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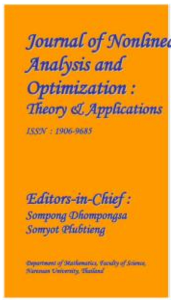

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AN INTELLIGENT ACCESS CONTROL BREATH ANALYZER

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ABSTRACT: - Alcohol consumption accounts for 5% of the global mortality or 1 in 20 deaths arising both from behavioural sequelae like motor vehicle accidents and medical morbidity. The International Centre for Alcohol Policies (ICAP) and the FRSC still maintains that Road traffic accidents involving alcohol and drugs remains the leading criminal cause of traffic related deaths in India [2] and despite the never-ending campaigns against drinking and driving by the FRSC and NURTW in commercial motor parks, drivers still find it easy to get behind the wheel after too many drinks. To truly prevent commercial drivers from driving under the influence in FRSC designated and other public motor parks, access to their vehicles should only be granted if their blood alcohol content is below the legal limit of 0.05g/dl for India. This can be achieved using technology-inspired approaches like the microcontroller-based driver Breathalyzer access-control turnstile. In this research. We have implemented an operational access-control drivers' turnstile that uses a reprogrammable MQ3 alcohol sensor and a servomotor which serves as an access limiter.

The aim is to develop a Breathalyzer access control and real-time notification system that prevents commercial drivers from accessing their vehicles if Blood Alcohol Concentration (BAC) values above the Indian legal threshold of 0.05g/dl(gram per decilitre) is detected from their breath. The design incorporated a reprogrammable MQ3 alcohol sensor and a servomotor to the turnstile which serves as access limiters to the vehicle. BAC levels above 0.05g/dl automatically locks the turnstile and the driver is denied access to the vehicle, because it will prevent intoxicated commercial drivers in public motor parks from accessing the road and hence reduce alcohol-induced traffic accidents.

I. INTRODUCTION

Road traffic accidents that result from the cases of driving under the influence (DUI) of alcohol have become a major source of concern to authorities in many countries of the world. In Nigeria, statistics released by the Federal Road Safety Corps (FRSC) for the year 2013 shows that the combination of the factors of speed violation, loss of control, and dangerous driving caused 61.2% of the total number of road traffic crashes for the year. These three factors most probably could be attributed to drivers who were drunk [1]. In India and United Kingdom the percentage of fatalities in road traffic accidents due to alcohol related problems is said to be as high as 40% [2]. The problem of drinking under the influence of alcohol has led to the introduction of laws in many countries to prevent its occurrence by penalizing offenders [2, 3, 4, 5, 6, 7, 8].

When a person consumes alcohol it enters the blood stream. This forms the blood alcohol concentration (BAC). As a result of exchange of chemicals and air in the alveoli, the exhaled human breath contains a concentration of alcohol known as the breath alcohol concentration (BrAC). The blood breath ratio (BBR) or partition ratio gives the relationship between the BrAC and BAC as 2100:1. This assumes that the amount of alcohol in 2100 liters of expired air from the lung is the same as is found in 1 liter of blood [4, 9]. In addition to alcohol the human breath contains a variety of gaseous components and condensates called volatile organic compounds (VOCs) that correlate physiological and metabolic processes to these compounds released from one's mouth [10, 11, 12, 13]. In many countries statutory limits are set for breath alcohol concentration; for most European countries the legal concentration limit is 0.25 mg/L or 0.05% BrAC [14]. In Great Britain the Road Traffic Act 1988 set the statutory limits as 9 μg/100mL and 35 μg/100mL [3]. In South Africa the legal limits are 0.24 mg/L for normal drivers and 0.10 mg/L for professional drivers [5] while in India the limit is 30 mg/L [2]. In Hong Kong the prescribed limit is stated as 22 μg/100mL of breath or 50 mg/100mL of blood or 67 mg/100mL of urine [6].

A variety of technologies have been used in non-invasive or unobtrusive breath analysis [15, 16, 17, 18, 19]. These methods have used sophisticated sensors based on electrochemical and infrared spectroscopy such as Selected Ion Flow Tube Mass Spectrometry (SIFT-MS) [15] and Laser Absorption Spectroscopy (LAS) [18]. When responses to a number of VOCs rather than one analyte are required, the use of electronic nose detection system (eNose) may be preferred [11, 19].

