DEVELOPMENT CO LEVEL MONITORING AND ALERT SYSTEM IN CAR CABIN USING ARDUINO

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF CO LEVEL MONITORING AND ALERT SYSTEM IN CAR CABIN USING ARDUINO

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This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronics Engineering Technology (Telecommunications) with Honours

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DEDICATION

With unwavering dedication and relentless pursuit of excellence, I commit myself to the success of this project. Every challenge we encounter will be met with resilience, every setback transformed into an opportunity for growth. I pledge to invest my time, energy, and expertise into achieving our goals, driven by a passion for innovation and a steadfast belief in our collective vision. Together, we will overcome obstacles, inspire creativity, and forge ahead with determination, knowing that our efforts will culminate in the realization of our shared aspirations.

ABSTRACT

This project abstract covers a step-by-step procedure to create an automobile cabin carbon monoxide monitoring and alert system based on Arduino microcontroller technology.The technology is targeted at enhancing vehicle safety, and solving the existing problem of CO emissions by offering real-time monitoring capabilities within the confined space of the automobile cabin. Through Arduino's flexibility, sensors measure CO levels continuously, while algorithms operate at the back-end to identify dangerous fluctuation. The instantaneous visual and audible indicators inform occupants of elevated CO levels, thereby reducing the risk of poisoning and increasing passenger safety.The system's thorough design and development aim to contribute to a safer and more secure driving experience for motorists globally.

ABSTRAK

Abstrak projek ini menerangkan kaedah lengkap untuk membina sistem pemantauan dan amaran karbon monoksida (CO) kabin kereta berdasarkan teknologi mikropengawal Arduino. Teknologi ini bertujuan untuk meningkatkan keselamatan kenderaan dan menangani kemungkinan isu pelepasan CO dengan menyediakan keupayaan pemantauan masa nyata dalam ruang terhad kabin kereta. Menggunakan kebolehsuaian Arduino, penderia secara berterusan mengukur tahap CO, dengan algoritma mengenal pasti turun naik berbahaya. Penunjuk visual dan boleh didengar serta-merta menasihati penghuni tahap CO yang tinggi, mengurangkan risiko keracunan dan meningkatkan keselamatan penumpang. Reka bentuk dan pembangunan menyeluruh sistem ini bertujuan untuk menyumbang kepada pengalaman pemanduan yang lebih selamat dan terjamin untuk pemandu di seluruh dunia.

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LIST OF SYMBOLS

LIST OF ABBREVIATIONS

V	-	Voltage
	-	
	-	
	-	
	-	
	-	
	-	
	-	

(List of Abbreviations is optional. Please remove this page if it is not used)

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CHAPTER 1

INTRODUCTION

1.1 Background

Carbon monoxide (CO) is a poisonous colorless, odorless, tasteless gas that is toxic to humans and animals. It is generated during the incomplete burning of substances containing carbon. This includes gasoline, natural gas, coal, wood, and propane. CO is dangerous because it binds to hemoglobin (the oxygen-carrying protein in blood) about 240 times stronger than oxygen, which can essentially starve the body of oxygen.While inhaling high levels of carbon monoxide even for a short time can quickly lead to carbon monoxide poisoning, resulting in symptoms such as a headache, dizziness, weakness, upset stomach, vomiting, chest pain, and confusion, and likely eventually unconsciousness and death, as the body's tissues and organs are deprived of required oxygen. Hence, it is very critical to maintain proper ventilation with no running of internal combustion engines, as well as other means of producing carbon monoxide into the atmosphere in confined places such as cars, where gas could accumulate quickly to dangerous concentrations, leading to the danger to health and life of a person.

The project aims to develop a comprehensive car cabin carbon monoxide (CO) level monitoring and alert system utilizing Arduino microcontroller technology. In response to the critical need for enhanced safety measures in vehicles, particularly concerning the potential threat possessed by CO emissions, this system endeavors to provide real-time monitoring capabilities within the confined space of the car cabin. By incorporating Arduino, an open-source hardware and software platform known for its adaptability and ease of use, the system aims to use sensor technologies to assess CO levels on a continual basis. Through the utilization of sophisticated algorithms and sensor data processing, the Arduino-based system will have the ability to precisely identify variations in CO concentration, guaranteeing timely diagnosis of potentially dangerous situations. In order to reduce the risk of CO poisoning and protect passenger safety, the system will also have alert mechanisms, such as visual indicators and audio alarms, that will enable it to rapidly notify occupants in the event of elevated CO levels. This research highlights the value of creativity in raising automobile safety regulations in addition to the potential of Arduino technology in addressing urgent safety concerns.

1.2 Addressing Societal Issues Through Carbon Monoxide Problems

Addressing the problem of carbon monoxide poisoning goes beyond the realm of individual health issues to societal ones concerning public safety, environmental stewardship, and technological innovation. By addressing the problem related to CO exposure, it can minimize adverse impacts on human health, avoid healthcare costs for treating CO-related illnesses, and reduce the burden on emergency response systems dealing with CO poisoning incidents. Also, improving air quality, reducing climate change and sustainable development modem address the results of CO emissions from vehicles and other sources.

Programs toward societal approaches to mitigate the CO problem involve imposing strict regulatory measures that limit emissions from vehicles, industrial processes, and residential sources and promote wider use of cleaner technologies and renewable sources of energy. Public awareness campaigns and educational initiatives create a very vital role for themselves by informing the public about the risks associated with poisoning due to CO along with creating awareness regarding preventive measures such as installing a CO detector in homes, vehicles and also promote safe practices associated with using combustion-based appliances. Added to this is the need for synergies between government agencies, research organizations and institutions, industry players, and civil society groups aimed at promoting research and development on CO detection technologies, the improvement of vehicle emissions standards, and the formulation and effective policy interventions to curb CO emissions and safeguard public health. Generally, as a social issue, CO poisoning calls for holistic interventions to build a safer, healthier, and more sustainable world for both current and future generations.

1.2.1 Addressing Global Issues Through Carbon Monoxide Problem

Addressing the global issue of carbon monoxide (CO) pollution entails implementing multifaceted strategies aimed at mitigating its adverse impacts on both human health and the environment. Firstly, enhancing awareness and education about the sources, risks, and symptoms of CO exposure is essential to empower individuals and communities to take proactive measures to reduce their carbon monoxide footprint. This can involve public health campaigns, educational programs in schools, and dissemination of information through various media channels to promote safe practices in the use of carbon-based fuels and appliances.

Furthermore, regulatory measures and policies at the local, national, and international levels play a crucial role in controlling CO emissions from industrial processes, transportation, and other sources. Stringent emission standards for vehicles, factories, and power plants can help limit the release of CO into the atmosphere, thereby reducing air pollution and minimizing the health risks associated with breathing polluted air. Technological innovations also hold promise in addressing the carbon monoxide problem. Advances in automotive engineering, for instance, have led to the development of more fuel-efficient engines and catalytic converters that can minimize CO emissions from vehicles. Similarly, improvements in indoor air quality monitoring systems and the availability of carbon monoxide detectors for homes and workplaces enable early detection of CO leaks and prompt intervention to prevent exposure-related incidents. Moreover, addressing socioeconomic factors that contribute to CO pollution, such as poverty, inadequate housing, and lack of access to clean energy alternatives, is crucial for promoting environmental justice and ensuring equitable outcomes in the fight against carbon monoxide-related health disparities.

Ultimately, tackling the global issue of carbon monoxide pollution requires a coordinated effort involving governments, businesses, civil society organizations, and individuals working together to implement sustainable solutions that prioritize public health, environmental stewardship, and social equity. By addressing the root causes of CO pollution and adopting a holistic approach to mitigation, we can create a healthier and more sustainable future for all.

1.3 Problem Statement

The danger of carbon monoxide (CO) exposure within automobile cabins persists despite improvements in automotive safety, particularly in older or poorly maintained automobiles. Because many modern car CO detection systems don't have real-time monitoring capabilities, their occupants could be exposed to CO without realizing it. Moreover, there aren't many accessible and inexpensive ways to include CO detection and warning systems into the current vehicle architectures. By utilizing Arduino microcontrollers to create an affordable and effective CO level monitoring and alert system, this project seeks to address these issues. By continuously monitoring CO levels inside the vehicle cabin and promptly alerting occupants to elevated CO concentrations, the device will reduce the danger of CO poisoning and improve overall automobile safety.

