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Development of Alcohol Detection with Ignition Lock System for Vehicles

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Abstract: There are so many cases of accidents involving the drunk driver recently. In the current situation, the detection of a drunk driver is based on roadblock and it is not relevant for detecting a drunk driver. Due to the problem, this project will help to decrease the cases of the drunk driving issue. An alcohol detection system with an ignition lock for vehicles is one of the solutions for the drunk driver issue. The system includes the algorithms that sense the alcohol by using MQ-3 sensor for detection of the alcohol. The system equipped with components including MQ-3 sensor, Arduino Mega 2560, LCD display, Red LED and DC motor for detecting the presence of alcohol in a vehicle. The prescribed limit of this system is 39 mg/L. Once the system is turned on, the sensor will sense the alcohol vapor by doing the experiment that using alcohol beverage and non-alcohol beverages. There are two types of conditions for this system. First of all, when the sensor is detecting the level of alcohol is under the prescribed limit, the ignition lock will turn on, and then the DC motor will works like normal. Next, the sensor is detecting the level of alcohol is over the prescribed limit and thus the DC motor will stop functioning and the ignition lock will be off and thus the car will not moving. As for results, the system functions as it was programmed, but unfortunately, the sensor of the MQ-3 sensor does not function well due to the error in detecting alcohol even though the sensor has been calibrated. Hopefully, this system can be used in the future by adding some features for notifications to the authorities and reducing cases, including drunk drivers.

Keywords: Alcohol Detection, Ignition Lock, MQ-3 Sensor

1. Introduction

A road traffic injuries is defined as the fatal or non-fatal incurred as a result of a road traffic. Moreover, the road traffic crash is defined as the accidents or collision that may cause to injury that occur on a public road involving at least one moving vehicles. The study from Bloomberg cited from World Health Organization (WHO) statistics says that Malaysia is among the highest country with the

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riskiest roads after Thailand and South Africa. Malaysia has recorded a death rate of about 23 per 100,000 population [1]. Nowadays, lots of the road deaths were because of the drunk driver issues. Malaysia has one amongst all time low rates of road deaths caused by alcohol consumption in the Southeast Asia according to the most recent information from the World Health Organization (WHO) [2]. Even though Malaysia has recorded lowest percentage, Malaysian Government recently has taken action for tougher penalties for alcohol-related road deaths due to the rise of cases happened in early this year. The Road Transport Act (Amendment) 2020 had been operates starts 23 October 2020 as a new law for the reckless or dangerous driving involving the offence of causing death [3]. There were some of methods to detect the drunk drivers. But first, to detect the amount of alcohol intoxication of a drunk driver is usually determined by a measurement of the blood alcohol content. Depending on authorities, the blood alcohol content is measured by blood, breath and urine. Moreover, the breathalyzer is a device to detect amount of alcohol presence of the drunk driver by blowing their breath. Under the new law, the limit of alcohol content is now 22 micrograms in 100 ml of breath and the level which are line with World Health Organization (WHO) standards [4].

Drunk drivers in Malaysia had recently become a hot topic due to the increasing number of accidents involving the drivers that suspected of driving while intoxicated with alcohol. The reports from the police statistics states that within January until May 2020, the total drink driving cases involving deaths or injuries in Malaysia had been reported was 22 cases [5]. There were quite increasing in number compared to 2019 cases only at 23 cases for the whole entire years. The methods to detect the drunk driver was measured by breathing, blood and urine. But the efficient method was measured by breathing. Breathalyzer is a device to check alcohol pressure of the driver's breath by blowing their breath into the device. But sadly, this approach was only used if there was a roadblock, and it would cause a major traffic jam during the peak hour. Moreover, the navigation apps today will reveal about the road block ahead and there were chances to escape from the road block by using the other routes. They threaten other road users if they escape from the roadblock and drive in a drunken state.

This project proposes to develop the alcohol detection with ignition lock system for vehicles. This project will develop hardware and software for detecting the alcohol with a detection lock system. In the controller algorithm phase, the coding of detection of alcohol will be uploaded by Arduino IDE. Arduino Mega 2560 is used as a microcontroller for the system to detect the presence of alcohol while MQ-3 sensor is used to detect the presence of alcohol in a vehicle. In the controller algorithm phase, the coding of detection of alcohol will be uploaded by Arduino IDE. The value limit of the system that has been programmed is above 39 mg/L of breath for high. Finally, this project will evaluate the functionality of the system in detecting drunk drivers.

