SMART BREATHALYZER DEVICE

Prof.Sagar Mhatre,Vinay Dalvi, Sohan Jogle, Aditya Joshi, and Prashant Kumbhar
sagar.mhatre@somaiya.edu,vinay.dalvi@somaiya.edu,sohan.jogle@somaiya.edu,aditya.dj@somaiya.edu,prashant.kumbhar@somaiya.edu
Department of Electronics &Telecommunication
K. J. Somaiya Institute of Engineering And
Information Technology
Sion (E), Mumbai University

***Abstract*— The idea of this project is to sense the alcohol content in the blood of a person through its breath. The breathalyser is made with the help of MQ-3 sensor that is interfaced with a mobile phone. The MQ-3 sensor will provide a reading based on concentration of alcohol in the breath of a driver. An android application is developed that has the functionality of capturing the picture of the guilty, storing the guilty personal information, place, time and date of incident. The android application gives the reading in terms of %BAC (Blood Alcohol Content). MQ-3 is calibrated using the regression table which provide corresponding ppm value for the analog output of MQ-3.**

***Key Words*—Blood Alcohol Content (BAC), Breathalyser, Arduino Nano, Android app, MQ-3.**

I. INTRODUCTION

From the recent study it can be concluded that driving under alcohol consumption condition is the cause of increase fatal traffic accidents[8]. In order to protect the lives of people, animals and have social stability it becomes necessary to take effective measure to eradicate the 'drink and drive' situation. By the law there are three ways to measure the level of alcohol in person's body viz. breath, blood and urine[9]. Out of this using breath to detect the level of alcohol is the best and effective method.

If there are two or more person in vehicle then alcohol level is 2.62% but when there is single driver present in vehicle alcohol rate is 0.84%,which is reflect the socialization of drinking habits[8]. The breathalyser is a device that helps to detect the level of consumption of alcohol in terms of BAC. But the MQ-3 sensor does not give the reading directly in terms of BAC. So its analog output are first converted in voltage, the voltage are then converted into ppm (parts per million) and finally the ppm value are converted into BAC.

The whole idea will be divided into three phases viz. (1) Prototype Development (2) Android Application Development (3) Breath Analyser Device Development. The cost of the product used by the traffic police officer to detect the blood alcohol content is approximately Rs.60,000($858). Product build using MQ3 sensor and mobile application will approximately Rs.6000($85). The figure 1 shows a commercialized breathalyser that is use to test the accuracy and precision of our device. The commercial device also has to reset everytime for a period of 10 seconds before its actual working.

II. LITERATURE SURVEY

The current device used by traffic police in India cost around Rs.60,000 as mentioned above[10]. Screening of devices is like old fashioned mobile phone. Driver is asked to blow a breath through a disposable pipe. After this, processing is done in the same standalone device. %BAC reading are displayed on the screen and depending on the predetermined value of %BAC it is decided whether he is guilty or not.

III. DEVICE PROTOTYPING

The breathalyser device consists of the MQ-3 sensor that is used with the collaboration of Arduino Nano microcontroller. A mini breadboard is used to hold the connection of sensor and microcontroller intact. The block diagram shown in figure 2 gives the descriptive idea of the working of device. The driver has to blow his breath to the MQ-3 sensor. The Arduino Nano will process the reading. For displaying the value Android app is used, and depending on the value the application will decide whether to take the picture of driver as well as stores his information in database or not

