Figure 4: Circuit Diagram of the MQ-3 Alcohol Gas Sensor (Component-101, 2020)

The MH infrared sensor module is the proximity sensor that is used; it is inexpensive and has a quick reaction time. The module has a coverage range of 2 to 30 cm and performs effectively with a DC input in the range of 3.3 to 5.0 V (Einstronic Enterprise, 2018). Photo Coupler makes up the sensor. The image of the MH infrared proximity sensor is seen in Figure 5

Figure 5: The image of the MH Infrared Proximity Sensor Module (Einstronic Enterprise, 2018)

The LM324 is set up to function as a voltage comparator. The LM 324 is a single supply, a low-power quad operational amplifier that runs from 3.0 to 32 volts of DC supply input (Rare-Components, 2022). The LM324operational amplifier's image and pin layout diagram are shown in Figures 6 and 7 respectively.

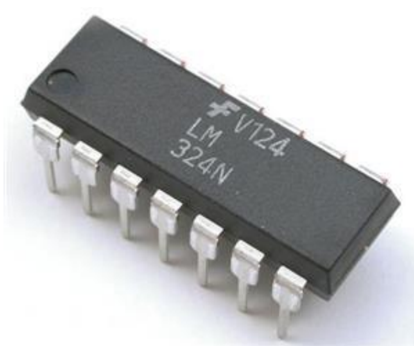

Figure 6: The Image of the LM324 Operational Amplifier (Rare-Components, 2022)

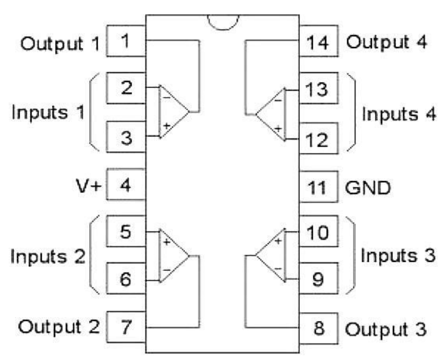

Figure 7: The Pin Configuration Diagram of the LM324 Operational Amplifier

SN74S04N NOT gate and SN74LS02N NOR gate are the gates that were used. The maximum propagation delay for each of them is 15 nS, and they both work within the supply voltage range of 4.75 V to 5.25 V (All About Circuit, 2022 and Rehmani, 2020). The pictures of the SN74S04N and SN74LS02N are shown in Figures 8 and 9 respectively. The relay in use is a single-pole JZC-32F with voltage and current ratings ranging from 5 to 30 volts DC and 5 to 10 amps, respectively (Amazon, 2018). A picture of the JZC-32F relay is shown in Figure 10.

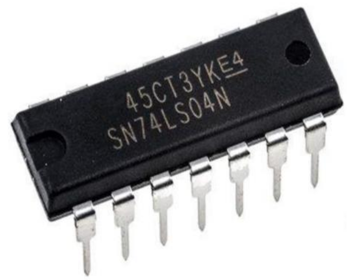

Figure 8: The Picture of the SN74LS04N (All About Circuit, 2022)

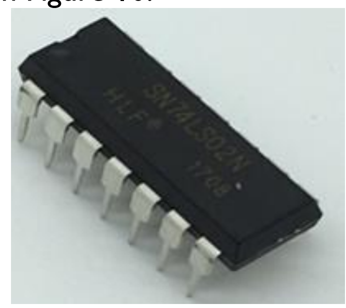

Figure 9: The Picture of the SN74LS02N (Rehmani, 2020)

Figure 10: The Picture of the JZC-32F Relay (Amazon, 2018)

2.1 *Implementation*

The modules and components were organized on a breadboard and connected and soldered to a Vero board as part of the hardware implementation process. The system enclosure was particularly chosen with both convenience and robustness in mind. Figure 11 shows the picture of the arrangement/connections/soldering of the modules/components on the breadboard. The system's circuit diagram and the picture of the housing (casing) of the system are shown in Figures 12 and 13, respectively.