2. Literature Review

Excessive intake of alcohol had been known as a primary factor of a driver's inability to properly drive a car and thus, will increase risk of the said driver to involve accidents. The risk of accidents that causing injury or death will be higher due to the influence of alcohol while driving. Deputy Housing And Local Government (KPKT) Minister Datuk Seri Ismail Abd Muttalib said "between 2016 and 2020, there were 771 cases of accidents caused by the influence of alcohol, which resulted in 44 deaths". Based on the data from The Royal Malaysia Police (PDRM), there were 21 cases of drunk drivers were reported within January 2020 until May 2020 with 8 deaths. Due to this problem, Malaysian Government had enforced about the new law in the amended Road Transport Act 2020 about taking the firm action for the drunk and reckless driving. Furthermore, the prescribed limit of alcohol will be lowered also by the government within 35 micrograms to 22 micrograms of alcohol in 100 ml of breath.

2.1 Measurement of Alcohol content

Blood alcohol content is refers to the volume of alcohol in bloodstream that expressed as milligrams per liter (mg/L). There are some factors that affecting the blood alcohol content such as the amount of drinks intake, the weight of the drunker, the gender of the drunk persons, the body fat and the meal

intake before drinking. A person with the empty stomach is more tend to reach the higher blood alcohol content due to the slows the rate at which alcohol passes into the bloodstream. The first legal limit for BAC used was 0.15 of blood alcohol content. In Malaysia, the government had announce the new amendment about the prescribed level limit of alcohol intake under Section 45G of the Road Transport Act 1987 including the 22 micrograms of alcohol in 100 millimeter of breath, 80 milligrams of alcohol in 100 milliliter of blood and 67 milligrams of alcohol in 100 millimeter of urine. Due to the prescribed limit for blood test which is at 80 milligrams, there is a formula to calculate the blood alcohol content. But first, it can be said that there is a standard ratio used for the conversion factor to determining the blood alcohol content which is 2100:1. This means that 1 millimeter of blood has 2100 times more alcohol than 1 milliliter of air in the lungs. BAC is expressed in ethanol weight, weighed by 210 liters of breath that measured in grams. Then, divide by 1000 the 210 to find the BAC percentage by multiplying by mg/L in breath. The equation below shows the formula to calculate the percentage of BAC:

$$\%BAC = breath\left(\frac{mg}{L}\right) x \frac{210}{1000} \qquad Eq.1$$

It is well known that the average percentage of blood alcohol content in Malaysia is 0.08. By using the aforementioned formula, it is possible to determine the value of breath where the breath (mg/L) for a 0.08 blood alcohol content is equivalent to 0.381 for the same amount of BAC. According to the data sheet for the MQ-3 sensor, the detecting range of this sensor is up to 10 mg/L and the range is up to 1023. The numeric value of 0.381 mg/L of alcohol can be determined using the 1023 value as a baseline for real-time computation. Therefore, if the breath contains 0.38 mg/L of alcohol, the numeric value for the amount of alcohol is roughly 39.

$$\frac{0.381}{10} = \frac{x}{1023} \qquad Eq.2$$

$$x = 38.97\ equivalent\ to\ 39 \qquad Eq.3$$

2.2 Review of the Previous Research

There are lots of the research that can be found on the internet that are related to the sensor that sense the presence of alcohol in the car which is being applied by many people to test the alcohol level. Furthermore, even the government had changed the law, there are still got the cases that involving of the drunk issue when driving. The literature review for this study is to collect the information or research about the previous work that related to the alcohol detection system in the car. This study also will figured out on how to improve the method of the presence of the alcohol and also providing a better understanding of the research study that have been discussed and summarized, as in Table 1. From the Table 1, it shows the comparison of the previous work on the detection system of alcohol. As seen from the table, the similarity of all the study is the uses of components are quite same and the difference is the notification system by using the communication components. But, there is a study where the notification is not used because of focusing more on how to ignite the engine of the car. In conclusion, some of the features can be used to the final year project to develop the detection system of alcohol.

Table 1: Comparison of previous research for detecting alcohol

Ref. No	Operation of the System	Microcontroller and sensor	Ignition System
[6]	The system use the microcontroller and a sensor to detect the presence of alcohol and had the IOT components to send the notification to the officers about the current location of the drunk driver. The system also displaying the text when the level alcohol in high or low.	ATMEGA 2560 of Arduino Mega as controller and use sensor MQ-2 first and the change to MQ-3 sensor for better detection.	Turn off the ignition system when the prescribed limit is more than 400 ppm.
[7]	The MQ-3 sensor will detects the presence of alcohol in the surroundings. If the alcohol concentration is high, the sensor will give the reading to Arduino and the DC motor will stop as representative the engine of the car. The notification system will send the location to the civil forces for take action.	Arduino Uno as microcontroller, MQ-3 sensor as sensor for the detection system	Turn off the DC motor when the reading of alcohol is greater than the threshold level.
[8]	The project is developed by integrating alcohol sensor by using sensor MQ-3. The sensor will detect the alcohol content in human breath. When the reading of alcohol level is too high, the buzzer will rings and the ignition will turn off by the relay and no notification system.	Arduino Uno as microcontroller, MQ-3 sensor as sensor for the detection system	The ignition lock will shut down when detecting the percentage of alcohol is over limit.

