

# Design and Implementation of Breath Alcohol Ignition Autolock System

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## Abstract

All over the universe, drunk driving has immensely contributed to the ever increasing number of traffic accidents. The design goal of this work is to use a miniature inexpensive passive alcohol sensor combined with the necessary signal conditioning circuitry along with an advanced low power microcontroller for processing the data for alarm, display and ignition. The purpose of this work is to develop an in-vehicle automatic system that prevents driving while intoxicated as an effort to reduce related traffic accident cases. This work is developed by integrating a passive alcohol sensor with the microcontroller. The alcohol sensor used in this work is MQ-3 which detects the presence of alcohol in the human breath. An ignition system which uses rotation of a motor is designed and implemented to act like the ignition starter over the vehicle's engine. The ignition system will operate based on the level of blood alcohol content (BAC) from human breath detected by alcohol sensor.

**Keywords:** Blood alcohol content (BAC), breath alcohol, Interlocks, alcohol sensors, driving while intoxicated

## 1.0 Introduction

For decades now, drunk driving has been a global issue. It has been found through research that an estimated 1.2 million people are killed annually through auto road mishaps worldwide, 30% of which is as a result of drunk driving. Particularly, in Nigeria, drunk driving has caused so many lives and properties to be lost [1]. Approximately 10% to 50% of total road crashes in the country are as a result of drunk driving. Corruption and the bad situation of roads have been a deterrent factor to the implementation of the methodology developed by the International Centre for Alcohol Policies (ICAP), to fight this ill. [2] opines that the legal blood alcohol concentration (BAC) in Nigeria is less than or equal to 0.5mg/ml.

Recognising that alcohol beverage is widely consumed around the world and its misuse can have severe consequences, it is therefore necessary to pay serious attention and conduct research on methods that can be used to get rid of excessive drinking, especially drunk driving. Beverage alcohol industries worldwide especially in Nigeria have initiated several road safety programmes aimed at combating drunk

driving. For some years now, Federal Road Safety Commission (FRSC) officials have been given breathalysers for checkmating the BAC of drivers, but all their efforts tend to be proved abortive as sometimes these officials are seldom found on the highways because of some official shortcomings and inadequate number of personnel to execute the programme.

Besides, these methods put in place to curb drunk driving globally and locally have been unsuccessful mainly because they are human controlled and subject to the constraints of the human ability. Thus an automatic system which will operate independent of the human factor is necessary.

The Breath alcohol sensor also known as breathalyser is a tool that can be utilised to effectively combat drunk driving. It is one of the latest technologies developed to reduce the size and cost of equipment required to detect the gas. Its high sensitivity to gaseous alcohol coupled with its portability make it suitable for use inside a vehicle says [2]. Thus when this sensor is interfaced with the vehicle start-up system or ignition system, depending on calibration and

the measurements gathered from the driver, it can control the car to start or not.

Breath Alcohol Ignition Interlock Device (BAIID), when embedded into a comprehensive monitoring and service program is a viable tool for stopping drunk driving. The device, which is designed to be installed inside a motor vehicle, forces drivers to take the breath test before they can move their vehicles.

The device will work better if interfaced with other alcohol detectors like the tissue spectrometry and the transdermal sensor. These sensors are however still undergoing development to make them cheaper and more readily available.

Before the advent of the modern Breathalyzer, determining inebriation was incredibly subjective. The police determined whether or not a person was inebriate by observing the driver for signs of intoxication. This method is purely based on human instinct. Many offenders are usually allowed to go scot free because law enforcement agencies were unable to prove that the driver was drunk. More and more lives were being lost. This led to the development of the first breath analyzer by Dr. Emil Bogen. It was the first serious scientific work on mechanizing the determination of inebriation. The first breath test employed a large football bladder that contained sulphuric acid and potassium dichromate [3]. A patient would breathe into it and as the chemicals in the football bladder changed from yellow to various shades of blue and green, they were compared to tubes of the same chemicals in which different amounts of alcohol had been added. Dr. Bogen's analyzer was effective but impractical especially for traffic stops.