The system described in this work uses a gas sensor that is sensitive to the detection of ethanol which is a prominent component in the breath of a person who has consumed alcohol. The system that has been designed in this work is built around a single microcontroller and it is cheap to implement in comparison to many existing breath analysers.

II. MATERIALS AND METHODS

The block diagram of the digital breath alcohol threshold limit detector is depicted in Fig. 1. The alcohol contained in the breath is detected by the alcohol sensor which, in this case, is the MQ3 gas sensor [20]. The sensor gives an analogue output voltage that is proportional to the amount of alcohol contained in the breath. This voltage is processed by the microcontroller which sends the output to visual and audible displays.

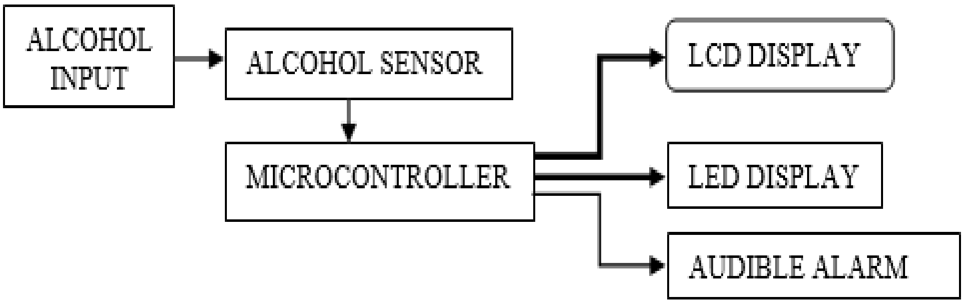

Fig. 1: Block diagram of a digital breath alcohol threshold limit detector

The block diagram was developed into the schematic diagram shown in Fig. 2 that was used to simulate the hardware of the system in Proteus Virtual System Modeling Environment version 8.0 [21]. The variable resistor RV2 is used to generate the voltage that represents the output of the alcohol sensor. The microcontroller used in this system is the PIC16F887 [22].