1.4 Project Objective

- There are three objectives which is aimed to be achieved upon completion of this project which are to:
  a) Develop a CO level monitoring system using Arduino microcontrollers
  b) Integrate CO sensor into the car cabin environment to continously measure CO concentrations
  c) Ensure the system is cost-effective and easily deployable in various vehicle models

1.5 Scope of Project

The scope explains the workflow of the project. It is divided into three stages which are Definition and Research, Development of Hardware and Software, and Testing :-

Stage 1: Definition and Research

a) Do research related to project topic.
b) Understanding objective and goal of the topic.
c) Choose suitable sensors to design the gas detector .

Stage 2: Development of Hardware and Software

a) Design the schematic circuit by using any related applications.To see that either the components are suitable or not for this project.

b) Using any suitable software to runs on the microcontroller and to control the components easily

Stage 3: Testing

a) Testing the hardware and debugging the components.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The review of literature on carbon monoxide (CO) detectors present in vehicles' cabins, helps to investigate the existing research work and knowledge base concerning CO detection as well as mitigation within cars. The current attention on vehicle air quality plus safety is particularly majoring on cars having enclosed spaces such as car cabins necessitating that one understands the need for efficacy, limitations and technological advances made so far in relation to CO detection. In this regard, an examination of various literatures including technical reports, studies and academic articles from automotive engineering disciplines, environmental sciences among other fields shall be conducted to provide a comprehensive overview with regards to the latest developments in CO detection systems that are specifically designed for use inside of vehicles. Through reviewing information contained in many sources this report will identify trends, problems, and prospects in the field so that it can guide future research agenda while also contribute to safer and more reliable CO detection solutions that can be used within automotive industry.

2.2 Previous Related Research

Development of Car Cabin CO Level Monitoring And Alert System Using Arduino involves creating a system that monitors the level of CO gas and sends alerts using microcontroller and MQ7 sensor to detect the presence of gas in car cabin. This technology could save victim that inhale the hazardous gas and suddenly become unconscious in the car. This technology also could send immediate help sign by email to the nearest emergency.

2.2.1 Carbon Monoxide Dtection Using IOT

The authors mentioning in this article, the factors such as smoke from vehicles and factories as well as dust and debris contribute to air pollution which causes health problems for general public.The authors also stated that the damaging not only humans beared other living things such as plants or animals can caused bad effects to them [1]. That is why, this authors make a simple gas pollution detector using arduino [1].

2.2.2 Further Evidence on environmental impacts of carbon monoxide from portable power generator on indoor air quality

This journal article shows that carbon monoxide exposed in the indoor [2]. The authors tells that indoor air pollutant cases may based on acute illness and discomfort. Carbon monoxide is one of pollutant gas that can caused discomfort and acute illness. CO is colourless,odourless, non irritating that produced by carbonaceous fuels or substances.High CO concentrations can cause acute CO intoxication by combining with the heamoglobin to produce carboxy-heamoglobin (COHb), and therefore interrupts sufficient transfer of oxygen from lung to human tissues.

Table 1. Relationship between health effects and exposure to COHB %	
COHb %	**Health symptoms associated with COHb level in bloodstream**
80	Death
60	Loss of consciousness; death if exposure is continued
40	Collapse on exercise; confusion
30	Headache; fatigue; jugdement disturbed
20	Cardiovascular damage; electrocardiographic abnormalities
5	Decline (linear with increasing COHb level) maximal oxygen uptake of healthy young men undergoing strenuous exercise; decrements in visual perception, manual dexterity, and performance of complex sensor motor tasks
2.5	Aggravation of cardiovascular disease

Figure 2. 1 Relationship between health effects and exposure to COHB%[2]

2.2.3 Suicidal Carbon Monoxide Poisoning Using Motor Vehicle Exhaust In An Open Space

This study shows that long exposure to carbon monoxide in open space can cause acute carbon monoxide poisoning. This should be considered by forensic, emergency, and occupational professionals for diagnosing poisoning by unknown agents[3]. A rare case of suicidal case happened because used of gases from the exhaust system of the car petrol engine in an open space area. A corpse of a 60-year-old male was found in a forest. It was established on site that the deceased had a taxi driver license in his pocket, and he was lying behind the taxi cab exhaust. CO poisoning from petrol engine exhaust is most commonly accidental. CO poisoning is one of the less common methods of committing suicide. In Denmark, 11.2% of the men and 3.7% of the women who committed suicide chose this method[3]. In a technically efficient car, the average CO concentration is ca. 12 ppm, while outside it is only ca. 2–5 ppm.

Figure 2. 2 Reconstructed how the victim lying behind the car exhaust[3]

2.2.4 Carbon Monoxide Poisoning

Carbon monoxide (CO) Is known since ancient time which is tasteless, colour less, odour less and non-irritating gas. It is sometimes termed a silent killer[4]. As the specific gravity of CO is 0.97, it is slightly lighter than air. This gas is mainly produced by incomplete combustion of organic compounds.

Carbon Monoxide Sources in the Home

- Water heaters
- Fireplaces, both gas and wood burning
- Gas stoves and ovens
- Motor vehicles
- Grills, generators, power tools, lawn equipment
- Wood stoves
- Tobacco smoke

Carbon monoxide has effects on the body systems whose mechanisms are not fully understood though they are complex ones[4].

Symptoms that can occured when inhale carbon monoxide

• Breathing problems, including no breathing,

shortness of breath, or rapid breathing

• Chest pain

• Coma

• Confusion

• Convulsions

• Dizziness

• Drowsiness

• Fainting

• Fatigue

• General weakness and achiness

• Headache

• Hyperactivity

• Impaired judgment

• Irritability

2.2.5 Health Risk assessment through probabilistic

This article shows that the rising number of vehicles is known to be the major contributor of air pollution[5]. This can adversely affects of humans health and environment. This author aimed to evaluate the concentration of carbon monoxide and find particulate matter in the air.

2.2.6 Carbon-Monoxide(CO):A Poisonous Gas Emitted From Automobile

According to this author, the emission of carbon monoxide from automobiles has caused hazard to human health. Human beings are faced with health challenges as they breathe air in their living environment. The breathing in of carbon monoxide has caused reduction of oxygen in take by man because when carbon monoxide is breathed into the lungs, it sticks to the hemoglobin thereby preventing oxygen flow smoothly[6]. This authors also, explains how catalytic converter can convert the hazardous gas which is carbon monoxide to less toxic by catalyzing a redox reaction (oxidation or reduction)[6].

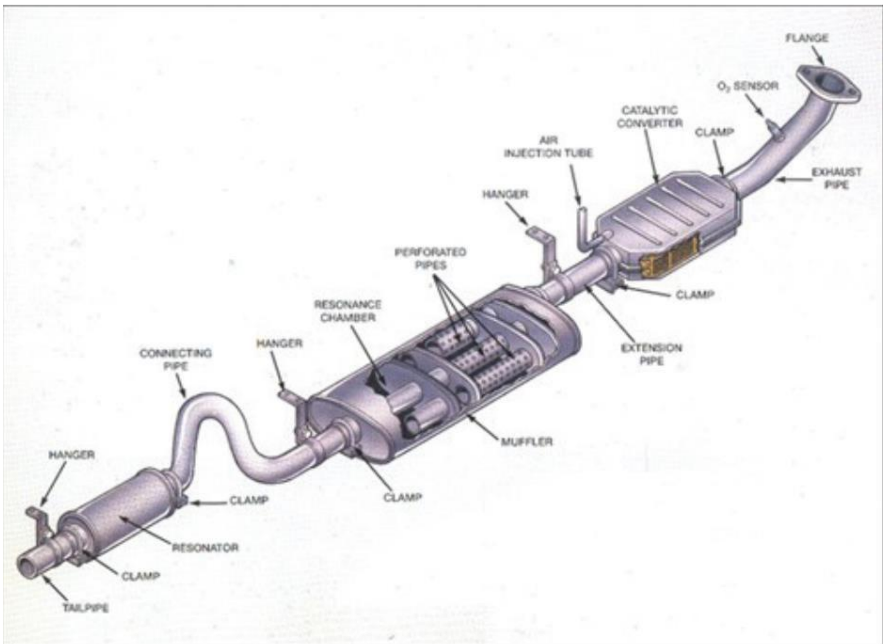


Figure 2. 3 The exhaust system[6]

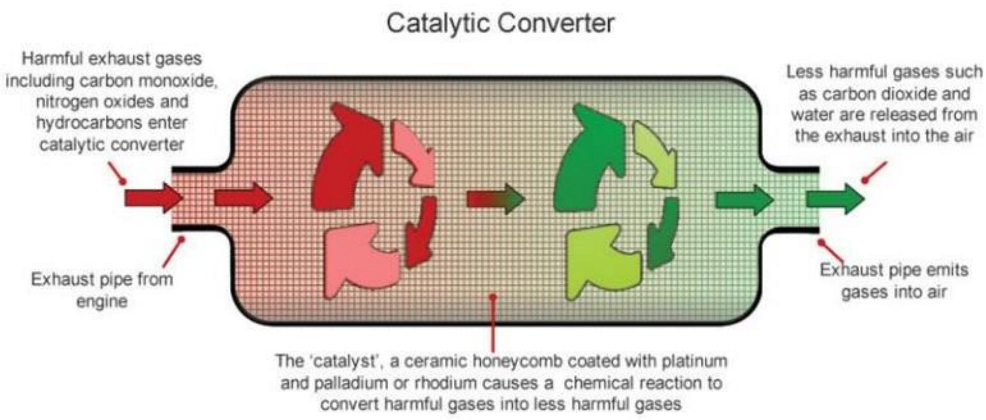


Figure 2. 4 The functionality of catalytic converter[6]

2.2.7 Design And development Of Fuzzy Logic Based Car Cabin Pollution

This paper presents the develop of air quality monitoring system based on internet of things[7]. The authors use fuzzy logic controller and it was divided to 5 range which are very low, low,medium,high and very high.