Since the evolution of the first breath tester, Researchers have been working very hard on providing a more reliable breath-tester that can be used to checkmate Driving Under the Influence (DUI). Breathalyzers estimate BAC indirectly by measuring the amount of alcohol in one's breath. Three technologies are in use: infrared, electrochemical and semiconductor. Semiconductor analyzers have the advantage of portability and ease of use over the other Breathalyzer types. Semiconductor analyzers

can be used anywhere, ranging from domestic applications to higher level applications. However to win the war against drunk driving, cars have to be self-equipped to prevent driving while intoxicated. So that in the absence of a law enforcement agent, the law against drunk driving can still be enforced. The semiconductor sensor is embedded into an ignition interlock system installed in a vehicle. Before the vehicle can be started, the driver must deliver a breath sample into the device, if the analyzed result is greater than the pre-programmed level, the device prevents the vehicle from being started. It is a small device attached to a vehicle's electrical system that requires a driver to submit to a breath test before the vehicle engine will start running.

## 2.0 Review of Related Works

An intelligent car system for accident prevention was proposed by [4] using new fatigue detection algorithms & techniques using eye blink sensor, alcohol sensor, impact sensor, gas sensor, etc. In this technique fatigue will be detected immediately and regularly traps the events driver and third party.

In his work on Vehicle Accident Prevention, [5] says the techniques that are best, based on accuracy, are the ones based on human physiological phenomena. This technique is implemented in two ways: measuring changes in physiological signals, such as brain waves, heart rate, and eye blinking; and measuring physical changes such as sagging posture, leaning of the driver's head and the open/closed states of the eyes. The first technique, while most accurate, is not realistic, since sensing electrodes would have to be attached directly onto the driver's body, and hence be annoying and distracting to the driver. In addition, long time driving would result in perspiration on the sensors, diminishing their ability to monitor accurately. The second technique is well suited for real world driving conditions since it can be non-intrusive by using optical sensors of video cameras to detect changes. The author proposed two methods for vehicle accident prevention: the eye blink detection using eye-blink sensor and head movement detection using tilt and turning sensor.

In [6], it was reported that Nissan developed a concept car with multiple preventive features against drunk driving, as part of a series of preventive measures. The concept car was designed to detect the driver's condition, to set the driver free from manual operation. If the system detects that there is a possibility the driver has drunk, warnings are issued to the driver to stop the car.

These methods employed to curb drunk driving globally and locally have been unsuccessful mainly because they are human controlled and subject to the constraints of the human ability. Thus an automatic system which will operate independent of the human factor is necessary.

The Breath alcohol sensor such as Breathalyzer is a tool that can be utilized to effectively combat drunk driving. It is one of the latest technologies developed to reduce the size and cost of equipment required to detect the gas. Its high sensitivity to gaseous alcohol coupled with its portability make it suitable for use inside a vehicle says [2]. Thus when this sensor is interface with the vehicle start-up system or ignition system, depending on calibration and the measurements gathered from the driver, it can control the car to start or not.

Breath Alcohol Ignition Autolock Device (BAIAD), when embedded into a comprehensive monitoring and service program is a viable tool for stopping drunk drivers. The device, which is designed to be installed inside a motor vehicle, forces drivers to take the breath test before they can move their vehicles.

### 3.0 System Design and Analysis

Considerations on the size, design complexity cost and voltage consumption of the device have been made. This work employs a miniature inexpensive passive (semiconductor) sensor which has been optimized for very accurate sensing and measurement of changes in driver BAC with time. The system estimates the BAC of a driver with the aid of the breathalyzer. It is connected to a comparator that compares the measured BAC with the limit value. The comparator sends a control signal to the microcontroller which effects the control according, activating or deactivating the ignition. The Status of the driver is displayed on

a 16X2 LCD screen. When a drunken level is detected, i.e. when the BAC is higher than the limit, the buzzer is triggered. The choice of LCD display and a miniaturized sensor aims at eliminating the need for a PC display while ensuring the system is as portable as possible for installation inside a vehicle. Another interesting feature of this design is the reprogrammable and open source nature of the product. The BAC limit that determines if a driver is drunk or not can be manipulated as desired using this device. This is necessary as different countries have their different limits.

