Available Online : https://proceeding.researchsynergypress.com/index.php/cset/index
RSF Conference Series: Engineering and Technology
ISSN 2809-6843 (Online) | 2809-6878 (Print)
Volume 2 Number 2 (2022): 119-126

Design and Development of Carbon Monoxide Gas Leak Detector in Vehicle Cabin

M. Kukuh Amrullah[1], Rukman Tea[1], M. Iman Nur Hakim[1], Langgeng Asmoro[1], Faris Humami[1]
[1]Automotive Engineering Technology, Polytechnic of Road Transportation Safety, Indonesia

Abstract

Vehicles are very important in transportation that humans widely use in carrying out their activities, including one of them is a passenger car. Safety and security factors in traveling are the most important aspects of traveling. The condition that often occurs in passenger cars is the frequent leakage of carbon monoxide gas in the vehicle cabin. Usually, CO gas leaks occur in the AC hose. So, this research aims to design an Arduino-based carbon monoxide gas leak detector. This study is research with research and development approach method or Research and Development (R&D). This research aims to produce a carbon monoxide detector design to automatically detect carbon monoxide gas leaks in the vehicle cabin based on Arduino Uno. The design performance of this CO gas leak detector can be obtained from the CO gas content of the MQ7 sensor, then the buzzer will make a sound, while the LCD will display the status "Safe/Alert/Very Dangerous" as a warning to passenger car drivers. DC motor will move the power window if the CO gas content exceeds the threshold of more than 25 ppm.

Keywords: *Carbon monoxide gas leak, Research and Development, Arduino Uno, MQ7 Sensor*

INTRODUCTION

A vehicle is transportation driven by a machine and used for land transportation other than vehicles that run on rails. Vehicles are means of transportation that are widely used by humans, one of which is a passenger car. Therefore, several supporters were made, such as Air Conditioner (AC), power windows, parking sensors, Anti-lock Braking System (ABS), and airbags that provide security and comfort to car users. The vehicle cabin is made very tight to block out sound or noise outside the vehicle. However, it can also pose a risk to vehicle users.

Carbon monoxide (CO) gas is one of the most common causes of poisoning for human health. This gas is hazardous because it is colorless, odorless, and tasteless. This condition is hazardous for humans because it can cause death (Widodo & Andrian, 2015). The main factor causing a person to be poisoned in a car because a leak of Carbon monoxide (CO) gas in the car caused by the exhaust system not functioning properly. Therefore, based on the problems, it is necessary to have a system that can work automatically to prevent leakage of carbon monoxide gas in the vehicle cabin for the driver as well as an early evacuation warning system for people around the vehicle as an emergency alarm that the driver is experiencing. Based on previous research, the design of the tool used to detect the CO, CO_2, and CH_4 gas content in a closed room has been carried out using the MQ 135 sensor and the ATMEGA 8535 microcontroller (Widodo et al., 2017), so in this research, a prototype

Corresponding author
M. Iman Nur Hakim, m.iman@pktj.ac.id
DOI: 10.31098/cset.v2i2.565

designed for a carbon monoxide gas leak detector with an Arduino Uno-based MQ7 sensor was made to provide a sense of safety for car users.

LITERATURE REVIEW

A. Carbon Monoxide (CO)

Carbon Monoxide is a gaseous chemical compound with the chemical formula CO, which is colorless, odorless, tasteless, and very toxic to humans (Widodo et al., 2017). Carbon Monoxide is produced from the incomplete combustion of carbon compounds, which often occurs in internal combustion engines, vehicle exhaust emissions, and burning garbage. CO gas has units of parts per million (PPM) which is a unit that is often used in the world of analytical chemistry for a chemical compound in the form of gas, and carbon monoxide is formed when there is a lack of oxygen in the combustion process (Septian et al., 2019). The threshold value for CO in the workplace is 25 ppm. The normal state of carbon monoxide concentration in the blood ranges from 0.2%-1.0% and an average of about 5% COHb.