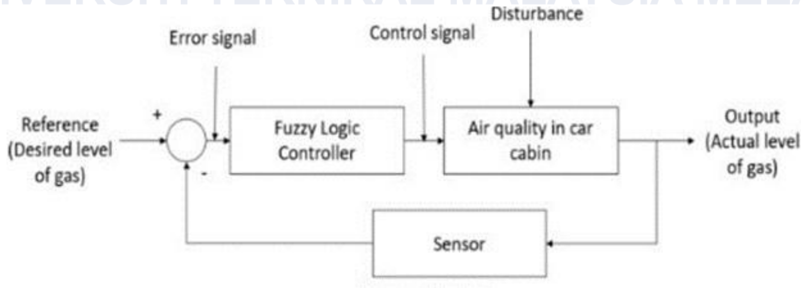


Figure 2. 5 Block Diagram for the gas monitoring system[7]

2.2.8 A charred body inside a burning car with a garden hose connected to exhaust pipe

This journal is about found of charred body in a burning vehicle[8]. In the present case, the absence of significant ante--and peri--mortem trauma and the presence of potentially lethal COHb levels clearly pointed toward the inhalation of combustion products as the cause of death[8]. The corpse was intentionally used the hosepipe to do suicide. On the other hand, the authors interpret it as a complicated suicide the victim intended to end his life by carbon monoxide poisoning. However, the victim movements were severely impaired by the combined effects of alcohol and the high levels of carbon monoxide in the car, and unintentionally spilt spirits on the driver's seat and accidentally caused a fire.

Table 2. 1 Complex suicide involving self-immolation and occuring in the car[8]

No.	Reference	Type of suicide	Sex and age (years)	Psychiatric condition and PSA	Suicide methods	Unintentional fatal trauma	Other data
1	[15]	Complex suicide inside a car	M 48	Negative No PSA	Stab wound drugs self-burning	-	COHb saturation = 43.6% TBSA = 100% Soot deposits BAC = negative
2	[15]	Complex suicide inside a car	F 32	Negative No PSA	Wrist cut self-burning (fire accelerant: "cocktail")	-	COHb saturation = 75% Soot deposits TBSA = 10% BAC = 0.03 gm%
3	[16]	Complicated suicide	M 60	DNP	Self-immolation	Stab injury by glass fragments (as a consequence of a fall against a glass door)	COHb saturation = 20% Soot deposits TBSA = 65% BAC = negative
4	[17]	Complicated suicide inside a car	M 53	Paranoid disorder No PSA	Gunshot to the mouth	Accidental CO poisoning and burns (fire as a result of engine overheating)	COHb saturation = 40% Soot deposits TBSA = 55–60% BAC = DNP
5	Current case	Complicated or complex suicide inside a car[a]	M 61	2 PSA (medicine ingestion)	Inhalation of exhaust fumes	CO poisoning, smoke inhalation and burns	COHb saturation = 45% Soot deposits TBSA = 100% BAC = 0.16 gm%

2.2.9 Worldwide epidemiology of carbon monoxide poisoning

According to this article it presents updated information on the worldwide burden of carbon monoxide (CO) poisoning[9]. The worldwide epidemiologic data were obtained from the Global Health Data Exchange registry, a large database of health-related data maintained by the Institute for Health Metrics and Evaluation. The incidence and mortality of CO poisoning in the two sexes are given in Table 1. Although the number of cases is virtually identical, the mortality for CO poisoning is nearly double in men than in women[9]. As regards the age distribution, we found two major peaks of poisoning cases, between 0–14 years (*31% of all cases) and 20–39 years (*34 of all cases).

Table 2. 2 Worldwide epidemiology of CO poisoning by sex

	Incidence		Mortality	
Sex	Cases[a]	OR	Deaths[a]	OR
Females	136	–	3.1	–
Males	137	1.01; 95% CI, 0.79–1.28; $p = 0.952$	6.2	2.00; 95% CI, 1.30–3.08; $p = 0.002$

CO: carbon monoxide; OR: odds ratio; CI: confidence interval.
[a]Per million.

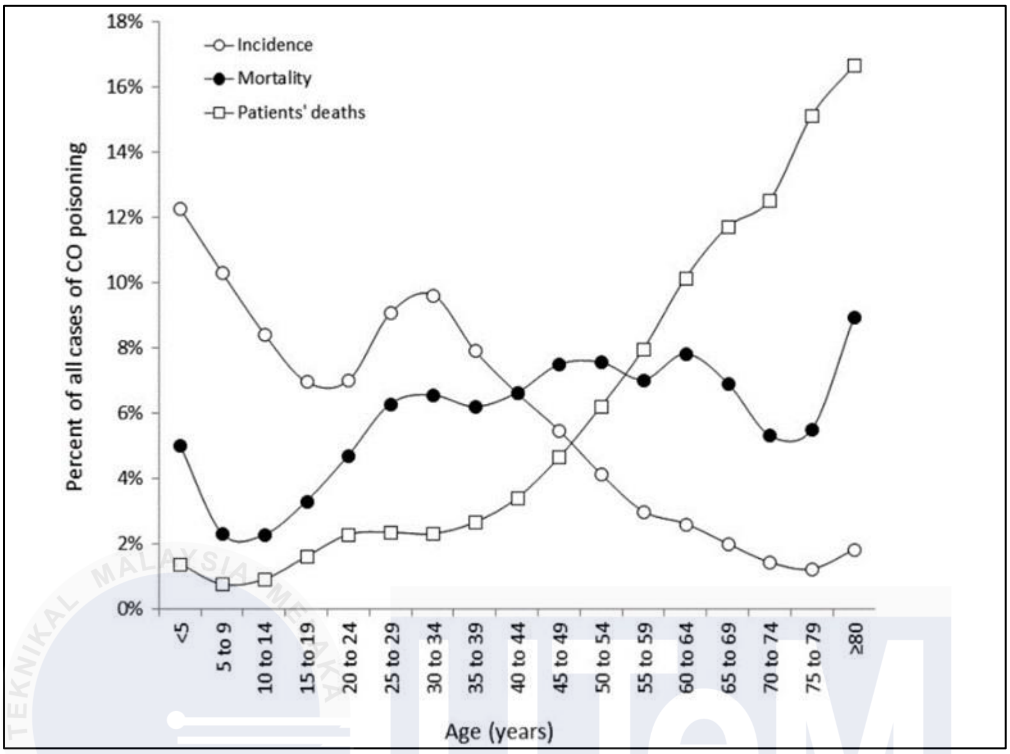


Figure 2. 6 Worldwide epidemiology of CO poisoning in different age gaps

2.2.10 Ischemia of the colon,brain and heart after carbon monoxide

Upon arrival, a 59-year-old man was found unconscious in a smoke-filled car with deep cuts on his wrist, in a state of semi-coma and hemorrhagic shock. His carboxyhemoglobin level was 16.6%. EKG showed ST-segment elevation at the precordial leads with positive troponin T. Magnetic resonance imaging revealed scattered cerebral ischemic lesions. He received 100% oxygen via mechanical ventilation but developed acute respiratory distress syndrome following inhalation injury[10]. Ischemic colitis caused by bloody stool, evaluated by CT scan, was managed conservatively. The patient regained consciousness and improved cardiac, pulmonary and bowel functions before being transferred to a psychiatric hospital. Similarly reported cases of ischemic colitis after carbon monoxide poisoning are few and therefore, many more should be gathered to define features of this condition after CO intoxication.[10]

2.2.11 Summary Table

No.	Title	Description	Advance/Method
1.	Design and development of carbonmonoxide gas leak detector in vehicle cabin[11]	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 .	The design of the tool used to detect the CO, CO2, and CH4 gas content in a closed room has been carried out using the MQ 135 sensor and the ATMEGA 8535 microcontroller.