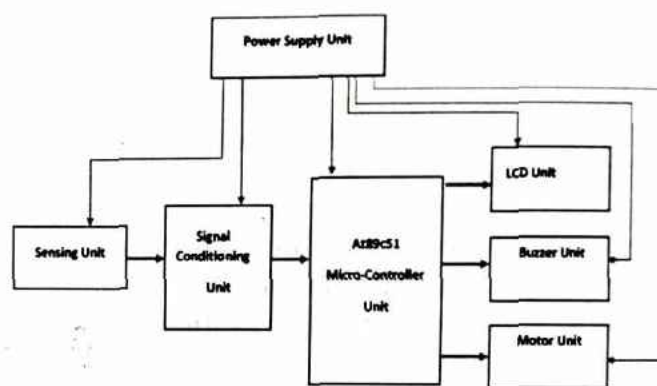


Figure 1: Architecture of the Proposed System

### 4.0 Functional Units of the System

#### (a) Power Supply Unit

This system requires a DC power supply of 5v for the sensor, controller unit and buzzer, a supply of 12V to power the motor. The source of power supply in this case is the car battery which is primarily 12 v d.c.

#### (b) Signal Conditioning Unit

Signal conditioning means manipulating an analog signal in such a way that it meets the requirements of the next stage for further processing. In this case the next stage is the microcontroller unit. The microcontroller accepts only digital inputs (high or low), therefore the analog output of the sensor must be transformed into digital form. This is achieved by employing a comparator.

#### (c) The Control Unit

The AT89C51 microcontroller is used because of its low-power and high-performance. Designing of a system basis on microcontroller is cheaper and easier and since this project aims

at reducing the cost of the device to make it available to all, it is best suited for this project. The device is manufactured using Atmel's high-density non-volatile memory technology and is compatible with the industry-standard MCS-51 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional non-volatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C51 is a powerful microcomputer, which provides a highly flexible and cost-effective solution to many embedded control applications.

#### (d) Sensing Unit

This unit consists of the alcohol sensor for monitoring BAC. This unit is powered by 5volts DC supply. The alcohol sensor circuit will detect the alcohol present in the human breath and the voltage signal generated is conditioned and then sent to the AT89C51 which acts as a controller to other circuits. The alcohol sensor MQ-3 is selected in this system because of its sensitivity to ethanol. The MQ-3 has four pins, one for connection to source (Vcc), ground, a digital output pin and an analog output pin. The latter is used to obtain the output value for this project.



Figure 2: MQ-3 Gas Sensor

#### (e) Display Unit

The display unit is part of the output or load. The display unit consists of a 2\*16 Liquid crystal display (LCD). This feature enables the BAC status of the driver to be viewed on a screen. The main application of LCD in this project is to display the current state of the driver; either sober or drunk. LCD is used because it is economical and easily programmable.

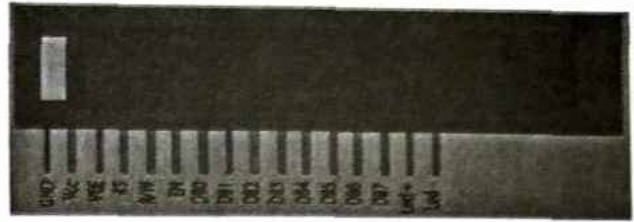


Figure 3: 16\*2 LCD pin-out

#### (f) Buzzer

A 5v buzzer was chosen in order to ensure that the project consumes low power. The buzzer triggers on receiving a high signal from the controller. This indicates that the driver is under the influence of alcohol. The Buzzer was simply powered with a regulated 5v and the annoying shrill sound observed.



Figure 4: 5V Buzzer

#### (g) DC Motor

A 12V DC motor is employed because it uses minimal power and this project aims to design a low power consumption device.. The DC motor represents the car ignition. The motor is switched on and off by a relay, according to the control signal received from the controller.