3. Methodology

3.1 System for detection of drunk driver

As seen from the block diagram in Figure 1, the LED, LCD, DC motor and Ignition lock are connected to an output from the microcontroller. First of all, the sensor will sense the presence of alcohol from the breath of the drunk driver and will send the signal to the Arduino Mega 2560 as a microcontroller if the sensor detects the alcohol. After that, the microcontroller will analyzed level of alcohol that programmed to determine the level is high or low. If the level of alcohol is high, the car will not start and the dc motor will be shut down for precaution for the driver. Next, if the level of alcohol is low, the LCD will display the level of alcohol and the dc motor will run as normal.

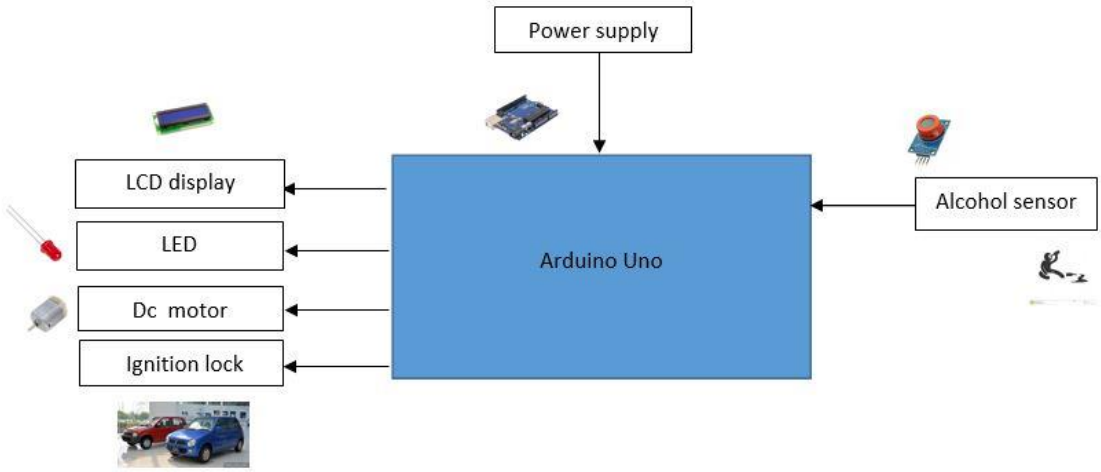

Figure 1: Block diagram of the system.

3.2 Flowchart of the system

The outcomes from this experiment had only two possible outcomes. Either low reading of alcohol presence or high reading of alcohol presence. If the reading are low, the motor will run as normal. For your information, the motor was represent the car's engine of the driver. After that, if the sensor detects the alcohol in high number, the motor will shut down by itself with usage of a relay to this circuit. Figure 2 below, shows the flowchart on how the system works.