2.	Highly catalytic electrochemical oxidation of carbon monoxide[12]	The production of toxic gases, such as sulfur oxides, nitrogen oxides, hydrocarbons, and carbon monoxide (CO) has risen rapidly in the last few decades. Among them, CO is a colorless and hazardous gas produced as a by-product of fuel combustion, affecting adverse effects on human health as well as environment.	Electrochemical gas sensors have several advantages, including low detection limit, low power consumption, high stability and selectivity. Amperometric gas sensors generally employ a variety of electrode materials catalyzing the electrochemical reactions of target analytes on the electrode surface. In fact, the amperometric sensing of CO requires electrode materials, which facilitate the oxidation of CO and are also highly resistive to the poisoning.
3.	High Sensitivity carbon monoxide detector using iron tetraphenyl[13]	An incomplete combustion of carbon results in the formation of carbon monoxide (CO), which is usually found in exhaust emissions from vehicles and household environments.	GO (graphene oxide) was synthesized via the oxidation of graphite using the Hummers method [37]. Concisely, graphite powder (1.2 g) and NaNO3 (2 g) were mixed with H2SO4 (50 ml). This mixture was kept in an ice bath with continuous stirring for 2 h as KMnO4 (6 g) was

			added to the suspension very slowly by carefully controlling the rate of addition to maintain the temperature below 14 °C.

4.	A Mini-Review On Metal Oxide Semiconductor Gas Sensors for Carbon Monoxide[14]	Carbon monoxide (CO) can cause headaches, discomfort, and the possibility of collapse when humans are exposed to it for two hours at a concentration of 200 ppm. At 3000 ppm, CO will cause human death after exposure for 20 min [1–5]. Thus, convenient and precise monitoring of CO is crucial for safety reasons	MOS CO sensors employ metal oxides like SnO2 as sensing elements. SnO2 CO sensors usually work at temperatures higher than room temperature, so a heater is necessary to provide the optimum working temperature. The heater will consume great amounts of electrical power, increasing the overall power consumption of the CO sensors. High power consumption gives rise to a problem for portable and IoT applications of MOS CO sensors, since a large lithium battery will be needed for the power supply.
5.	The Application Of Mobile Sensing to Detect CO and NO2 Emission spikes in polluted cities[15]	Carbon monoxide (CO) and Nitrogen dioxide (NO2) are major air pollutants that negatively impact the health of humans. CO is a colorless, odorless, and tasteless toxic gas produced by the incomplete combustion of carbonaceous fuels. Breathing air with a high concentration	Aeroqual series-500 is a portable pollution monitoring instrument that logs data in the CSV format at a minimum of 1 min intervals. It comes with several Interchangeable sensor heads, each measuring a specific pollutant. Only one head can be used at a time. For this experiment, two Aeroqual monitors were used to measure the concentration of CO and NO2.

		of CO reduces the amount of oxygen that can be transported in the bloodstream to critical organs	
6.	Carbon Monoxide Sensor Based On Printed ZnO[16]	This work describes the fabrication of a Carbon monoxide (CO) sensor based on a Zinc oxide (ZnO) Schottky diode that can detect CO at low concentrations as low as one part per million (ppm) at room temperature.	Different additive microfabrication techniques are used to fabricate the devices. A precisely controlled fabrication is enabled byemploying a microcantilever (μC) printing system. The fully printed sensor has a high sensitivity of 23.7% towards CO at room temperature.

2.2.12 Summary

This project aims to develop a car cabin carbon monoxide detector to warn occupants of dangerous gas levels. By implementing a CO sensor and alarm system, the detector will improve driver and passenger safety by providing early warnings of potential poisoning. This can offer peace of mind and potentially reduce accidents caused by CO-induced drowsiness.

CHAPTER 3

METHODOLOGY

3.1 Introduction

Carbon monoxide (CO) is a colorless, odorless, and highly poisonous gas that poses a serious threat to human health, especially in confined places like automobile seats. Exposure to high quantities of CO can cause serious health problems such as headaches, dizziness, nausea, and, in extreme circumstances, death. To reduce this risk and protect vehicle occupants, a dependable and effective CO detection system is required. By incorporating the MQ-7 sensor into our system, I can continuously monitor CO levels in the automobile interior and take immediate action when harmful levels are identified. The device includes a buzzer that acts as an auditory warning mechanism, alerting inhabitants to the presence of high CO levels. In addition, a servo motor is used to replicate the automatic opening of the automobile windows, which provides ventilation and allows CO to exit the cabin. When the detection system activates the servo motor, it moves from 0 degrees (closed) to 90 degrees (completely open). To enable quick intervention, the buzzer is set to sound continuously for five minutes after detecting harmful CO levels. to get the occupants' attention and motivate them to take immediate action, such as exiting the car or seeking fresh air. The deployment of this CO detecting technology in automobiles has the potential to save lives and avoid fatalities due to carbon monoxide poisoning. Providing early warning and automatic ventilation allows occupants to react quickly and reduce their exposure to the hazardous gas. This proactive strategy tackles a major safety risk and highlights the possibility for integrating modern sensor technologies and automation into automobiles to improve occupant safety.

With my research, I hope to contribute to the ongoing efforts to reduce the risk of CO-related events and promote safer transportation behaviors.

3.2 Project Flowchart

Overall, the primary components of this project are the arduino wemos , mq7 sensor, buzzer, servo motor, led and bluetooth module. Wgile for the software part, the emergency help or sign will be sent through email to the nearest hspital or clinic. The victim will be detected by gps. To summarize this system, it will triggered the mq7 sensor whenever the concentrations of CO is above than it should be , which means it has passed the safe limit. Then, the buzzer as honk will produce sound to notify any person at that place , servo motor as windows will roll down to allow good airflow for the victims and led as car signal also will blink.

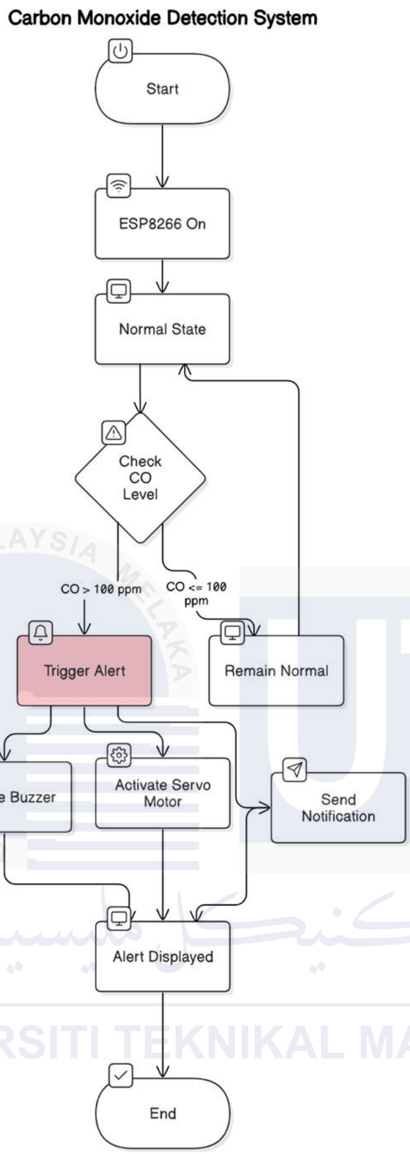


Figure 3. 1 Flowchart of the project

3.3 Gantt Chart of PSM's 1 flow

Table 3. 1 Gantt Chart flows from week 1 untill week 14

Appendix A Gantt chart for PSM 1

PROJECT ACTIVITY / TASK	WEEK													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Project Briefing	■													
Start searching journal		■	■	■										
Progress work 1			■	■	■	■								
Project research					■	■								
Research literature review						■	■	■	■					
Report progress									■	■	■			
Progress work 2										■	■	■	■	
Result Test												■	■	
PSM 1 Report submission														■
PSM 1 Presentation														■

3.4 Block Diagram

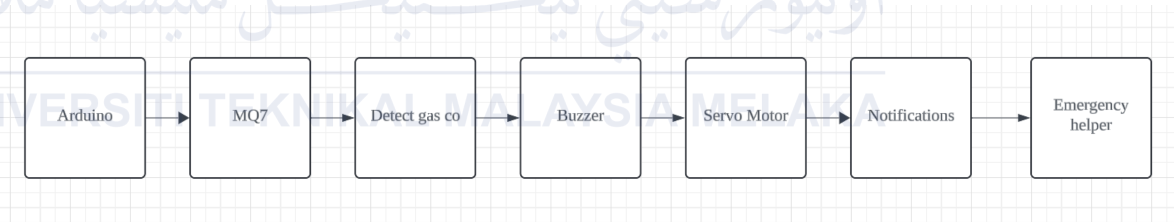


Figure 3. 2 Block Diagram of the project

3.5 List of Components

This main components to make this project works is esp8266 as the microcontroller. Then, servo motor as indicator of car window. The buzzer as honk in the car will triggered if the reading of co level is pass the safe limit. The gas will be detected by mq7 and it will be sent to blynk application as alert message .

