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Research Article

The Portable Carbon Monoxide (CO) and Hydrocarbons (HC) Gas Detection System in The Car Cabin Uses The MQ-9 and TGS 2610 Sensors

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ABSTRACT

The increase in the number of vehicles especially cars causes the air environment to look polluted. This is caused by vehicle exhaust gases that can affect the level of human health. Harmful gases such as carbon dioxide (CO) and hydrocarbon (HC) can also enter the car cabin, making people inside feel suffocated and even death. To find out the presence of these gases, a monitoring system prototype is made which is placed in the car cabin. This system consists of input in the form of an MQ-9 sensor and a TGS2610 sensor. The readings of these sensors are processed by Arduino Uno. The system output is made in the form of a buzzer and LCD. Tests carried out on the car cabin area are divided into three, namely front, middle, and rear. The results of the 6 tests show that the smallest percentage of CO errors is 8% in the middle area and HC of 8.7% in the rear area of the car cabin.

Keywords: Carbon Monoxide, Hydrocarbon, Arduino Uno, Sensor MQ-9, TGS 2610

Introduction

Indonesia is a developing country in the field of transportation, especially cars. With each passing year, the number of these vehicles seems to be increasing. Based on data [1], private cars rank second with a total of 13253142 units, followed by motorbikes with 91085532 units. This increase creates problems for the environment due to the presence of car exhaust gases that contain hazardous substances such as carbon monoxide (CO) and hydrocarbons (HC).

The cases of death caused by imperfect exhaust gas are increasing day by day. One reason is that the gas enters the car cabin, poisoning someone inside. Also, the cause is the lack of air circulation because the cabin space is always closed [2]. Based on data [3] [4] it shows that CO gas above 2 ppm and HC gas above 200 ppm for vehicles ≥ 2010 are categorized as polluted.

To minimize hazardous gases being inhaled above the normal threshold, many studies have been carried out on these gas detectors. As [5] simulated a CO detector in the car cabin using the MQ-7 sensor. The results of these studies

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indicate that the prototype can detect CO levels in normal rooms and when CO increases or decreases. The study [6] used the MQ-7 and MQ135 sensors to detect harmful gases in the car cabin. This research is based on circuit simulation using the ProSPICE program. Another study is [7] where the sensor used is the MQ-7 type. The test results on conditions inside and outside the car cabin show that the range of 16-52 ppm is in the safe category, the range of 123-161 ppm is in the alert category, and above 399 ppm is in the hazard category. Tests were also carried out 5 times for CO levels from cigarette smoke. Research [8] also made a prototype of a monitoring system for hazardous gases in the cabin other than CO. The sensor used is the MQ-7 and the system output is connected to the blower / AC motor and the LED indicator. The use of fuzzy is done by [9] by inputting the reading of the CO gas sensor for vehicles under and above 5 years. While the exit is to turn off and turn on the tool. Currently, the detection result of CO gas is sent via the GSM module and its location is sent via the GPS module [10].

Research [11] also made a detection tool for CO and HC gases in the car cabin. if the detected gas value exceeds the normal limit, the power windows actuator will work. The difference between the test errors with a gas analyzer for CO gas was 19.79% and HC was 6.82%. This research also determines the amount of electrical load.

Based on previous studies, this research emphasizes the CO and HC gas monitoring system, in which tests are carried out in three areas, namely the front, middle, and rear of the car cabin. While the sensors used are the MQ-9 and TGS 2610 sensors. The novelty of this research is the detection area for harmful gases in the front, middle, and back cabin in the car. In addition, the detection system is made portable.

Methods

a. System Architecture

In the process of designing this system, there are several block parts, namely input, process, and output. The three blocks are arranged in sequence and precisely and become a complete unit so that an accurate system is formed and can work as expected. In Figure 1, a system block diagram is shown.

The system input is in the form of an on / off switch, the TGS 2610 sensor, and the MQ-9 sensor. This switch or switch is used to turn the appliance on and off. The TGS 2610 sensor functions to detect carbon monoxide (CO) gas. The third sensor functions to detect hydrocarbon gases in the car cabin. In addition, the input to the system is a power supply in the form of 4 18650 li-ion batteries.

The system created is based on Arduino Uno. This is a microcontroller board based on ATmega328 which has 3 main PORTs, namely PORTB, PORTC, and PORTD with a total of 23 input or output pins. This microcontroller uses a 16 Mhz crystal oscillator.

The output block consists of a Buzzer and LCD. The buzzer is used for alarms, while the LCD functions to display the measurement results of the tool. The display module used is a 2x16 LCD.

