

# Blood Alcohol Level Sensing Instrument for Car Drivers

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**Abstract**— this document provides information regarding experiment carried out using a blood alcohol level sensing instrument for cars. There have been numerous drunken driving cases which have had dire effects on the lives of involved parties. This device measures the alcohol level in the driver's breath and starts the car only if the alcohol level is under prescribed limits, if the alcohol level is above the limit then the motor does not start and an alarm is given out. In this experiment an Arduino UNO (Atmega-328) microcontroller is used along with an MQ-3 gas sensor to measure the alcohol level in the breath of the driver. A pushbutton acts as the key of a car. A 6V DC motor is used as the car engine. A green color LED is used to indicate allowable alcohol level. To alarm the driver crossing prescribed alcohol limits, a piezo buzzer and a red color LED are provided. The inbuilt GPRS/GSM system helps to inform relatives or friends of the driver regarding the driver's condition for more safety through SMS. The experiment was carried out following the prescribed BAC (Blood Alcohol Concentration) levels of the Government of India and the results were satisfactory and close to the actual values. The system is inexpensive with total cost around \$40. The built is easy and simple to maintain and repair. The alcohol levels can be manipulated according to respective governmental limits by carrying out software changes.

**Keywords**— Arduino UNO microcontroller, MQ-3 gas sensor, alcohol level, BAC (Blood alcohol concentration), GPRS/GSM shield

## I. INTRODUCTION

Alcohol levels in automobile drivers are measured by the traffic police but this does not stop the drivers from driving cars in drunken state. Road users who are impaired by alcohol have a significantly higher risk of being involved in a crash. According to WHO (World Health Organization) in low and middle-income countries a survey found that alcohol was present in the blood of between 4% and 69% of injured drivers, 18% to 90% of crash-injured pedestrians and 10% to 28% of injured motorcyclists. In most high-income countries about 20% of fatally injured drivers have excess alcohol in their blood [1]. According to CADD( The Community against Drunken Driving) 70% of the total road accidents in India are due to drunken driving [14]. Age was found to be a redundant factor in drunken driving cases. Drivers from all age groups were found to be having proportionate shares when it came to drunk driving in Mumbai. Majority of the drivers were driving two wheelers followed by 4 wheelers. [16].

The following figure 1.1 shows drunken driving cases in Mumbai [16].

From January 1 to December 31, 2014

Age	Drunk caught	Vehicles	Caught drunk driving
18-20	225	2-wheelers	9,929
21-25	3,299	4-wheelers	4,934
26-30	4,040	3-wheelers	332
30-35	3,309	Tempo	189
36-40	2,127	Truck	75
41-45	1,326	Bus	29
46-50	662	Dumper	53
51-58	553		
<b>Total</b>	<b>15,541</b>	<b>Total</b>	<b>15,541</b>

Fig 1.1 Drunken driving cases in Mumbai [16]

The statistics clearly depict the seriousness of the issue and the urgent need to combat it.

It is impossible to monitor every driver for alcohol level for the traffic department. Such incidences have led to numerous accidents all over. In the city of Mumbai, there were 18,035 drivers booked for drunken driving. Despite strict laws this number has been shooting up every year [2]. According to the findings by Kloeden and his peers, the risk of accident increases with increase in the BAC levels. The following figure 1.2 supports the statistics [15].

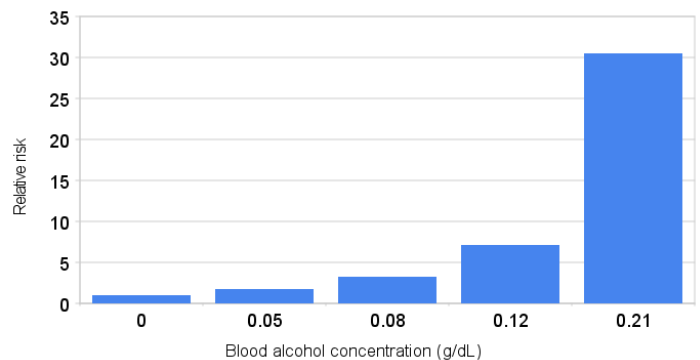


Fig 1.2 Relative risk of accident based on BAC levels [15]

For law enforcement forces, there hasn't been much success to curb the number of such incidences. Thus, there was a need to implement a cost effective instrument for measuring the alcohol level of the drivers in cars.