B. Arduino Uno and Sensor MQ7

Arduino Uno is a board that uses the ATmega328 microcontroller. The Arduino Uno has 14 digital pins (6 can be used as PWM outputs), six analog inputs, a 16 MHz crystal oscillator, a USB connection, a voltage source connector, an ICSP header, and a reset button. Arduino Uno uses ATmega16U2, which is programmed as a USB-to-serial converter for serial communication to a computer via a USB port (Basith, 2017). The author chose Arduino because it is open source and has an economical price value. In this study, Arduino will be connected to the MQ7 sensor as sensor to obtain data. The MQ 7 sensor is a gas sensor used in equipment to detect carbon monoxide (CO) gas. The feature of this MQ7 gas sensor is that it has a high sensitivity to carbon monoxide (CO), stable, and durable (Suhendrik, 2018).

RESEARCH METHOD

In this study, the authors use the Research and Development method to produce and improve the previously studied products, which are used as detectors of harmful CO gas in the room. In the R&D method, several stages can be described as follows:

1. Requirements Plan
   At the initial stage, planning is carried out to meet system requirements by analyzing problems that occur to complement the research results on previous tools.
2. Design Process
   At this stage, the system design process is carried out according to needs; then, the design is used as an application system with the coding stage. Before assembling the tool, it is necessary to design a circuit design first by using the fritzing application so that it can detect a lack of equipment that still exists, and complete equipment can be done.
3. Prototype Test
   After designing and manufacturing the application system, the process of testing the tool is carried out to determine whether there is a system that is not running. If there is a system that is not running, then repairs are made, but if the system is running well, it means that it is following the initial design.

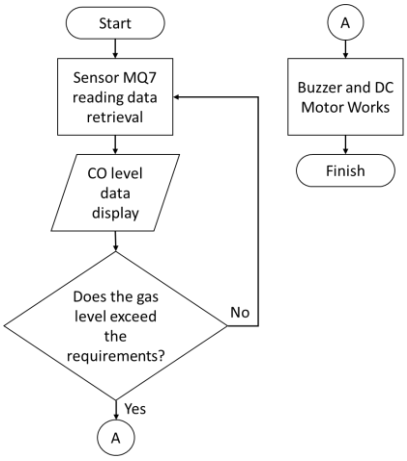

Figure 1. Flowchart

Starting with the MQ7 sensor reading, sensor information will be read directly to the MQ7 sensor, which will then be displayed on the LCD regarding the gas ppm status "Safe / Medium / Dangerous / Very Dangerous." Suppose it is detected that the gas ppm condition exceeds the threshold according to the predetermined data point set. In that case, the buzzer and power window motor will be turned on to lower the window as a warning to the driver. However, if the gas ppm level does not exceed the safe limit, the tool will continue to loop to read the measurement results from the MQ7 sensor.

FINDINGS AND DISCUSSION

This study's result is a carbon monoxide detector prototype with an Arduino-based MQ7 sensor. The research begins with assembling the tools, as shown in Figures 2 and 3. This CO gas leak detector will work if the air around this tool contains a dangerous gas, namely CO gas. Suppose the gas has been detected and exceeds the safe limit. In that case, the Arduino Uno microcontroller provides three outputs, namely LCD, Buzzer as a warning, and DC Motor to drive Power Window to open windows automatically.