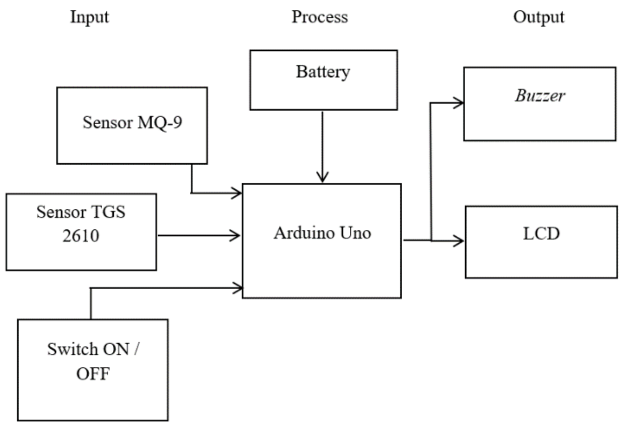

Figure 1. Block Diagram of CO and HC gas detection system in the car cabin

b. Circuit schematic

In Figure 2, the schematic of the system that is made is shown.

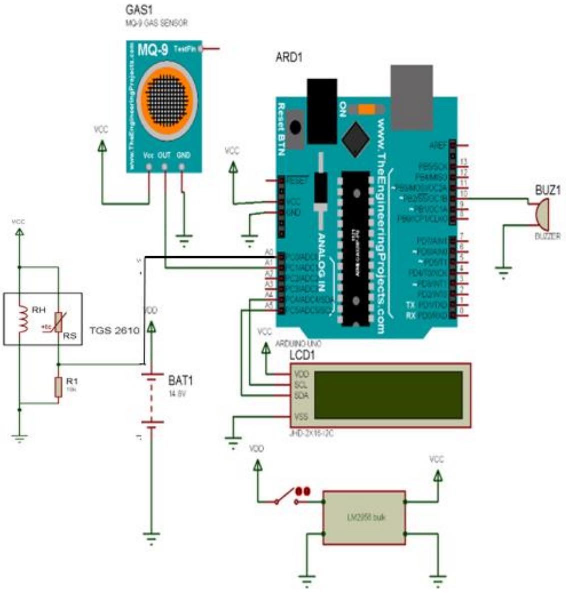

Figure 2. Schematic circuit of the CO and HC gas detection system in the car cabin

c. Design software

The software design flowchart is shown in Figure 3 below.

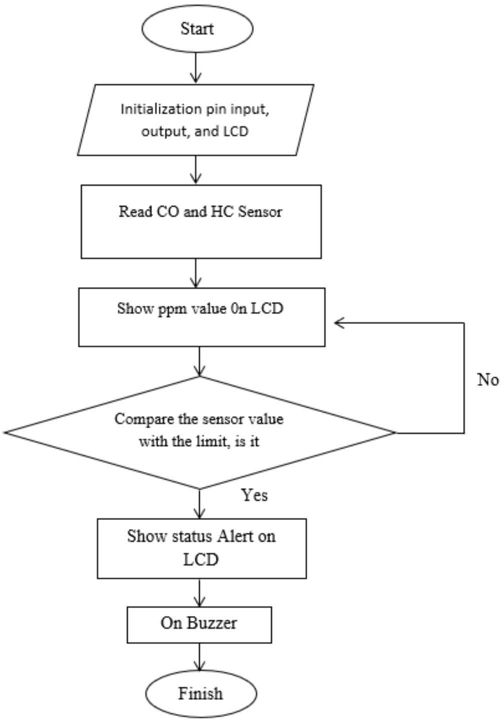

Figure 3. Flowchart of the CO and HC gas detection system in the car cabin

d. Testing

The test locations for this tool are the front (1), middle (2), and back (3) car cabins. In Figure 4, the test instrument placement area is shown.

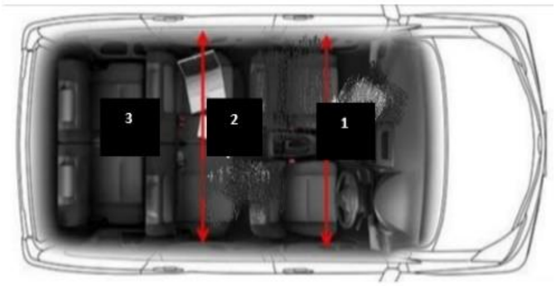

Figure 4. Test locations

The results obtained will later be compared with the gas analyzer manufacturer's test tool GROTECH with specifications that can measure CO, HC, CO2, AFR, and NOX with a heating time of between 2-8 minutes.

Figure 5. Manufacturer's test equipment for comparison

After obtaining the value of the reading of the tool, the next step is to determine the error level of the tool which is calculated by the formula:

Gas Error =
(level of manufacturer tool - gas level of design tool)

Then calculate the percentage error with the following formula.

$$\%\ Error = \frac{\text{Gas Error}}{\text{Level of manufacturer tool}}\ x\ 100$$

Result and Discussion

Following is the testing program for a gas detector as follows:

1) Room temperature is normal
2) Prepare the vehicle to be tested in a dry place
3) Turn on the tool wait until the LCD (liquid crystal display) shows a stable value
4) Turn on the ON switch, then the MQ-9 and TGS 2610 gas sensors will get the input of the emission gas in the car cabin in the form of an analog signal voltage sent through the ADC port which then the voltage will be sent to the Atmega 328 microcontroller (Arduino Uno) which has been filled in the language program. programming which is then processed according to a program created by the software that is output on this tool, which is displayed via the LCD and the buzzer will light up.
5) The accuracy of the observation for 1 minute for each change in value.
6) When you have finished doing research, turn off the tool by pressing the OFF button.