Figure 5: DC Motor

## 5.0 System Implementation and Evaluation

### 5.1 Software Development

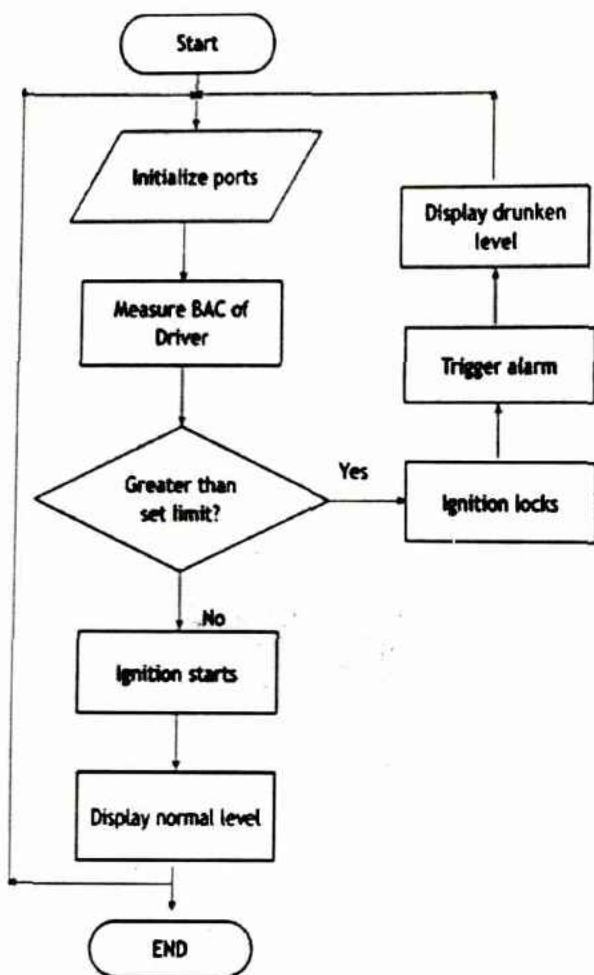


Figure 6: Flow chart for program implementation

The software is decomposed into modules so that each module can be individually tested as a unit and debugged before the modules are integrated and tested as a software system in order to ensure that the software design meets its specification. The software flowchart is as shown in Fig. 6.

### 5.2 System Evaluation

This system is programmed such that it will sense and monitor the alcohol level whenever a breath is sampled on the Breathalyzer and conditions the motor, alarm and display accordingly. The motor is stopped and an alarm is buzzed whenever the critical threshold value of the alcohol level is exceeded. The table below shows the summary of the entire system performance as well as the tests carried out on the entire system to ascertain if it's working

according to the desired objectives and specifications intended for it. The entire system is evaluated based on the tests, observations and results captured in the table below.

Table 1: Test Results

| Alcoholic Beverage<br>(% alcoholic content) | Output Partial airtight jar<br>(Volts) | Output inside the mouth<br>(Volts) |
|---------------------------------------------|----------------------------------------|------------------------------------|
| Whisky (47%)                                | 2.9                                    | 1.92                               |
| Gin (43%)                                   | 2.6                                    | 1.8                                |
| Cream (17%)                                 | 2.21                                   | 1.48                               |
| Beer (5.1%)                                 | 2.18                                   | 1.5                                |
| Toothpaste (traces)                         | 0.97                                   | 0.59                               |



Figure 7: Parts of the BAID

The following are the way to conduct a blackbox testing of the system.

Plug the system to AC supply using the cable (i)

Switch on the system with the power button (ii)

Start the ignition system using the switch in (iii). The motor (vi), display and sensor will be activated.

Take a breath test using the sensor box in (iv)

If breath contains alcohol beyond the set limit, the motor deactivates, the buzzer (vii) activates and the display reads "Drunken Level"

If breath is clear or the alcohol level is below the limit, everything stays as it is

Note: to vary the alcohol limit, vary the variable resistor inside the box.

### **6.0 Conclusion**

The Breath Alcohol Ignition Interlock Device (BAIID) was successfully built. In terms of performance and efficiency, this project has provided an efficient method of preventing driving under the influence (DUI) of alcohol. The device is an automatic system that employs passive sensors. It eliminates the need of a law enforcement office to check for the BAC of a driver. Also, by employing passive sensors the device does not require the driver/car owner to be aware of its presence. It can be easily implemented in any vehicle by connecting it to the ignition wires with a relay which acts as switch. A more complex method is to connect the device to the fuel tank, use a valve to reduce/cut the fuel supply according to the BAC of the driver.

The BAIID is not limited to use in a motor vehicle. It can be employed in companies and places that prohibit alcohol consumption. It can

be modified for use in aircrafts, heavy duty trucks, ships, etc.

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