3.5.1 ESP 8266

Figure 3. 3 ESP 8266

Espressif Systems, headquartered in Shanghai, China, has gained significant recognition in the tech industry for manufacturing the ESP8266, a revolutionary low-cost Wi-Fi microcontroller. This small yet powerful chip integrates TCP/IP networking software and microcontroller functionality, providing developers with a versatile tool for creating connected devices. By offering a cost-effective solution to wireless communication, the ESP8266 has enabled the development of numerous Internet of Things (IoT) applications. It delivers a balance of affordability and performance, making it an appealing choice for hobbyists, educators, and commercial developers alike.

The widespread popularity of the ESP8266 was significantly boosted by the introduction of the ESP-01 module, designed and produced by Ai-Thinker, a third-party company. Launched in August 2014, the ESP-01 became a game-changer in the English-speaking maker community. Its compact design and accessible price point quickly captured the attention of enthusiasts eager to experiment with wireless networking. With the ability to interface with other microcontrollers, the ESP-01 provided a gateway for non-specialist users to add Wi-Fi connectivity to their projects, sparking a surge in DIY smart devices.

One of the standout features of the ESP-01 module is its use of Hayes-style commands, allowing users to configure and control the chip via simple AT commands. These commands enable microcontrollers to establish basic TCP/IP connections and seamlessly connect to Wi-Fi networks. However, during the early days of its release, documentation and resources in English were sparse. This created challenges for many users outside of China who wanted to explore the capabilities of the ESP8266 but lacked detailed instructions or examples to follow. Despite these hurdles, the module's potential was evident, and dedicated enthusiasts began to reverse-engineer its commands and share their findings online.

As the ESP8266 gained traction, the global maker community rallied to fill the knowledge gap. Open-source projects, tutorials, and forums emerged, providing a wealth of information and fostering a vibrant ecosystem around the chip. The availability of comprehensive guides and development tools allowed users of all skill levels to harness the ESP8266's full potential. Today, the ESP8266 stands as a cornerstone of many IoT projects, demonstrating how a small, affordable device can drive innovation and bring advanced technology within reach of the broader public.

Hardware Design

The Arduino ESP8266 is a popular microcontroller board . It is widely used for Internet of Things (IoT) projects due to its small size, low power consumption, and built-in WiFi capabilities. Below is a detailed description of the hardware design of the ESP 8266:

3.5.2 Hardware Design for ESP8266

The **ESP8266** is a versatile Wi-Fi-enabled microcontroller that has been widely adopted for Internet of Things (IoT) applications. Its hardware design plays a crucial role in its functionality and adaptability. Below, we outline the key components and considerations for designing hardware around the ESP8266.

1. Core Components of the ESP8266 Chip

The ESP8266 includes several integrated features:

Tensilica L106 32-bit processor running at 80-160 MHz. Built-in **2.4 GHz Wi-Fi transceiver** supporting 802.11 b/g/n. **GPIO Pins** for interfacing with external components. Integrated **Flash Memory** (SPI flash, typically 512 KB to 4 MB or more). Support for **UART, I2C, SPI, PWM, ADC, and I2S** communication protocols.

2. Power Supply Requirements

The ESP8266 operates at **3.3V** and has a relatively high peak current consumption during Wi-Fi transmission (up to 300 mA). A stable power supply is essential to avoid performance issues. Design considerations include:

A **low-dropout regulator (LDO)** to provide 3.3V from a 5V source. **Decoupling capacitors** (e.g., 10 µF and 0.1 µF) close to the power pins to reduce noise and stabilize voltage Adequate power supply for peripherals that the ESP8266 may control.

3. Antenna Design

The ESP8266 requires an efficient antenna for stable Wi-Fi connectivity. Options include:

- **PCB trace antenna** for low-cost, compact designs. **External antennas** (using U.FL or IPEX connectors) for better range and signal strength. Proper antenna placement is critical; it should be clear of metallic enclosures and other high-frequency components to reduce interference.

4. Reset and Flash Circuitry

To program and reset the ESP8266, the hardware design must include:

- **Reset (RST)** pin connected to a momentary push button or external signal. **GPIO0** pin, which must be pulled low during boot to enter flash mode. A combination of resistors, capacitors, and switches for reliable operation in development and production environments.

5. PCB Layout and Design Guidelines

When designing a printed circuit board (PCB) for the ESP8266, follow these guidelines:

- **Minimize noise** by keeping traces for the power supply and critical signals short and wide. Ensure **good ground plane continuity** to reduce EMI (electromagnetic interference). Place decoupling capacitors close to the ESP8266's power pins. Follow RF design practices for the Wi-Fi antenna to maximize signal quality.

6. Peripherals and External Components

The ESP8266 can interface with various peripherals, including sensors, relays, and displays. Design considerations include:

- **Pull-up or pull-down resistors** for GPIOs, depending on their function. Level shifters for communication with 5V logic devices if needed. Headers or connectors for ease of development and testing.

7. Programming Interface

The ESP8266 is typically programmed using its UART interface:

- Connect **TXD and RXD** pins to a USB-to-Serial adapter (e.g., FTDI, CP2102, or CH340). Use a tool like **esptool** or an integrated development environment (IDE) such as **Arduino IDE** or **PlatformIO** for flashing firmware.

3.6 Servo Motor

Figure 3. 4 Servo Motor

Servo motor, a motor intended to operate at a particular angular or linear position, velocity and acceleration, comes with a sensor for position feedback. Servo motor is basically an electric motor which is coupled with a sensor for the position feedback. The controlling signal to the motor essentially specifies the desired or intended position. It is achieved by the internal feedback mechanism of the servo motor. Such a mechanism normally includes a potentiometer or an encoder that measures the position of the output shaft and ensures that it goes to a position that represents the position commanded. With its high torque, this motor can therefore move with high precision and sit in one position when it needs to. For these reasons, servo motors find a great application in areas where high accuracy and reliability are present. In everyday life, servo motors have applications or are used in robotics, automation, and remote control devices.

They make possible the very fine movements that robotic arms, CNC machines, and even do-it-yourself projects, like radio-controlled cars and airplanes, require. their ability to provide feedback and adjust with respect to that feedback lets them make complex, highly precise maneuvers, which are absolutely vital in an industrial environment where consistent, repeatable actions are indispensable. Servo motors, due to their versatility and control capabilities, already constitute a very important part of modern applications in engineering and technology.

3.6.1 Hardware Design

A servo motor is a type of electromechanical actuator designed for precise control of angular or linear position, velocity, and acceleration. It typically consists of a motor, a feedback sensor, a control circuit, and a drive mechanism. Servo motors are widely used in robotics, automation, and control systems due to their accuracy, reliability, and ease of control.

Key Components of a Servo Motor:

1. DC Motor or AC Motor:

a) Provides the mechanical power to rotate the output shaft.
b) Most commonly, DC motors are used in small-scale applications, while AC motors are used in larger industrial settings.

2. Feedback Sensor:

a) Measures the position of the output shaft.

b) Common types of sensors include potentiometers for analog feedback and encoders for digital feedback.

3. Control Circuit:

a) Processes the feedback signal and compares it with the desired position.

b) Generates an error signal that is used to adjust the motor's position.

c) Typically includes a microcontroller or a dedicated servo controller.

4. Drive Mechanism:

a) Transmits the motor's rotational motion to the output shaft.

b) Can include gears, linkages, or belts to achieve the desired torque and speed.

5. Housing:

a) Encases all the components to protect them from environmental factors.

b) Often includes mounting brackets for easy installation.