The objective of this instrument is to devise an inexpensive, time efficient and error free method for measuring the alcohol concentration in the breath of a driver. On the lines of open source technology, this prototype was created. Arduino is an open source platform that allows users to create electronics

projects using hardware and software. It can drive various electrical components like sensors at low voltages. [3]. The MQ-3 sensor is a commonly used sensor in breathalyzers.

While breathalyzers are successful in doing this job, there is no such equipment inside the cars which shall prohibit a drunk driver from driving. Various interlock devices have been produced and tested over the last few decades. However, they have not been successful as far commercial use is concerned. The success and response of such devices have been mixed [4]. But after several testing the number of violations reduced in the cars fitted with interlock devices. [4]. Drivers already convicted by DWI (Driving While Impaired) offence are expected to be repeat offenders [5]. Drivers convicted under DWI are 4.1 times more likely to be involved in fatal crashes rather than the average driver. [6]. There has been a 69% reduction in re-arrests of drivers previously booked for drinking driving. [7]. Failure rate of these previously used devices was 3.4% [8].

This experiment was carried out with the help of 2 male volunteers aged 21 and 58 respectively. The tests were successful when the BAC levels were above the limit of 30mg/dl of blood [9]. Further more tests are anticipated in real life situations after advances in the prototype.

The use of inbuilt GPRS/GSM based system gives this prototype an edge over previously used interlocks. As in this prototype the friends or relatives of the driver are immediately informed if the BAC levels are beyond permitted value. This alerts them so they can take required actions to contact with the driver too.

This experimental prototype can be useful to prohibit the driver from driving in an inebriated state. This method can be useful due to its high efficiency, low cost and simple installation.

## II. METHODOLOGY

### A. Working Principle

The heart of this instrument is an Arduino Uno R3 microcontroller which is based on the open source platform. A gas sensor primarily used to measure alcohol concentration MQ-3 gas sensor is employed to monitor the alcohol levels [10]. One green LED and one Red LED are used as indicators for passing and failing the alcohol test respectively. A push button acts as the key of the car which activates the motor connected to the microcontroller upon passing the alcohol level test. If the driver fails the alcohol test then the red LED glows and a buzzer is set to alarm the user. In such a scenario, despite pressing the push button key the motor of the car cannot be activated. Furthermore, the GPRS/GSM module is used to alert the relatives of the driver to inform them about the driver's inability to drive [11]. This can help to assist the driver and avoid any mishaps. The programming of the entire system is carried out on the Arduino IDE software.

### B. Equipments

1. Arduino UNO (Atmega- 328) microcontroller
2. MQ-3 Gas sensor.
3. GPS module
4. 2 LED's (red and green)\
5. 6 V DC motor
6. Piezo buzzer
7. Arduino IDE
8. Push Button
9. 9V battery as power supply

## II. CONSTRUCTION AND WORKING

The prototype was not physically installed in a working automobile. However, such a device can be installed on the dashboard of a vehicle besides the steering wheel. This experiment created a prototype that used a DC motor to simulate ignition of the automobile.

### A. Connections

The MQ-3 sensor, piezo buzzer, DC motor, GPRS/GSM shield, push button key and LED's were all connected to the Arduino microcontroller. The entire circuit was connected on a PCB (Printed Circuit Board). This PCB was located inside a cardboard housing with external components like the sensor, LED's and alarm being completely visible to the user. The microcontroller and the GPRS/GSM shield were located inside the housing. DC motor was visible outside in order to simulate the working of ignition system of a motor vehicle.

Following figure 2.1 shows the schematics of the circuit.