Figure 6 shows the results of the CO and HC gas detection tools made.

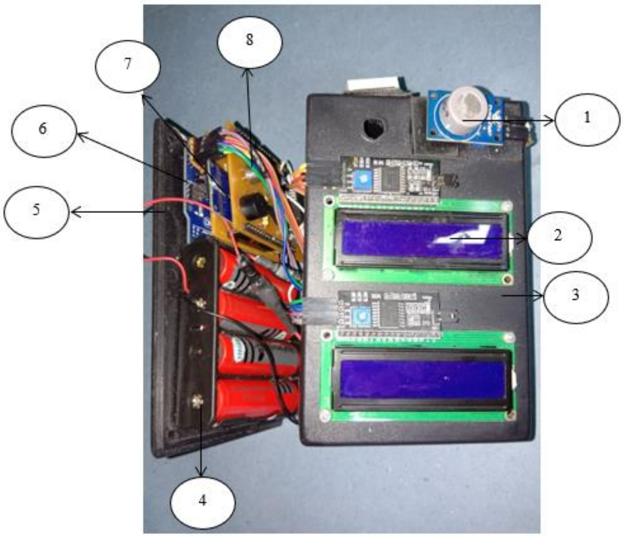

Figure 6. Results of the CO and HC gas detection tools made

Information:

1. MQ9 gas sensor
2. 16 X 2 LCD
3. Switch
4. Li-ion 18650 battery
5. Arduino Uno
6. Datalogger
7. Buzzer
8. TGS 2610

a. The results of component testing on that system made

System testing begins with testing each component so that the response is known. Table 1 shows the results of testing the response of electronic components used in this study.

Table 1. System component test results

No.	Components	Results
1	Battery	9 V
2	Buzzer	Sounds
3	LCD	 

b. CO gas test results

Table 2 shows the average results of CO gas measurements in the car cabin in the front, center, and rear areas. Whereas Figure 3 shows the percentage of error in each cabin area.

Table 2. Average results of CO testing in the car cabin

Location	Test	CO level (%)	
		Manufacturer tool	Design tool
Front	1	0.07	0.06
	2	0.06	0.04
	Average	0.065	0.05
Middle	1	0.15	0.15
	2	0.10	0.08
	Average	0.125	0.115
Back	1	0.18	0.16
	2	0.07	0.05
	Average	0.125	0.105

Table 3. The result of the percentage of CO error in the car cabin

Location	Average CO Level (%)		Error CO	% Error
	Manu-facturer tool	Design tool		
Front	0.065	0.05	0.015	23.08
Middle	0.125	0.115	0.01	8
Back	0.125	0.105	0.02	16

c. HC gas test results

The same as CO testing, HC gas testing is carried out in these three areas. Table 4 shows the average results of 2 tests. Whereas in Table 5 the results of the percentage error of the six tests are shown.

Table 4. Average results of HC testing in the car cabin

Location	Test	HC level (%)	
		Manufacturer tool	Design tool
Front	1	32	30
	2	29	24
Average		30.5	27
Middle	1	31	28
	2	37	27
Average		34	27.5
Back	1	52	45
	2	51	49
Average		51.5	47

Table 5. The result of the percentage of HC error in the car cabin

Location	HC level (ppm)		Error HC	% Error
	Manufac-turer tool	Design tool		
Front	30.5	27	3.5	11.5
Middle	34	27.5	6.5	19.1
Back	51.5	47	4.5	8.7

d. Data analysis

Based on the test results, it can be seen that the error percentage of the smallest CO gas is 8% when the test equipment is placed in the middle of the car cabin and HC is 8.7% when the tool is placed at the back of the cabin. This is because the exhaust gas concentration that is put into the car's cabin is not evenly distributed.

From Table 3, it can be seen that the largest percentage of errors is 23.08% when the tool is placed on the front of the car cabin. This is caused by the device being close to the exhaust gas source. Based on the data, it can be found that the back area with the middle has a difference in the percentage of errors by 8%.

Table 5 shows that the largest percentage of errors when testing HC is in the middle of the car cabin, which is 19.1%. This proves that the gas concentration has accumulated in the middle and is also due to the influence of opening the car door to place the appliance in the area.

Conclusion

A detection tool for carbon monoxide (CO) and hydrocarbon (HC) gases has been made in the car cabin. Tools made of the following components such as the MQ-9 sensor, TGS2610 sensor, Arduino Uno, LCD, and Buzzer. As a comparison of the results of the design tool, the manufacturer's gas analyzer is used. From 6 tests, it was found that the smallest percentage of CO errors was 8% when the tool was placed in the middle and the smallest HC error percentage was 8.7% when the tool was behind the car cabin. This research can be continued so that the data obtained by the device can be accessed remotely, for example with a bluetooth or wireless connection.

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