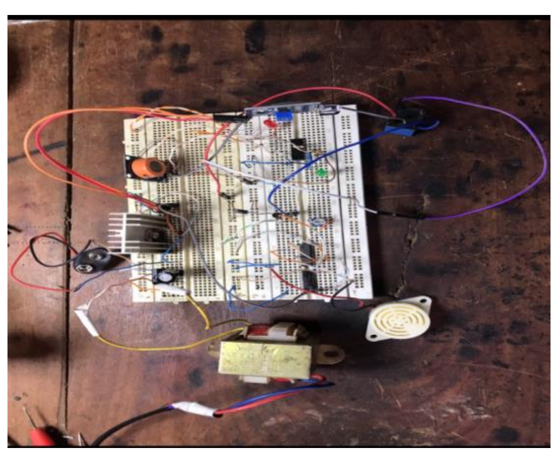

Figure 11: The picture of the arrangement/connections/soldering of the modules/components on the breadboard

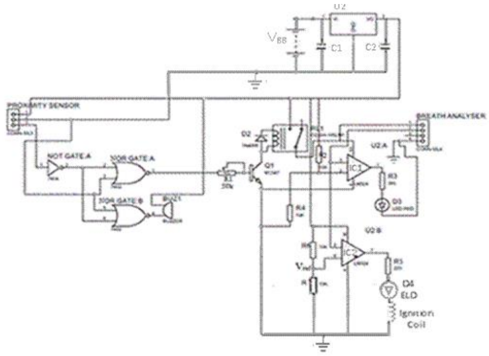

Figure 12: The system's circuit diagram

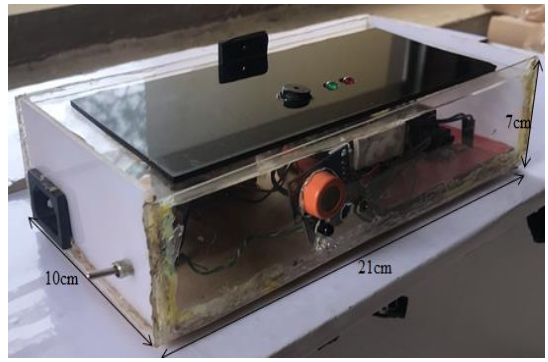

Figure 13: The Picture of the Protoype system

2.2 Performance Evaluation of the Designed System

To verify the degree of performance of the constructed system, the following tests were conducted: the drunker distance performance and the sensor obstruction distance performance. Drunker distance performance was carried out by using a drunken person to as a drunk driver. The drunken person (driver) now stands in front of the system at a distance of 4 cm and moves away from it in step of 4 cm up to 40 cm. While the sensor obstruction distance performance was carried out by using hand to block the sensor. This was done by placing hand (obstruction) at a distance of 1 cm and moves away from it in step of 1 cm up to 7 cm.

3. Results and Discussion

The experimental results of the measured Drunker-Distance Performance and Sensor Obstruction Distance Performance are as shown in Table 1 and 2 respectively. It is observed from the Drunker-Distance Performance (Table 1) that within the distance of 4 cm and 28 cm, the green and red light representing the status of ignition system in Figure 13 is ON and blinks respectively (column three of Table 1) thereby the ignition is OFF and this indicated that the sensor is able to detected alcohol vapor in the air in excessed of the permissible level of 0.5 g/100 mL by the law. At 36 cm the green and red lights OFF thereby ignition is ON and this indicated that no alcohol vapor detected. Also observed from Sensor Obstruction Distance Performance (Table 2) was that within the distance of 1 cm and 5 cm, the green and red light representing the status of ignition system in Figure 13 is ON and blinks respectively (column three of Table 2) and this indicated the system sensor is been covered (obstructed). At 6 cm, the green and red lights OFF and this indicated that no one cover (obstruct) the system sensor.

Table 1: Drunker-Distance Performance

S/N	Drunker-Distance from the System (cm)	Green Light	Red Light
1	4	ON	Blink
2	8	ON	Blink
3	12	ON	Blink
4	16	ON	Blink
5	24	ON	Blink
6	28	ON	Blink
7	36	OFF	OFF
8	40	OFF	OFF

Table 2: Sensor Obstruction-Distance Performance

S/N	Sensor Obstruction Distance from the System (cm)	Green Light	Red Light

1	1	ON	Blink
2	2	ON	Blink
3	3	ON	Blink
4	4	ON	Blink
5	5	ON	Blink
6	6	OFF	OFF
7	7	OFF	OFF

4. Conclusion

A prototype system that automatically detects drunken drivers based on the proximity to the steering wheel and prohibits the car from starting has been developed. It is highly effective because it detected a drunk driver in the range of 4 to 28 cm which is in accordance to Insurance Institute of Highway Safety report in 2004 that states the maximum allowable distance between a driver and the steering wheel to be 24.5 cm. The system also prevents drunk drivers from obstructing the system by a way of sensor blockage. In addition, it also sensitizes the passenger whenever the driver is drunk through blinking red light. As a result, the system can be combined with the new technologies of modern vehicles to enforced don't drive when drunk rules which are often violate by drunk drivers.