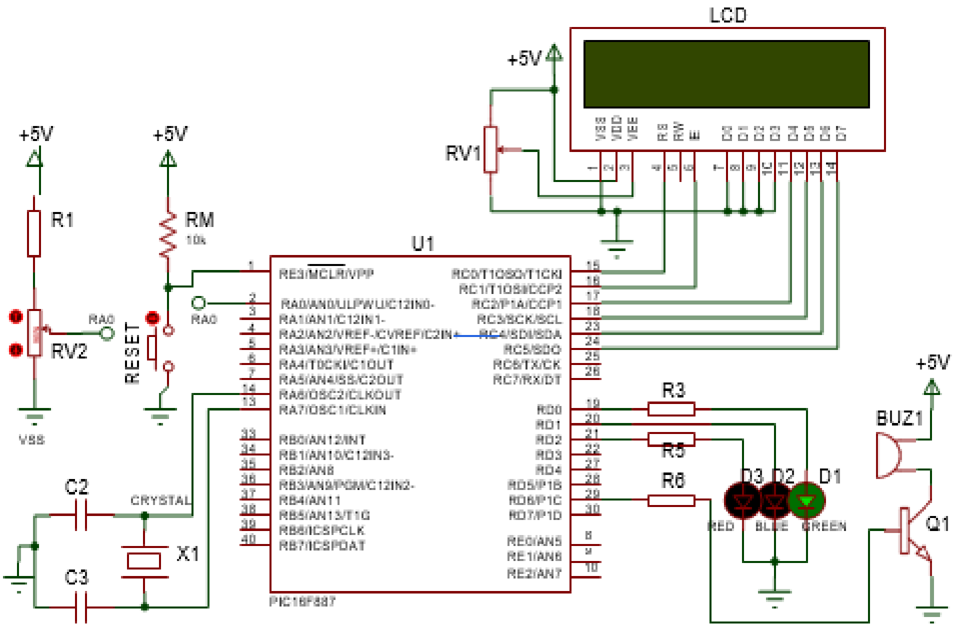

Fig. 2: Schematic diagram of digital breath alcohol threshold limit detector

2.1 Sensor Calibration

Solutions that contained ethanol of various concentrations were made. The concentrations of the solutions were correlated to the blood alcohol concentration which is defined to be the percentage of alcohol, in grams, in 100 mL of blood. Thus 0.02% BAC implies that there is 20 mg of alcohol in 100 mL of blood. The concentration range varies from below the legal limit to values above the legal limit. The concentrations were thus made to correspond to BAC values of 0.00, 0.02, 0.04, 0.06, 0.08, 0.10, 0.12, 0.14, 0.15, 0.16, 0.18, and 0.20 [23]. The solutions were placed on the sensor and the corresponding output voltages were recorded on a digital voltmeter. These voltages were reproduced by the variable resistor RV2 in Fig. 2 during hardware simulation; the voltages were also used to set the threshold values during the implementation of the hardware.

III. FIRMWARE DEVELOPMENT

The flowchart of the firmware of the system is depicted in Fig. 3. When the system is powered ON, it monitors the analogue input from the alcohol sensor. This input is then converted into the corresponding blood alcohol concentration (BAC). The program then checks if this BAC is within the legal range. Appropriate decisions are taken and these are sent to the visual and audible displays to advise the driver. The legal limits vary from one country to another and these can be set in the firmware of the system.

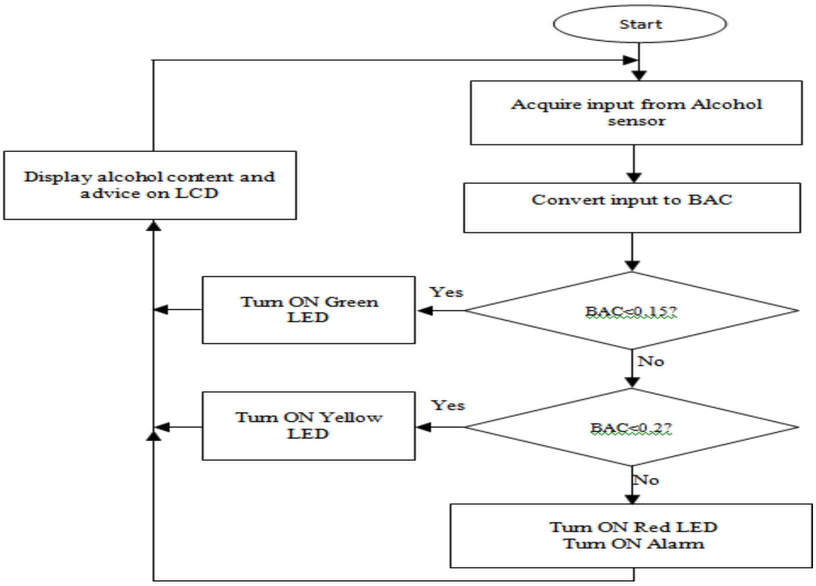

Fig. 3: Flowchart for program of the digital alcohol breath alcohol threshold limit detector

IV. RESULTS AND DISCUSSION

The firmware for the system was written in C language using MikroC Integrated Development Environment (IDE) version 6.0 [24]. Upon successful simulation of the firmware in this environment, the executable file was then imported into Proteus Design Suite IDE [21] where the circuit in Fig. 2 was simulated. A screenshot of the program development in MikroC IDE is shown in Fig. 4. Figs. 5, 6 and 7 show the simulation results for the three possible cases: the alcohol in the breath is less than the set limit; the alcohol in the breath is within the range of set limit and the alcohol in the breath is greater than the set limit. These three situations are also explained in Table 1.