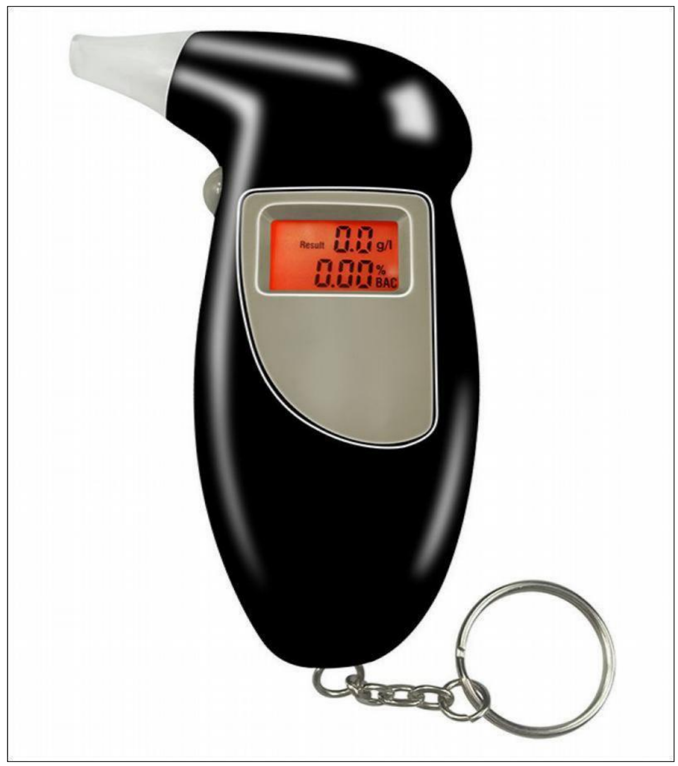

Figure 1: Digital Alcohol Tester Breath Analyser with LCD Display and LED(Source: Amazon.in)

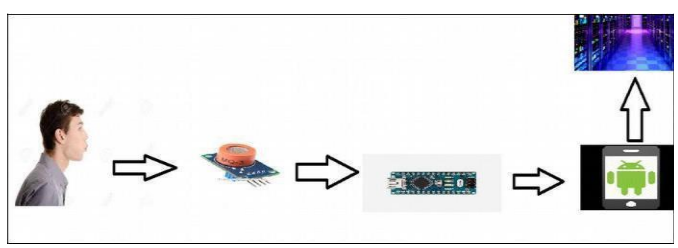

Figure 2: Block Diagram of Smart Breathalyzer Device

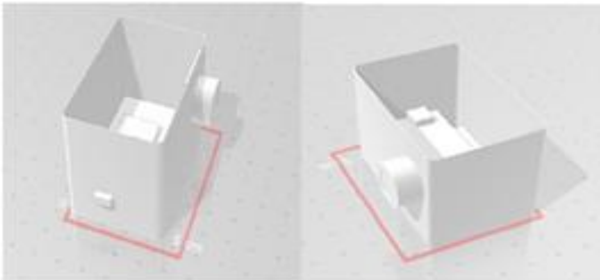

Figure 3: Smart Breathalyzer Device with 3D drawing showing the position of all the components along with the slot that will be used for connecting the device to the smart phone

The MQ-3 sensors front part is expose through a small opening from where it can intake the breath of a person. A disposable mouthpiece is made available for each user. The expose part of the sensor is covered with glass lead when not in used. The implementation of the prototype is shown in figure3. Solder the alcohol sensor to the gas sensor breakout board.We can connect sensor anyway to A1,B1,H1,and GND and can be rotated 180^0 Just careful that silkscreen marking facing down,away from sensor.You are able to read them when the sensor is soldered to the board and assume resistor value 4.7k Ω from B1 to GND..Solder A1 and H1 together. The whole unit will be interface to the smart mobile phone in which one application is created for further processing.

IV. SOFTWARE ALGORITHM

Figure 5 shows the flow of how the software will program on nano and android. Both the nano and android code will be programming parallely. The nano microcontroller is required the calculation of %BAC value only. On the other hand the android application has three functionality that is first to display the BAC value and then according to value it will decide to open the camera and bio-data function or not.

First of all the android will display the message as 'Getting ready to read'. It requires a pre-processing of 10 seconds. For this purpose a switch will be provided. After 10 sec the device is ready to take the reading. The driver requires to blow a breath through the pipe. The microcontroller will process the %BAC value as shown in flowchart and transmit it serially to the mobile unit. The calculation required for %BAC is all carried out in nano microcontroller and it is shown in the calibration and testing part. Since the MQ-3 sensor is develop as a module the conversion from analog to digital is done internally and a separate ADC module is not required. The android app will display the %BAC value. Now based on the value of %BAC if the value exceed the legal limit (0.08 in India) then camera function will open to capture the image of the guilty, it is followed by opening the bio-data function that will write the person name, the location, time, number plate and all this information is being stored on database of police for future requirements. In either case if the value of %BAC is below the legal limit then the camera and bio-data function will not be operated

V. CALIBRATION AND TESTING

It was not so easy to compute BAC from the alcohol sensor, as we know that MQ-3 will not give direct BAC value. On the 5th page of the MQ-3 datasheet, we can see that there is a curve shown in figure 4 that maps parts per million (PPM) of alcohol to a voltage at B1 assume 4.7k resistor connected to GND. We used a polynomial regression table (To fit a 5th order polynomial to several points taken