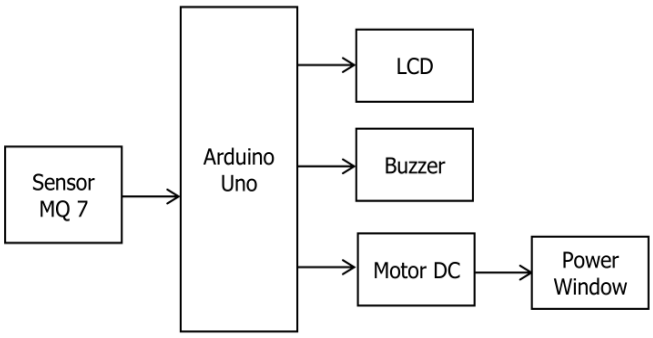

Figure 2. Tools Diagram

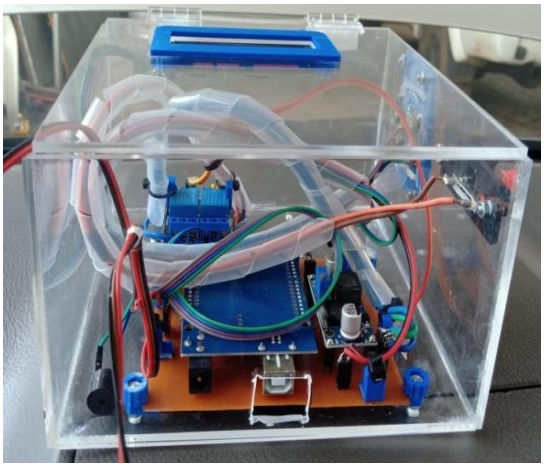

Figure 3. Equipment Assembly

After completing the assembly of tools and determining the CO level category shown in Table 1, a test is carried out to measure CO gas levels. In the tool's initial trial, the sensor's performance will be tested in detecting carbon monoxide gas in front of the MQ7 sensor. The way to find out the sensor is working properly is to connect the power input from the battery or adapter to the Arduino, position the switch on automatic ON, and the tool circuit is in the standby position (ready to work) with the LED sign on. Then put the smoke or CO gas source in front of the MQ7 sensor gradually to know each sensor's performance from input to output and find out that the program on the Arduino is running well. The information displayed on the LCD (Liquid Circuit Display) can be seen in Figures 4, 5, and 6.

Table 1. Status Category CO

Category	Gas Level (ppm)
Safe	0 – 10
Alert	10 – 25
Very Dangerous	> 25

In Figure 4, at this position, the MQ7 sensor detects a source of CO gas in front of it or in the room. The LCD will display the Safe status "*aman*" with levels of 0-10 ppm.

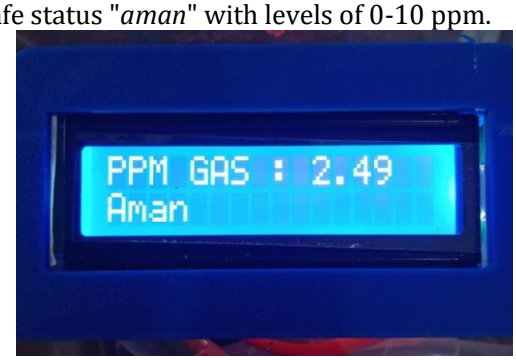

Figure 4. Results of CO Detection at Safe Limits

In Figure 5, at this position, the MQ7 sensor detects a source of CO gas in front of it or in the room. The LCD will display an alert status "*waspada*" with levels of 10-25 ppm.

Figure 5. Results of CO Detection at Alert Limits

In Figure 6, at this position, the MQ7 sensor detects a source of CO gas in front of it or in the room, and the LCD will display the status Very Dangerous "*Sangat Berbahaya*" with levels of more than 25 ppm.

Figure 6. Results of CO Detection at Danger Limits

When the measurement is within the maximum limit, the DC motor will activate automatically to open the glass. Figure 7 shows the glass opening information on the screen display, and Figure 8 shows the simulation results of the vehicle window opening.

Figure 7. Screen Display When Opening the Glass

Figure 8. Simulation of Automatically Opened Vehicle Glass

The next stage is testing the tool's implementation to determine the tool's response time. Several state simulations were carried out with variations in the sensor distance to the CO gas source. The distance variation data and the average response time of the device are shown in Table 2 and Figure 9. The data shows that the farther the sensor is placed from the gas source, the response time tends to be longer.

Table 2. Sensor Placement Distance Variations

No.	Range (cm)	Time (seconds)
1	2	2,41
2	4	5,04
3	7	6,25
4	10	7,54
5	13	8,98
6	15	13,91
7	20	18,40

The graph in Figure 9 shows that the sensor detection time for CO gas is linear according to the sensor distance to the CO gas source. The closer the CO gas source is to the sensor, the faster the responsiveness of this sensor is indicated by the shorter detection time. The sensor response to detect CO gas in a closed room with the maximum distance from the CO source in this study, which is 20 cm, takes 18.40 seconds.