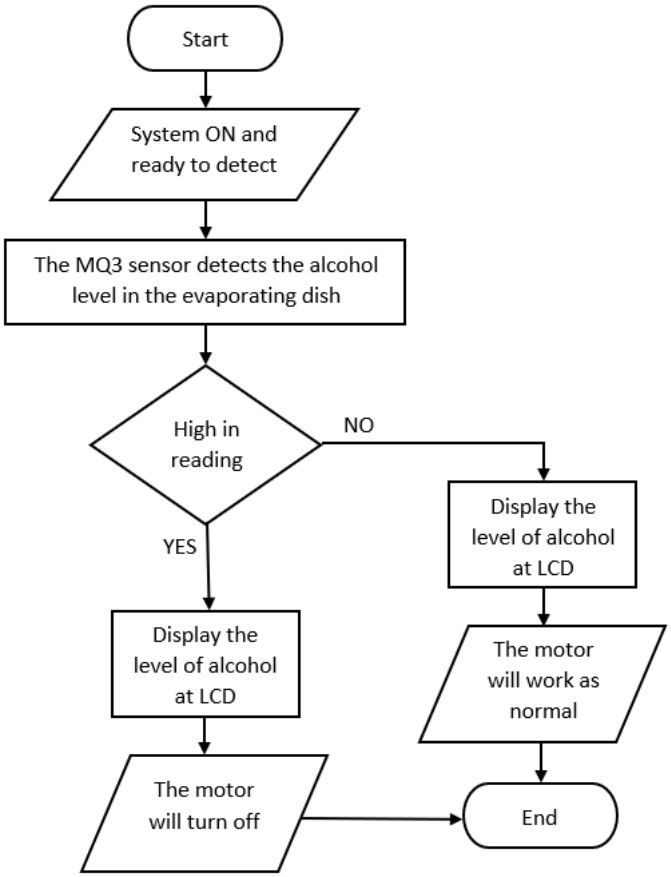

Figure 2: Flowchart of the system to detect the presence of alcohol.

3.3 Specification of hardware

It has been determined which kind of hardware specification would best suit the system in terms of power, level of alcohol, and other factors for accuracy in the detection of alcohol in order to complete the project. Table 2 shows the description of the specification.

Table 2: Description of the Specification

Hardware	Software
• Arduino Mega 2560 as microcontroller • MQ-3 Alcohol Sensor • Dc Motor • Liquid Crystal Display (LCD) • Key Ignition Switch • Light Emitting Diode (LED) • Relay	• Arduino IDE • Fritzing

3.4 Circuit Connection

The system is equipped with the MQ3 sensor that will sense the presence of alcohol and the sensor will give the output to the Arduino Mega 2560 and then it will display the level of alcohol by the LCD. As seen from Figure 3, the illustration of the system's circuit that sketch in the Fritzing software.

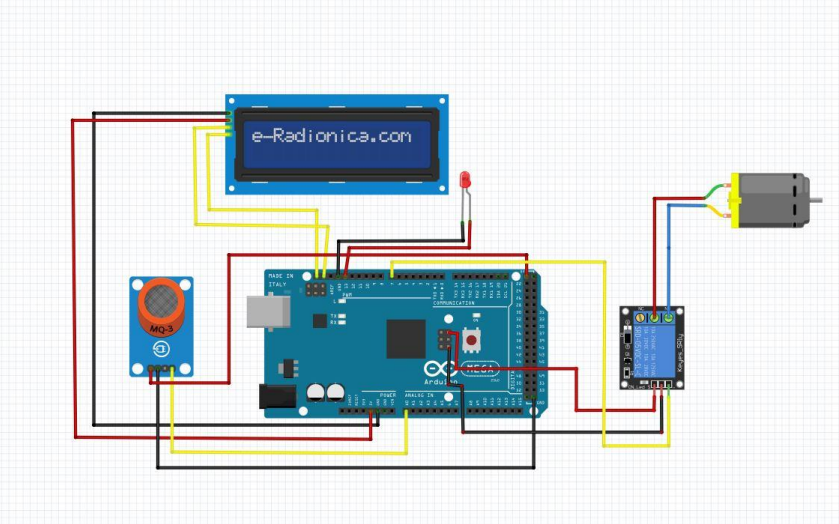

Figure 3: The system's circuit connection to detect alcohol.

4. Results and Discussion

The result that has been obtained from integrated system as stated in Figure 3. This project will be used the two sensors of MQ3 as seen in Figure 4 because of there will be error for detection alcohol. For your information, only a sensor will be used to detect the alcohol at one time and then the other sensor will be replaced the existing sensor to see the comparison for both of the sensor.

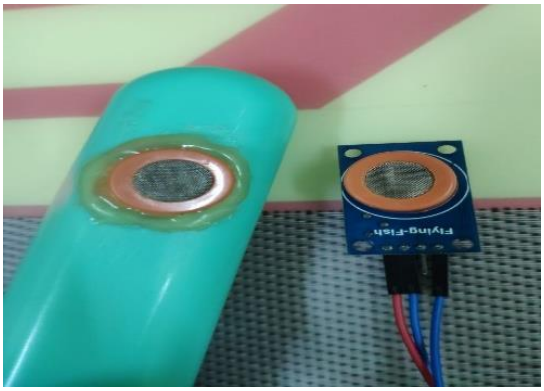

Figure 4: The old (left) and new (right) of MQ3 sensor that been used.

4.1 Calibration of MQ-3 sensor

The outcome for the previous test was not successfully done because of the error on reading the alcohol. To overcome the problem, the calibration need to be done to get the maximum accuracy for detecting the alcohol presence. As stated in the website [5], the sensor must be fully warmed up in order to achieve maximum accuracy. Figure 5 shows the process of calibration for the MQ-3 sensor by using some simple coding to sense the alcohol in the hand sanitizer solution that contain alcohol.