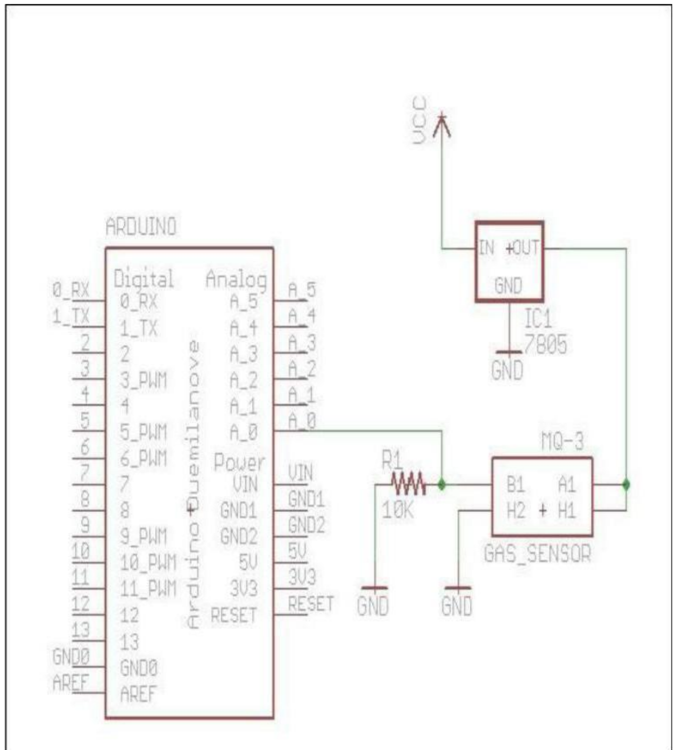

Figure 4: Interfacing the MQ-3 sensor with Nano Arduino

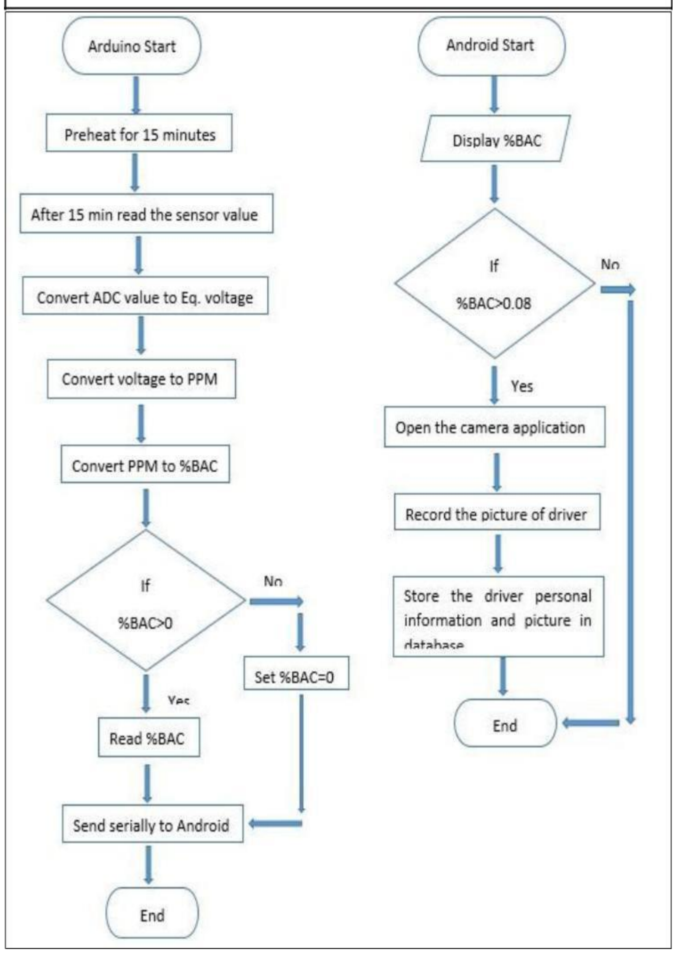

Figure 5: Flowchart of software approach for Arduino and Android programming

from the curve we get this equation in terms of PPM:-

$$PPM = 150.4351049*v^5 - 2244.75988*v^4 + 13308.5139*v^3 - 39136.08594*v^2 + 57082.6258*v - 32982.05333$$