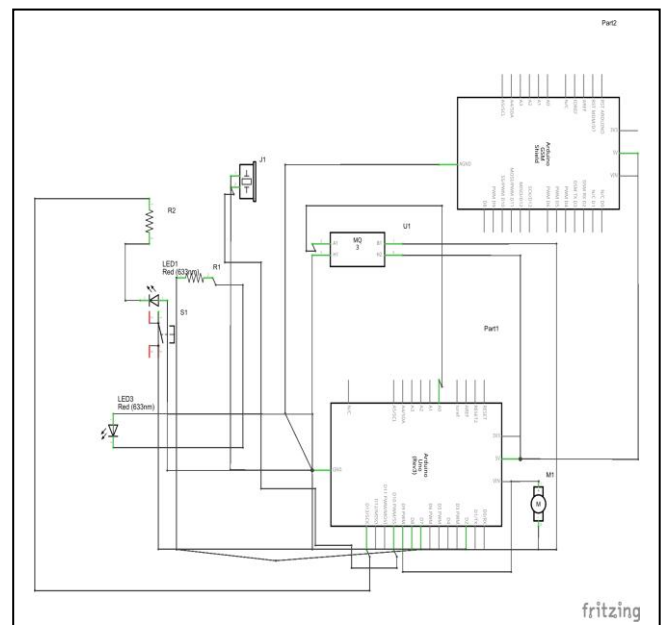


Fig 2.1 Schematics of the circuit

After completing all the required connections, the prototype appeared as shown in figure 2.2

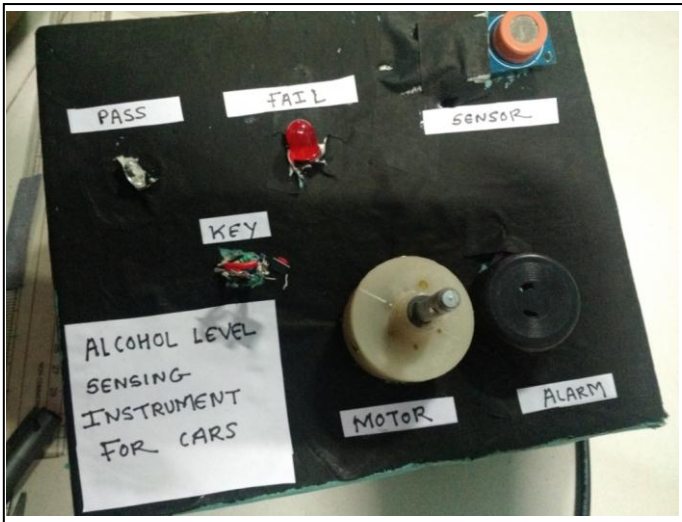


Fig 2.2 Actual prototype

**B. Alcohol sensing**

An MQ-3 gas sensor is used for detection of the alcohol levels. The MQ-3 sensor consists of a sensitive material of SnO<sub>2</sub> which is at low conductivity when normal breath is blown into it. As the level of concentration of alcohol in the breath increases, the conductivity of the sensitive material increases. The alcohol level is calculated as BAC (Blood Alcohol Concentration) level. A 0.1% BAC is 1000mg/L of alcohol. Breath and blood alcohol content differ by a factor of 2100; that is, for every mg of alcohol in the breath, there are 2100mg of alcohol in the blood. So, a person with BAC of 0.1% has 1000mg/L of alcohol in their blood and 1000/2100 = 0.4762mg alcohol in their breath [12].

The prescribed limit of BAC in India is 30 mg/dl which is 300mg/l [9]. Therefore, the alcohol content in breath which is allowable is 0.143mg maximum. When there is no breath blown onto the sensor, the motor cannot be started despite pressing the key. However, if a driver who has no or low level of alcohol in his breath blows into the sensor, the motor can be started by pressing the pushbutton key. This is achieved as the conductivity of the sensor is very low when there is no breath blown into it. When a normal or low alcohol level breath is blown into it the conductivity of the sensor increases and there is a moderate rise in the value which starts the motor by pressing the pushbutton key and green Led is turned on. Finally when a breath with high concentration of alcohol is blown into the sensor there is a very high increase in the conductivity of the sensor due to which an alarm is set along with a red LED. Simultaneously, the GSM/GPRS module sends a text message to relatives or friends of the driver. The sensor is programmed according to the prescribed BAC limits for drivers provided by the Government of India.

**C. Units**

- Alcohol in body is measured in terms of mg/L (milligrams per liter)
- Power supply for the microcontroller is 9V DC
- MQ-3 sensor, Motor and buzzer operate on 5V DC provided by the microcontroller.