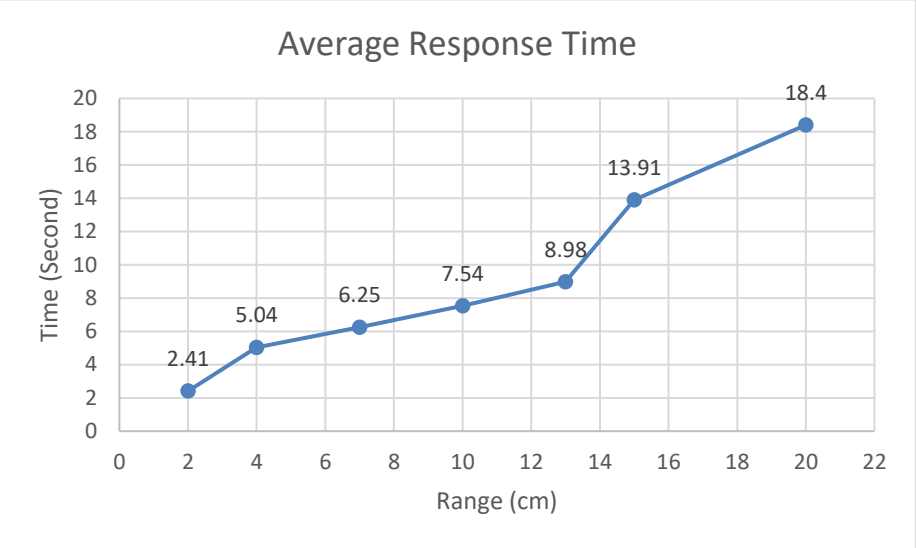

Figure 9. Graph of Response Time Against Placement Distance Sensor

CONCLUSION AND FURTHER RESEARCH

Based on the results of the testing a Carbon Monoxide Gas Leak Detector in a Vehicle Cabin with an Arduino Uno-Based MQ7 Sensor, it can be concluded that there are three stages in the design of a carbon monoxide gas detector, namely designing, manufacturing the device, device test. This CO gas leak detector begins with reading CO gas levels from the MQ7 sensor, and the LCD will display the status of Safe / Alert / Very Dangerous as a warning to passenger car drivers. The buzzer will sound if the gas level is in the alert category and is very dangerous. At the same time, the DC motor will automatically move the power window if the CO gas level is in the very dangerous category. Based on the results of the initial responsiveness test of the sensor detection time, the distance affects the sensor detection time. The fastest sensor initial detection time is 2.41 seconds at a distance of 2 cm, and the longest sensor detection time is 18.04 seconds at a measurement distance of 20 cm. in the cabin. The results of this study can be appropriately applied to passenger cars to provide a sense of security and comfort and early warning to the driver.

REFERENCES

Basith, M. A. (2017). *Penerapan Sensor Ultrasonik HC-SR04 pada Sistem Pengukur Volume pada Mobil Tangki Air Bersih*. Politeknik Negeri Sriwijaya.

Septian, G., Mardiati, R., & Effendi, M. R. (2020). Perancangan Sistem Deteksi Gas Karbon Monoksida Berbasis Mikrokontroler Arduino pada Kendaraan Roda Empat. *Prosiding - Seminar Nasional Teknik Elektro UIN Sunan Gunung Djati Bandung*, 569–575.

Suhendrik (2018). *Rancang Bangun Sistem Peringatan Dini Kebakaran Hutan Menggunakan Wireless Sensor Network (Wsn) Berbasis Arduino*. Universitas Islam Negeri Sultan Syarif Kasim Riau.

Widodo, S. & Andrian, D. (2015). Prototipe Alat Pendeteksi Kebocoran Gas Beracun Co Pada Mobil Menggunakan Array Sensor Berbasis Sms Gateway. *Pseudocode*, *2*(2), 98–106. doi: 10.33369/pseudocode.2.2.98-106.

Widodo, S., Amin, M. M., Sutrisman, A., & Putra, A. A. (2017). Rancang Bangun Alat Monitoring Kadar Udara Bersih dan Gas Berbahaya CO, CO2, Dan CH4 di Dalam Ruangan Berbasis Mikrokontroler. *Pseudocode*, *4*(2), 105–119. https://doi.org/10.33369/pseudocode.4.2.105-119