Then we used Excel to create a list of ADC values in the Arduino, that ranges from (0 – 1023) and their associated voltages (0 - 5V). In the next column,we get the PPM from the voltages and Finally, we can convert PPM to BAC with the help of formula:-

$$\% BAC = PPM /2600.$$

It turns out that there is a standard conversion from breath alcohol content to BAC that is employed by commercial breathalysers. Breath and blood alcohol content differ by a factor of 2600; that is, for every mg of alcohol in the breath, there are 2600 mg of alcohol in the blood. So, a person with BAC of 0.1% has 1000 mg/L of alcohol in their blood and 1000/2600 = 0.4762 mg alcohol in their breath. For testing purpose we purchase digital alcohol tester breath analyser with LCD display and LED back light so that we can analyse how closely our device reading matches with the standard device. We observe that our device reading were same with respect to the standard one.

VI. TEST RESULT

As the steps shown in calibration a lot of calculation is required to calculate the actual value of %BAC from the analog output of the MQ-3 sensor. In the software approach in order to have a very precise value of BAC we have make use of sliding window. In this technique average of some numbers of BAC are taken for example we have make use of 10 windows. In this the first 10 value of %BAC are taken and average of these 10 values are displayed. This is done so that we will get an precise value because even one decimal point in the reading can make a difference. As shown in figure 7 initially the message will read as ‘Getting Started’, this is because we have put a timer of 10 seconds so that MQ-3 get pre-processed as well as preheat. Then it will display ‘Take Reading’ after which we have to take reading. So finally a reading i.e. %BAC is displayed. We have displayed both with and without alcohol.

VII. DISCUSSION

As seen in figure 6 the MQ-3 sensor is most reactive rather sensitive to alcohol and is also the cheapest alcohol sensor. But the fall back is that if the alcohol retain for long time around the sensor then it will definitely give wrong reading even if the driver is not drunken. So in order to suppress this fall we will provide disposable pipe to each new user. And also there will be enough ventilation provided.

Even though the calibration of the MQ-3 sensor was somewhat challenging because of the non-linear characteristic, but with the help of regression curve it become possible to have its calibration done. The development of Android app had remarkably reduced the cost of the current system that the traffic police use is from 60,000 to 6000. And also it provides a real time data by making a record on the police database. Before the next reading the MQ-3 sensor should be provided a rest time of atleast 10 seconds. A rest time of more than 10 sec will be more accurate if apply. It was observe that if fresh air is blown before the next reading then it will be useful.

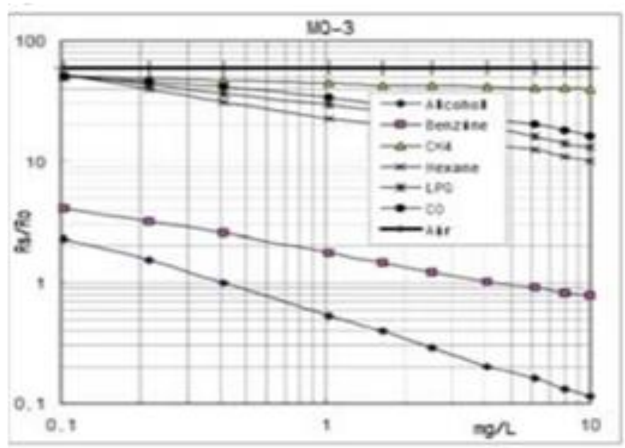

Figure 6: Sensitivity of MQ-3 sensor

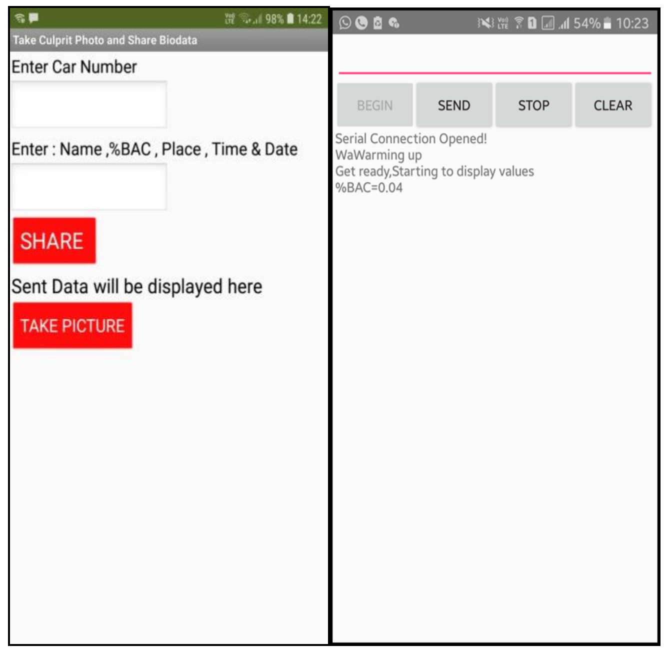

Figure 7: Android application for reading the value of MQ-3 sensor (left side) and taking the picture of guilty and along with picture sending the personal information of guilty on database