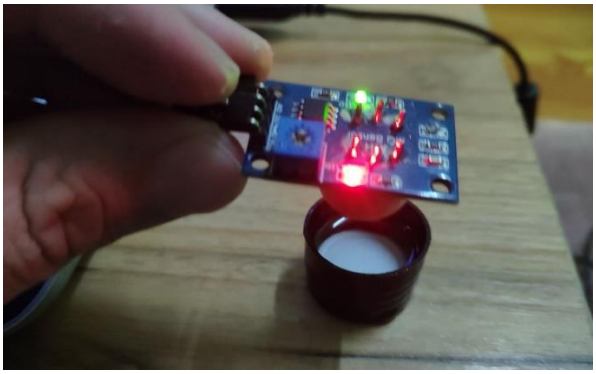

Figure 5: The process calibration of the MQ3 sensor.

4.2 Detection of alcohol presence

The system begins to operate once the power source is linked to the microcontroller and is capable of providing electricity to all of the circuit's components. After that, the LCD will light up to indicate for the circuit to fully functions. The sensor was set at 39 for the limit for the alcohol concentration. There were two conditions to test the effectiveness of the sensor to sense the alcohol:

a) Heating process of the alcohol by using gas stove or Bunsen burner.
b) The sensor was placed direct to the alcohol with no heating process.

4.3 Tables of results for both method

a) Heating process of the alcohol by using gas stove or Bunsen burner.

In this method, the alcohol beverages need to be heated to get the vapor from the heating process. The alcohol solutions need to be heat same as our body temperature which at 37 degree Celsius. The Table 3 shows the outcomes of the result. As seen from this table, the system detects the alcohol in high level of reading and then all of the components works as it programmed.

Table 3: Result for detecting alcohol by heating process

Components	Results
Dc Motor	Stop Running
LCD display	High in reading the alcohol level
Led light	Lights up

As shown in the Table 3, the system detects alcohol at a high level of reading and then all of the components function as expected. When the level of alcohol is high, the Dc motor will stop running, LCD display will appear the level of alcohol in high and then Led light will turn on.

b) The sensor was placed direct to the alcohol with no heating process

There are two conditions of the system that must be carried out in this method, which are by using alcoholic beverages and non-alcoholic beverages. This method also uses the two sensors of the MQ3 to see the comparison of each sensor. Table 4 shows the results for non-alcoholic by using the old and new MQ3 sensors, respectively. From Table 4, it shows the system was working fine due to the dc motor and led lights. When the reading of alcohol is low, the dc motor will run as normal, led light will not light up and if the reading of alcohol is high, the dc motor will turn off, the Led light will be light up. But unfortunately, there was an error to the old sensor. The reading of alcohol was high and it caused

the system to function as it was designed to. The old sensor should have detected the non-alcoholic beverage with a low alcohol reading, but it detected it with a high reading.

Table 4: The results for non-alcoholic by using the old and new MQ3 sensor.

Components	Results	
	Old MQ3 Sensor	**New MQ3 Sensor**
Dc Motor	Stop Running	Not stop
LCD display	High in reading the alcohol level	Low in reading the alcohol level
Led light	Lights up	Lights off

Table 5 shows the results for alcoholic by using the old and new MQ3 sensor, respectively. From the Table 5, the system working fine but there was an error for the new MQ3 sensor because the sensor detect the alcohol beverage in low level. The new sensor should have detected the alcoholic beverage with a high alcohol reading, but it detected it with a low reading. From the results collected, the sensors was not sense the alcohol accurately even though the sensor already calibrated.

Table 5: The results for alcoholic by using the old MQ3 sensor.

Components	Results	
	Old MQ3 Sensor	**New MQ3 Sensor**
Dc Motor	Stop working	No stop
LCD display	High in reading the alcohol level	Low in reading the alcohol level
Led light	Lights on	Lights off

5. Conclusion

The development of alcohol detection with ignition lock system for vehicles is a research project that may be used to prevent road accidents caused by drunk driving. There were two objectives of this project that need to be fulfilled at the end of the research. The first objective was to develop the hardware and algorithm for the alcohol detection system. The system works perfectly as it was programmed, but the sensor was not working well due to the inability to sense the alcohol accurately, even though the calibration had been done. Next, the second objective was to evaluate the functionality of the system in detecting drunk drivers. Hopefully, the project can inspire all car manufactures in the country to develop this project in the future.

Acknowledgement

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