Working Principle:

a) The servo motor receives a control signal that represents a desired output position.

b) The control circuit measures the actual position using the feedback sensor.

c) The control circuit compares the actual position with the desired position and calculates the error.

d) The error signal is used to adjust the motor's position by driving the motor in the direction that reduces the error.

e) This process is repeated continuously to maintain the desired position with high precision.

Servo Motor Specifications:

1. Torque: The rotational force the servo can exert, usually measured in kg-cm or oz-in.
2. Speed: The speed at which the servo can rotate, typically given in seconds per 60 degrees.
3. Voltage: The operating voltage range, commonly 4.8V to 6V for standard servos.
4. Size and Weight: Physical dimensions and weight, important for fitting into specific applications.
5. Control Signal: Pulse Width Modulation (PWM) signal used to control the position, typically a 1-2 ms pulse within a 20 ms frame.

A servo motor is an integral component in precision control systems, providing accurate and reliable position control. Its design includes a motor, feedback sensor, control circuit, and drive mechanism, all housed within a protective casing. Servo motors are essential in various applications, from hobbyist projects to advanced industrial automation.

3.7 Buzzer

Figure 3. 5 Buzzer Piezo

A buzzer is an electric audio signaling device widely used for alerting or notifying that a certain event or condition has occurred by producing sound. In this case, it is done through a diaphragm of a magnetic stripe, for instance, or the popular piezoceramic element. This application is seen in electronic devices and systems such as timers and alarms and can be either confirmation indicators in various forms. While the electromechanical buzzers employ the magnetic coil and a vibrating diaphragm to give the sound, the piezoelectric buzzers achieve the same because of the vibration of its piezoelectric element under influence of an electric field to produce the tones that can be heard. Other major advantages of this device are simple functions, good reliability, and strong effectiveness of instant audio feedback.

They range from continuous tone buzzers all the way from intermittent buzzers to programmable ones that can mute, beep, or have other specific forms of sound. The domains of applications range from home appliances-microwaves, washing machines-to industrial equipment and automotive systems. Because buzzers can quickly and easily convey information, they play a vital role in user interfaces and alert systems where the end users must use the messages quickly to react to whatever the warnings are either indicating.

3.7.1 Hardware Design

Key Components of a Piezo Buzzer:

1. Piezoelectric Element:
   a) A thin disk or plate made of piezoelectric material (such as quartz or ceramic).
   b) Converts electrical energy into mechanical vibrations and vice versa.
2. Metal Diaphragm:
   a) A thin metal plate to which the piezoelectric element is bonded.
   b) Vibrates when the piezoelectric element expands and contracts, producing sound waves.
3. Housing:
   a) Encloses the piezoelectric element and metal diaphragm.
   b) Often designed to enhance the sound output and protect the internal components.
   c) Can have an opening or cavity for sound emission.
4. Electrical Contacts:
   a) Terminals or leads that connect the piezoelectric element to the external circuit.
   b) Typically, there are two contacts: one for the positive voltage and one for the ground.
5. Mounting Features:
   a) May include holes, adhesive backing, or other features for securing the buzzer in place.

6. Working Principle:

Input Signal:

a) A voltage signal, often in the form of a square wave, is applied to the piezoelectric element via the electrical contacts.

Piezoelectric Effect:

a) The piezoelectric material expands and contracts in response to the applied voltage, generating mechanical vibrations.

Sound Production:

a) These mechanical vibrations cause the metal diaphragm to oscillate, producing sound waves that are emitted through the housing.

7. Specifications:

Operating Voltage:

b) The voltage range within which the buzzer operates, commonly 3V to 12V for small buzzers.

Resonant Frequency:

a) The frequency at which the buzzer naturally resonates, typically specified in Hz (e.g., 2 kHz, 4 kHz).

b) This is the frequency at which the buzzer produces the loudest sound.

Sound Pressure Level (SPL):

a) The loudness of the sound produced, measured in decibels (dB) at a given distance (usually 10 cm or 1 meter).

Current Consumption:

a) The amount of current the buzzer draws when operating, usually measured in milliamps (mA).

Dimensions and Weight:

The physical size and weight of the buzzer, important for fitting into specific designs.

8. Applications:

Consumer Electronics:

a) Used in devices such as microwaves, washing machines, and alarm clocks to provide audible feedback and alerts.

Automotive:

a) Employed in car alarms, seatbelt warnings, and other notification systems.

Industrial Equipment:

a) Used in machinery and control panels to signal alerts and warnings.

Medical Devices:

a) Integrated into equipment like patient monitors and hearing aids to provide audio alerts.

9. Example: Standard Piezo Buzzer

a) Operating Voltage: 3V to 12V

b) Resonant Frequency: 2 kHz

c) Sound Pressure Level (SPL): 85 dB at 10 cm

d) Current Consumption: 10 mA

e) Dimensions: 12 mm diameter, 8 mm height

3.8 LCD Display

Figure 3. 6 LCD Display

It is a flat-panel display technology that has vast use; the devices include everything from televisions to computer monitors, to even smartphones and digital signage. This display technology called Liquid Crystal Display works by manipulating liquid crystals aligning in different patterns when they come in contact with electric fields, controlling light passage. These liquid crystals are not emitting light themselves, but work to modulate light reflected by a backlight, or reflector to create color, or monochrome images. Typically there are five layers to an LCD, with a polarizing filter at the top and bottom; a glass substrate, or base, with indium tin oxide, or ITO, electrodes; the actual liquid crystal layer; another layer of electrodes; and then another polarizing filter at the top. This enables LCDs to produce clear and sharp images with a relatively low use of electricity when compared with other technology of displays such as the CRTs. Cathode Ray Tubes.

Their numerous advantages have made the application of LCDs very extensive. A few of the advantages include their light weight, slim nature, high resolutions, as well as high brightness in image presentation. These have relatively low power usage, which creates suitability for battery-operated devices. The ability to produce a wide range of colors and the viable size and shape made them an integral part of everything from wristwatches to large public displays. With brand-new fledged developments like OLED, or Organic Light Emitting Diode, monitors gaining in popularity with their improved contrast ratios and greater angles of view, LCD technology is also still a staple in the display market owing to its cost-effectiveness and reliability and mature manufacturing processes.

3.8.1 Hardware Design

Key Components and Features of an LCD Display with I2C:

1. LCD Panel:
   a) **Display Type**: Typically, these LCDs are character-based (e.g., 16x2 or 20x4), showing characters in rows and columns.
   b) **Characters**: Each character is displayed using a 5x8 dot matrix.
2. I2C Interface Module:
   a) **I2C Controller**: An integrated circuit (often a PCF8574 or similar) that allows the microcontroller to communicate with the LCD using the I2C protocol.
   b) **Pins**: Only four main pins are used—VCC, GND, SDA (data line), and SCL (clock line).
3. Backlight:
   a) **LED Backlight**: Provides illumination for the display, making it readable in low-light conditions. The backlight can be controlled via software.
4. Control Pins:
   a) **Contrast Adjustment**: Typically done through a potentiometer or via software to adjust the visibility of the characters on the screen.

5. How It Works:
1. Communication:

a) The I2C interface allows the microcontroller to send commands and data to the LCD using only two lines (SDA and SCL). This significantly reduces the number of pins required compared to parallel communication.

2. Power:

a) The LCD is powered through the VCC and GND pins, typically requiring 5V or 3.3V, depending on the specific module.

3. Addressing:

a) Each I2C device on the bus has a unique address. The I2C controller on the LCD module will listen for data sent to its address, allowing multiple I2C devices to share the same data and clock lines.

6. Advantages of Using I2C LCD Displays:

1. Reduced Wiring:

a) Using I2C simplifies connections, as only two data lines are needed, reducing the complexity of wiring.

2. Ease of Use:

a) Many libraries are available for microcontrollers (like Arduino) to interface with I2C LCDs, simplifying programming and integration.

3. Expandability:

a) Multiple I2C devices can be connected to the same bus, making it easier to add more components to your project without using many additional pins.

3.9 Project Casing

Figure 3. 7 Project Casing

Figure 3.7 displays an electronic project enclosure box with dimensions of **115 mm x 90 mm x 33 mm**. It is a small, compact housing commonly used for enclosing and protecting sensitive electronic components, circuits, or microcontroller projects. The box's primary function is to safeguard the internal components from physical damage, dust, moisture, and other environmental factors, ensuring their longevity and reliable operation. The enclosure is rectangular and designed for surface-mounting or desktop use in various industrial, commercial, or DIY applications.