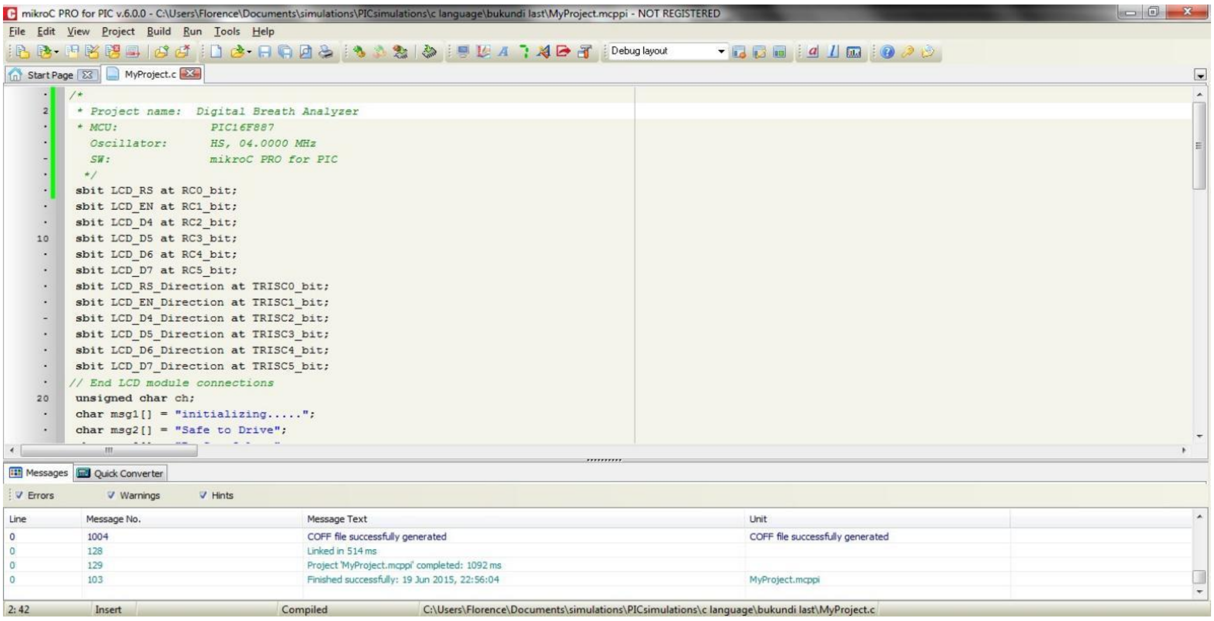

Fig. 4: Development of program using miCroC IDE

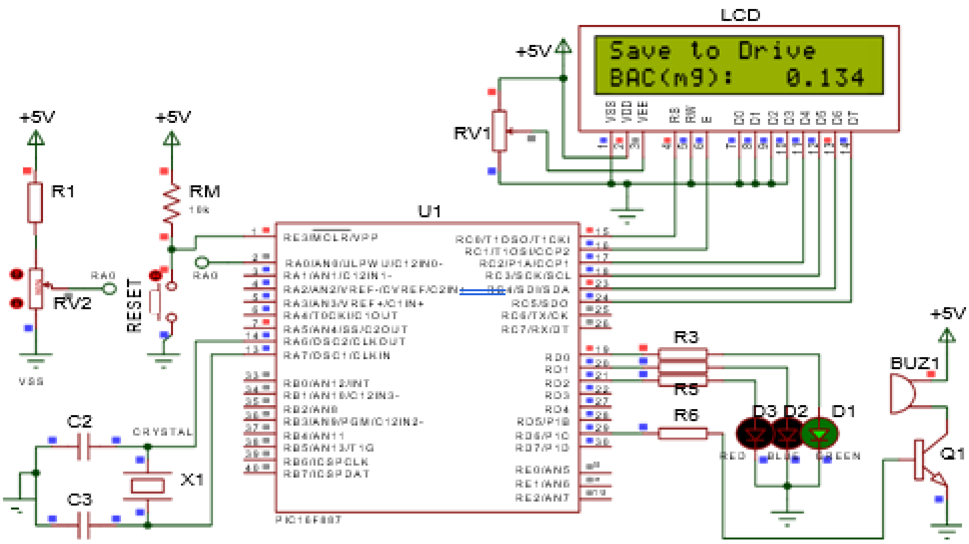

Fig. 5: Simulation results for alcohol content less than the set limit

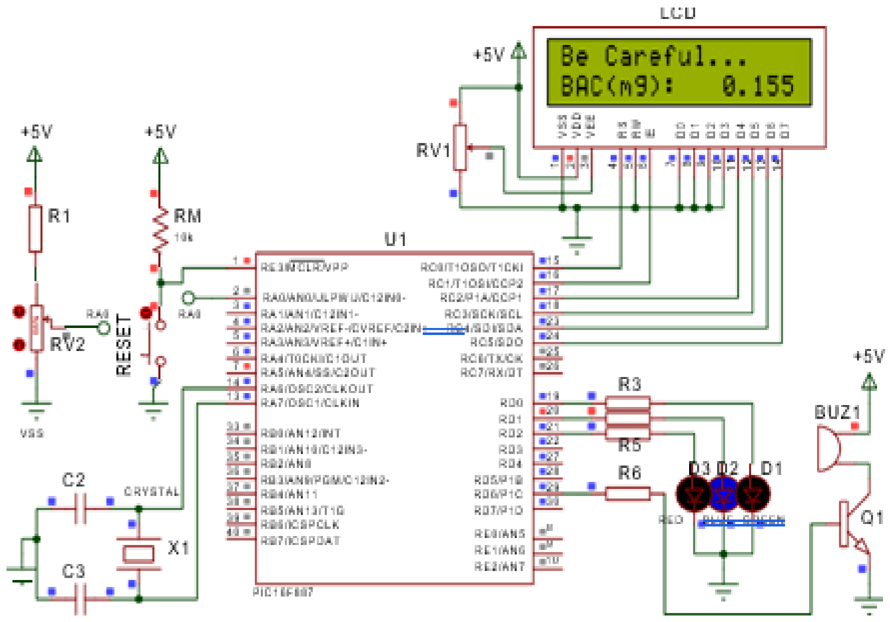

Fig. 6: Simulation results for alcohol content within the range of the set limit

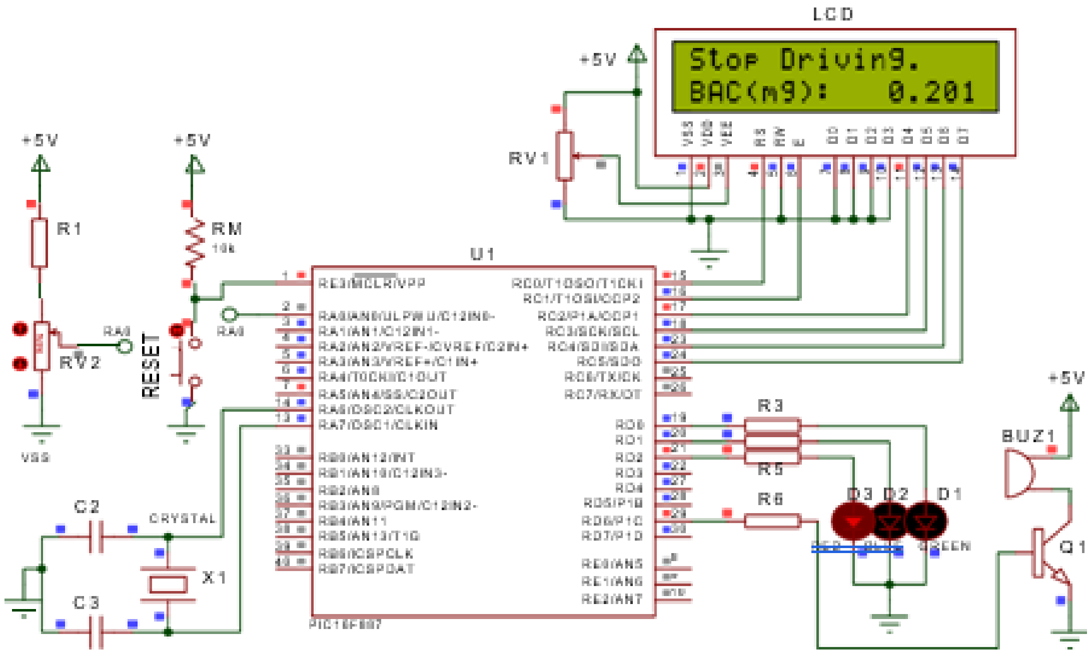

Fig. 7: Simulation results for alcohol content greater than the set limit

V. CONCLUSION

A digital breath alcohol threshold limit detector that uses a microcontroller as a major component has been implemented. This purely advisory system takes the breath of the driver as input and, through indications, advises the driver whether to continue driving or not. The system can be installed in a car or it can be made as a handheld device to be used by relevant regulatory agencies for checking drivers on the highways.

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