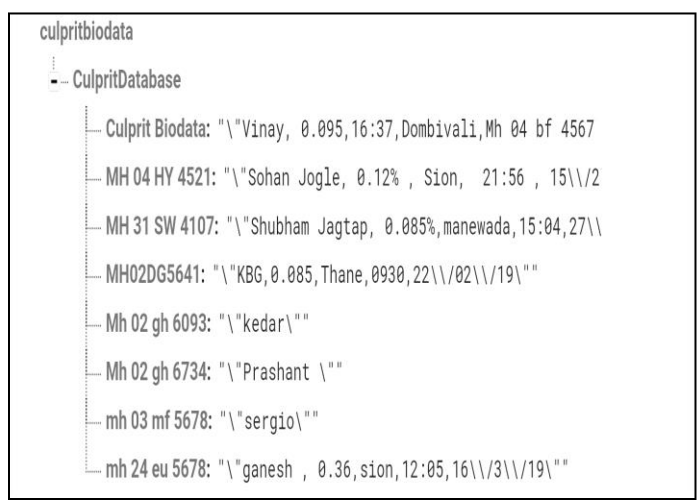

Figure 8: Data stored in Database

VII. CONCLUSION AND FUTURE DEVELOPMENT

From the performance of MQ-3 sensor we can say that a precise value of %BAC is provided, but initially when the system is started for the very first time during each day it will take a period of 10 to 15 minutes to stabilize. So the user must take care to keep ready the system before use. Though this delay is present then also the development of interactive smartphone android application has overwhelmed it. Possibly the device should be initialize at the start of the day, and after every six hours for efficiency. The idea to use the smartphone for this purpose rather than using the current standalone system will be beneficial. After this in software approach the range of reading especially the decimal point range must be taken care of. Another type of calibration (other than using regression table) should be used.

Future development of this product should be based on the search for a sensor that can be used in continuous trial without any delay or rest time. Also the development should make a plan to remove the microcontroller and all the processing should be done in android application. For this the knowledge of the serial transmission is required from the sensor to the smartphone. Further if this product has to use for mass production then proper modelling of the component in the device is needed.

REFERENCES

(1) Technical Data MQ-3 Gas Sensor [Online].
https://www.sparkfun.com/datasheets/Sensors/MQ-3 .

(2) Tristan Novak, Nischala Thumula, Mo Chen, and Zhongqiang Chen 'Design and Characterization of Breath Analysis System for BAC Prediction',pp 1-5, 2015

(3) Arduino projects [Online]. Available
http://educ8s.tv/arduino-breathalyzer-project/
https://nootropicdesign.com/projectlab/2010/09/17/arduino-breathalyzer/

(4) DIY Breathalyzer [Online]. Available
https://www.hackster.io/ShawnHymel/diy_breathalyzer-1efe13

(5) Effects of Blood Alcohol Concentration [Online].
http://www.cdc.gov/motorvehiclesafety/impaired_driving/bac.html

(6) Firebase [Online].Available
https://www.google.com/search
client=ubuntu&channel=fs&q=firebase&ie=utf-8&oe=utf-8

(7) Autocad drawing[Online].Available
https://www.google.com/search
client=ubuntu&channel=fs&q=autocad&ie=utf-8&oe=utf-8

(8) Drink and drive[Online]
https://www.bing.com/search?q=drink+and+drive+accident&form=EDGTCT&qs=PF&cvid=8b549f63a4774236ae52bcabdef7d120&cc=IN&setlang=en-US

(9) Alcohol consumption methods[Online]
https://pubs.niaaa.nih.gov/publications/AssessingAlcohol/sobell.pdf

(10) Traffic police start testing
https;//www.hindustantimes.com/Mumbai news/Mumbai police start testing high