**D. Equations**

Formula for calculating BAC from the alcohol measured in the breath is:

$$\% \text{ BAC} = X * 0.21 \quad (1)$$

Where, %BAC= Blood alcohol concentration in percentage  
 X= alcohol concentration in breath in mg/L

**E. The GPRS/GSM shield**

This shield provides GSM network to the experiment in order to communicate with the friends or relatives of the inebriated driver. The GPRS/GSM shield communicates with the microcontroller through serial communication. It is controlled through UART (Universal Asynchronous Receiver Transmitter). The serial communication can be hardware or software. For the purpose of sending SMS we use software serial communication. It is quad band in nature so that it is compatible with telephone networks all over the world. It operates on 5V and 50mA [13].

Once the controller finds out that the BAC level is beyond permissible limits, it commands the GPRS/GSM shield to send a SMS with text “ The driver is drunk beyond permissible driving limits” to the preprogrammed mobile phone numbers.

**F. Programming**

The programming was carried out on the Arduino IDE (Integrated Development Environment) which is open source software that allows coding using the basics of C and C++ languages. The program can be uploaded onto the microcontroller using a USB cable. Once the program is uploaded, the microcontroller can be connected to a battery pack for power supply.

The following figure 2.3 represents the block diagram of the system.

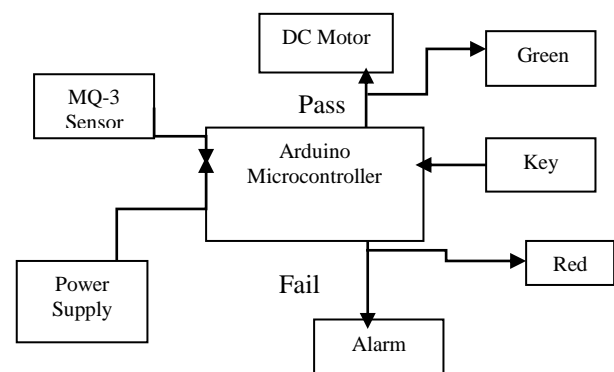


Fig 2.3 Block diagram representation of the system

**III. RESULTS**

There were 2 male subjects A and B were used for testing of this prototype from different age groups of ages 20 and 55 respectively. The readings were taken without and with different amounts of alcohol in the body. The results obtained were successful after comparing the results using commercial breathalyzer. The deviation in readings was +/- 0.5%. For experimentation purpose the readings were viewed in a computer screen through the serial monitor of the Arduino IDE software. For actual device in field, a LED screen can be incorporated in the system to display the BAC level.

**A. READINGS**

The two subjects A and B were tested separately on different occasions and the instrument’s performance was found to be consistent. The liquor used for the experiment was Signature whisky which has an alcohol content of 42.8% by volume.

The following table I shows the readings for subject A with a body weight of 65 kg.

TABLE I.

Sr. No	Alcohol Content (ml)	Measured BAC (mg/dl)	Actual BAC (mg/dl)
1	0	0	0
2	5	4.89	5
3	10	8.92	9
4	20	17.55	18
5	35	31.78	32

The readings for subject B with a body weight of 85 Kg are represented by following Table II

TABLE II

Sr. No	Alcohol Content (ml)	Measured BAC (mg/dl)	Actual BAC (mg/dl)
1	0	0	0
2	5	2.83	3
3	10	5.74	6
4	20	11.55	12
5	35	20.94	21
6	45	26.67	27
7	55	32.89	32

**B. OBSERVATIONS**

After recording the readings of both the subjects belonging to different age and weight groups the following observations were made,

1. The BAC is dependent on the body weight, for higher body weights the BAC value is lower compared to lower body weights for the same volume of liquor.
2. Alcohol absorption property of a body varies according to age and also rate of metabolism.
3. Individuals with higher body weights can consume higher quantity of alcohol without disturbing their decision making required to drive and stick to permissible limits.

**C. CONCLUSION**

This prototype experiment used an Arduino microcontroller with MQ-3 sensor to measure the alcohol content in an automobile driver’s breath. A DC motor was used to simulate the working of an ignition system. The DC motor started if the driver consumed no alcohol or within the limits. An alarm was sounded using piezo buzzer in case the driver failed the test. Simultaneously, a GPRS/GSM shield was used to communicate with relatives or friends of the driver by sending an SMS to them. This system was found to be working successfully under standard conditions. It shall come across as major combat mechanism to the problem of drunken driving that is rife in the society. The response time of the system is very low so there are no lags found during the operation. Thus, this design can be incorporated in various automobiles by connecting it with the ignition mechanism of the vehicle.

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