References

Report, A. (2017). Nigeria recorded 11, 363 road accidents in 2016.. https://www.premiumtimesng.com/news/top-news/226990-nigeria-recorded-11-363-road-accidents-2016-nbs.html accessed on 17 October, 2022.

Al-Youif, S., Musab, AMA. and Mohammed, MN. 2018. Alcohol detection for car locking system. Proceedings of IEEE Symposium on Computer Application & Industrial Electronics (ISCAIE), 28 - 29 April, Penang, Malaysia: 230 - 233

All-About-Circuit. 2022. Texas Instruments SN74LS04N,Hex Inverter, 14-Pin PDIP-Logic Gates.https://www.allaboutcircuits.com/electronic-components/datasheet/SN74LS04N--Texas-Instruments/ accessed on 17 October, 2022.

Amazon. 2018. JZC-32F 012-HS3/ JZC-32F 024-HS3 Subminiature Industrial Control Relay Automotive Relay. https://www.amazon.com/JZC-32F-012-HS3-Subminiature-Industrial-Automotive/dp/B07K1FCWTF accessed on 17 October, 2022.

Bhuta, P., Desai, K., and Keni, A. 2020. Alcohol detection and vehicle control. Journal of Xidian University, 14(8): 92–97.

Component-101. 2020. Introduction to Gas Sensors: Construction Types and Working. https://components101.com/articles/introduction-to-gas-sensors-types-working-and-applications accessed on 25 October, 2022.

Ehikhamenor, E., and Agwubike, EO. 2007. The need for Blood Alcohol Concentration (BAC) Legislation in Nigeria. Tropical Journal of Pharmaceutical Research, 3(1): 319–327.

Einstronic-Enterprise. 2018. MH Infrared Obstacle Sensor Module. https://einstronic.com/product/infrared-obstacle-sensor-module/ accessed on 25 october, 2022

Emmanuel, GD., Isseini, HH., Adekunle LA., Emmanuel, OA., and Author, C. 2017. Alcohol

Detection of Drunk Drivers with Automatic Car Engine Locking System. Nova Journal of Engineering and Applied Sciences DO, 6(1): 1–15.

Groot, K. . 2018.. Global Status Report om Road Safety. A Pubication of World Health Organization, 1(1): 1-424.

Jankhotkaew, J., Casswell, S., Huckle, T., Chaiyasong, S. and Phonsuk, P. 2023. Quantitative Tools and Measurements for Assessing the Implementation of Regulatory Policies in Reducing Alcohol Consumption and Alcohol Related harms: A Scoping Review. Drug and Alcohol Review, 42(1): 157–168.

Kousikan, M.,and Sundaraj, M. 2014. Automatic Drunken Drive Prevention System. International Journal of Students Research in Technology & Management, 2(02): 74–77.

Mohamad, MH., Amin, M., and Hafizzie, M. 2013. Vehicle Accident Prevention System Embedded with Alcohol Detector. International Journal of Review in Electronics & Communication Engineering (IJRECE), 1(4): 100–102.

Rahim, HA. and Hassan, SDS.. 2010. Breathalyzer enabled ignition switch system. Proceeding of 6th IEEE international Colloquim on Signal Processing and its Applications, 21 - 23 May, Malacca, Malaysia: 1 - 4.

Rare-Components. 2022. *LM324N, Quad Operational Amplifiers, 14-PDIP, Texas Instruments*. https://rarecomponents.com/store/1187 accessed on 2 November, 2022.

Rehmani, A. 2020. 74LS02 Quad Two Input NOR Gate – Datasheet. Circuits-DIY. https://www.circuits-diy.com/74ls02-quad-two-input-nor-gate-datasheet/ accessed on 2 November, 2022.

Tapadar, S., Ray, S., Saha, HN., Saha, AK. and Karlose, R. 2018. Accident and alcohol detection in bluetooth enabled smart helmets for motorbikes. Proceedings of IEEE 8th Annual Computing and Communication Workshop and Conference, (CCWC)8 - 10 January, Las Vegas, USA: 584–590.