The material of the enclosure appears to be **ABS plastic** for the base and a **transparent polycarbonate lid**. ABS plastic is known for its durability, lightweight, and resistance to impact, while the transparent lid allows for easy visual inspection of the internal components without having to open the box. This feature is particularly useful in monitoring devices like sensor modules, where the user may need to check LED indicators, screens, or other display outputs.

The enclosure design includes four screw holes on the corners of the lid, which help securely fasten it to the base. This ensures a tight seal to prevent dust or debris from entering while still allowing for easy access when needed. The interior of the box is typically designed with mounting posts or grooves to accommodate circuit boards, sensors, or other components, helping keep them in place and preventing them from moving around inside the box during operation or transport.

Such enclosures are ideal for use in a variety of electronic projects, including microcontroller-based systems like those using Arduino, Raspberry Pi, or ESP8266. They can also be used for sensor modules, wireless communication setups, and custom-built IoT devices. Given its size, this specific enclosure is well-suited for small-scale projects where space efficiency and protection are key considerations.

3.9.1 Hardware Design

1. Enclosure Material and Structure

The enclosure is composed of two main parts: a base made of ABS plastic and a transparent polycarbonate lid. These materials were chosen for their specific properties:

a) ABS Plastic Base: Provides durability, impact resistance, and electrical insulation, making it ideal for housing sensitive electronic components.

b) Transparent Lid: Enables visual inspection of internal components, such as LED indicators, displays, or sensor readings, without opening the box. This allows for quick diagnostics or monitoring during operation.

The overall structure is designed to protect the internal hardware from environmental factors such as dust, dirt, and mild moisture. The box dimensions—115 mm x 90 mm x 33 mm—are suitable for compact electronics projects that require portability.

2. Lid and Fastening Mechanism

The lid is secured to the base using four screw holes located at the corners. This fastening mechanism ensures:

a) A tight seal between the lid and base, preventing contaminants from entering.
b) Easy access for maintenance or adjustments to the internal hardware, as the screws can be easily removed when needed. The transparent lid also provides protection while maintaining visibility, which is useful for projects requiring constant monitoring.

3. Internal Mounting Features

The interior of the enclosure is likely equipped with mounting posts or grooves for securing components such as:

a) PCBs (Printed Circuit Boards): Dedicated posts may allow for easy screw-based mounting of boards like Arduino, Raspberry Pi, or custom circuit boards.
b) Sensors or Modules: The design ensures components remain securely in place, preventing damage from vibration or movement.
c) Wire Routing: Grooves or channels may be included to organize and route wires neatly, reducing the risk of short circuits or interference.

4. Applications and Usage

This enclosure is suitable for various applications, especially in IoT devices, sensor modules, or microcontroller-based projects. For example:

a) IoT Systems: Houses an ESP8266 or similar Wi-Fi module with sensors and relays.
b) Environmental Monitors: Protects components like gas sensors, temperature sensors, or humidity modules.
c) Home Automation: Contains motor drivers, relays, or control boards for operating smart home devices. The compact size makes it perfect for installations in tight spaces while providing adequate protection.

3.10 Jumper Wires

Figure 3. 8 Wire Jumper

Technically, a jumper is an insulated wire that is used to connect two points in an electric circuit. The tinned or bare conductors are pliable and thin, making them easily conformable and possible to insert in breadboards, headers, or connectors without soldering. The jumper wires differ from one another in length, color, and gauge to befit design specifications in a manner that befits an efficient process of prototyping and testing. When used practically, jumper wires allow engineers, hobbyists, and students to make temporary or even semi-permanent electrical connections between circuit parts or different electronic components. They are really helpful for quickly prototyping new circuits, debugging existing designs, and trying out different configurations without making complicated wiring or permanent solder joints. Because of their high versatility and usability, jumper wires are a top requirement for educational institutions and professional electronics development for easy and cost-effective modification and iteration of circuit designs.

3.10.1 Hardware Design

Key Characteristics of Jumper Wires:

1. Flexibility: Jumper wires are very flexible and hence can be bent and routed easily to achieve connection between two distant points on a circuit board or even between different circuit boards.

2. Lengths and Colors: They are available in different lengths and also in different colors, so engineers or hobbyists can use them to organize and differentiate connections in complex circuits.

3. Temporary Connections: They are also used mostly in temporary connections made during prototyping, testing, or even troubleshooting stages of hardware development.

4. Permanent Solutions: Jumper wires are used as a permanent solution to bridge gaps or create connections between various components where traces on a circuit board are not available or adequate.

5. Types: Single-core or solid wire jumper wires, and multi-core or stranded jumper wires are availed depending on the requirements of their implementation and the degree of flexibility or rigidity required in the application.

6. Insulation: There cannot be any possibility of short circuiting, and also provide reliable electrical isolation between connected points.

7. Versatility: They are mostly used in breadboarding. Breadboarding involves mounting the components temporarily on a board. It allows the designer to quickly prototype, test the circuit design, and later finalize the finished product.

8. User-friendliness: These wirers are very user-friendly, and in most situations, would not require soldering. Hence, a person who is even a fresher or experienced electronics hobbyist can use them easily.

9. Applications: These are extensively utilized in an electronics laboratory, teaching institute and do-it-yourself for interconnection between microcontrollers, sensors, light emitting diodes and other electronic components.

10. Integrate: Jumper wires are one of the principal tools in hardware design. They are used in a process to build versatile, customized circuits without the inflexibility of printed circuit board results.

3.11 Breadboard

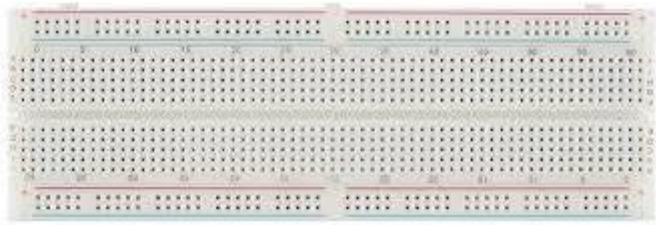


Figure 3. 9 Breadboard

A breadboard is the most basic tool when it comes to prototyping and experimenting with electronics, aiming to quickly, temporarily assemble and test electronic circuits without soldering. The breadboard is a small, rectangular, plastic board with a matrix of holes spaced at a standard distance. This board has metal clips or strips underneath its surface that connect these holes, making it convenient to put components or wires in them, and even connect them. The big advantage a breadboard offers is the flexibility of use and accessibility. A circuit built using it can be immediately constructed and modified by inserting its component parts into the holes of the board that mainly includes resistors, capacitors, ICs, and LEDs. The board typically comprises rows and columns of holes, with each row connected internally but also insulated from the next row to allow for horizontal and vertical interconnection

Breadboards come in handy when one is prototyping and testing a circuit design, and want easy reconnect or dis connection of the connections on fly. This feature makes your work much faster and also saves you from the chances of damaging the parts soldered on due to incorrect connections. In short, a breadboard is a most valuable tool in every electronics laboratory and university; where learning by experimentation with real devices for electrical engineering and circuit designing is concerned.

3.11.1 Hardware Design

Key Characteristics of Breadboards:

1. Holes and Rows: It is a grid of holes arranged in rows and columns. Each row has five holes connected internally, and columns are placed for components to be placed and connected.

2. Contacts and Connections: Breadboard holes are metal-lined. Components such as resistors, capacitors, IC or integrated circuits, and LEDs are placed inside these holes with appropriate leads/pins inserted into the holes for connectivity.

3. Terminal Strips: Breadboards have terminal strips where power supply and ground connections are made. These are marked red (+) for positive voltage and blue (-) for ground connections.

4. Versatility: This is also another advantage of breadboards as they come in different sizes; from small ones, which can be used for individual component prototyping, to large boards used for complex circuits that can have several components.

5. Reusable: Breadboards are reusable and allow rapid change as well as alteration with circuit designs without the need to desolder or make permanent connections.

6. No Soldering Needed: Unlike traditional printed circuit boards, breadboards do not need any soldering, and hence they are ideal for rapid prototyping and educational purposes where experimentation and learning are key.

7. Organization: Most breadboards have marked rows and columns to allow components to be placed in an organized way and to assist the user in coming up with a clean and logical circuit layout.

8. Learning tool: Breadboards are used in most electronic labs, schools, and workshops as a learning platform to teach circuit principles and also hands-on skills in general electronics.

9. Verifying: Breadboard, engineers, and designers run circuits to test functionality, validate design concepts and troubleshoot an electronic system before implementing the circuit in more permanent form, such a printed circuit board, PCB.

10. Integration: Breadboards are seamlessly integrated with other tools widely used in electrical engineering and electronics, such as jumper wires, oscilloscopes, and power supplies to create complete electrical circuits that are holistically complete an electrical circuit in very simple applications, like simple blinking of light-emitting diodes- LEDs up to complete microcontroller-based systems

3.12 Software

3.12.1 Blynk Application

Figure 3. 10 Blynk Logo

Blynk is a powerful Internet of Things (IoT) platform that enables developers to build and control IoT projects remotely. It offers a user-friendly mobile and web-based interface to monitor real-time data from sensors and interact with connected devices like microcontrollers, including ESP8266, Arduino, and Raspberry Pi. With Blynk, users can create customized dashboards using various widgets such as buttons, sliders, graphs, and gauges to visualize data and control hardware remotely. The platform is cloud-based, allowing seamless communication between hardware, software, and mobile devices from anywhere in the world.

One of Blynk's key features is its ability to send notifications, log data, and trigger automated actions based on predefined conditions. This makes it an ideal solution for a wide range of applications, from home automation and industrial monitoring to personal safety systems. The app is easy to set up and requires minimal coding skills, making it accessible to both beginners and professionals. By simplifying the process of connecting hardware to mobile devices, Blynk has become a go-to platform for developing efficient and interactive IoT solutions.

3.12.2 Hardware Design

Key characteristics of the Blynk application:

1. User-Friendly Interface

Blynk provides a simple, drag-and-drop interface for creating custom dashboards. Users can easily add widgets such as buttons, sliders, graphs, and gauges to control and monitor connected devices in real-time.

2. Cross-Platform Compatibility

Blynk works seamlessly on both Android and iOS devices, offering a consistent experience across platforms. Additionally, it includes a web dashboard for remote monitoring and control.

3. Wide Hardware Support

The platform supports a variety of microcontrollers, including Arduino, ESP8266, ESP32, Raspberry Pi, and other IoT boards, allowing flexibility in project development.

4. Cloud-Based Connectivity

Blynk uses cloud services to establish reliable connections between the hardware and the mobile application. This enables real-time data transfer and remote device control from anywhere in the world.

5. Real-Time Monitoring and Control

With Blynk, users can view real-time data from sensors and send commands to devices instantly. This feature is essential for applications like environmental monitoring and home automation.

6. Notification and Alert System

The application can send push notifications, emails, or SMS alerts based on certain triggers, such as high gas levels or device malfunctions, ensuring timely responses to critical events.

7. Data Logging and Visualization

Blynk allows users to log sensor data over time and visualize it using charts and graphs. This feature helps in analyzing patterns and optimizing performance.

8. Event Automation

Through features like Blynk Timer and Webhooks, users can automate actions based on specific conditions, such as turning on a fan when the temperature rises above a set threshold.

9. Energy System for Widgets

Blynk uses a unique energy-based system to add and configure widgets. Users allocate "energy" to customize their dashboards, and additional energy can be purchased if needed.

10. Easy Integration with APIs and Services

Blynk supports integration with third-party APIs and platforms, enabling more complex functionalities, such as sending data to external databases or integrating with voice assistants like Google Assistant or Alexa.

CHAPTER 4

RESULT AND DISCUSSIONS

4.1 Introduction

This chapter presents the results and analysis of the project which is the development of car cabin co level monitoring and alert system using Arduino. This is the chapter where its shows how the system works. The results and discussion focus on evaluating the performance of the CO level monitoring and alert system developed for car cabins using Arduino. This system was designed to detect harmful carbon monoxide concentrations in real-time, providing immediate alerts to ensure occupant safety. The project incorporates components such as the MQ-7 gas sensor, ESP8266 microcontroller, servo motor, and a buzzer to achieve accurate monitoring and efficient response. By measuring CO levels and triggering alerts when concentrations exceed the safe threshold of 100 ppm, the system ensures a prompt response to prevent potential hazards caused by prolonged CO exposure in enclosed spaces.

The analysis of the system's performance includes the detection accuracy of the gas sensor, the effectiveness of alert mechanisms, and the system's overall reliability in responding to dangerous CO levels. Data collected from testing under simulated conditions show how CO levels fluctuate over time and how the system responds to spikes in concentration. The discussion emphasizes the system's ability to notify users through visual and auditory signals, as well as its role in improving ventilation through servo motor activation. These results demonstrate the importance of implementing such monitoring systems in vehicles to safeguard against CO poisoning.

Table 3. 2 Table between time and gas concentration

ndex	Concentration (PPM)
1	17
2	17
3	18
4	18
5	18
6	18
7	18
8	18
9	18
10	18
11	18
12	17
13	18
14	18
15	18
16	17
17	17
18	17
19	18
20	18
21	18
22	17
23	18
24	18
25	17
26	18
27	18
28	18
29	18
30	17
31	17
32	18
33	18
34	22
35	23
36	23
37	23
38	22
39	70

40	239
41	192
42	157
43	122
44	97
45	80
46	68
47	58
48	50
49	46
50	41

4.2 Results and Analysis

The table below is the table time vs gas concentration. The table shows the monitored CO concentration levels over time, measured in parts per million (ppm). Initially, the CO levels remain stable, fluctuating between 17 and 18 ppm, indicating a safe environment. A noticeable increase starts at index 34, where the concentration rises to 22 ppm, followed by a significant spike, peaking at 239 ppm at index 40. This sharp increase suggests a sudden release of CO, likely from a malfunction or poor ventilation. Following the peak, the levels gradually decrease, returning to safer levels by index 50. This pattern highlights the importance of real-time CO monitoring to detect hazardous conditions and ensure timely corrective measures.

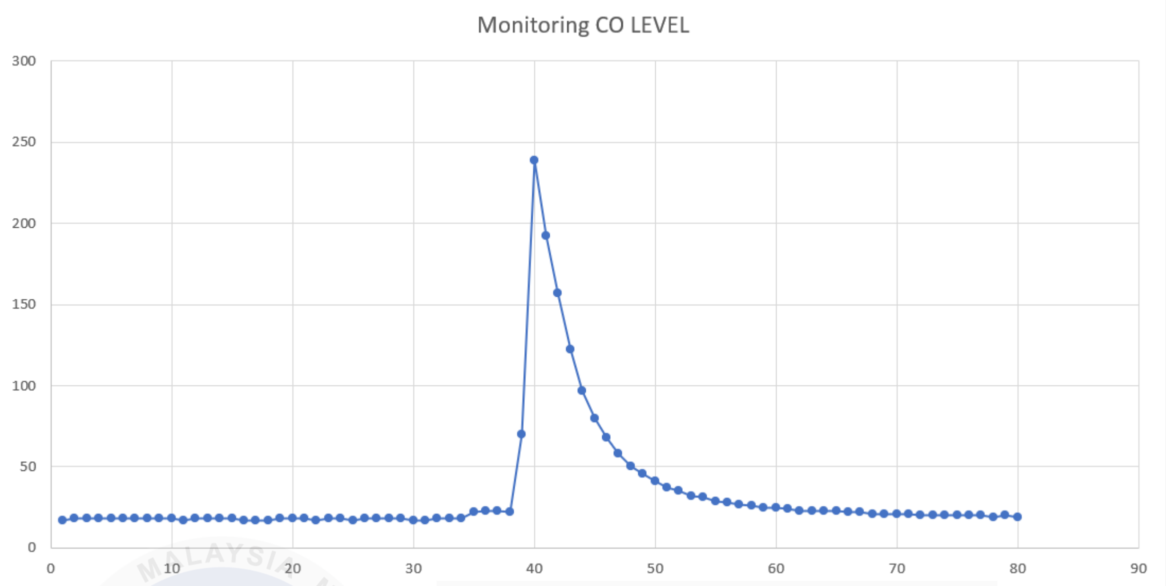


Figure 4. 1 Figure of CO level

4.2.1 Explanation of Gas Concentration Levels:

Safe Levels (17-22 ppm): These readings indicate a normal and safe gas concentration. No action is required, and the environment is within acceptable limits.

Moderate Levels (23-70 ppm): These readings suggest a slight increase in gas concentration. While not immediately dangerous, continued monitoring is necessary to prevent potential risks.

High Levels (70-239 ppm): These readings indicate a hazardous concentration of gas, which could pose serious health risks. Immediate action is needed to address the situation, such as improving ventilation, turning off gas sources, or evacuating the area.

4.2.2 Arduino Ide Software

The Arduino IDE (Integrated Development Environment) is an open-source software application designed to facilitate the development and uploading of code to

Arduino-compatible microcontroller boards. It provides an easy-to-use interface where users can write, edit, and debug programs in a simplified version of C/C++. The IDE includes a text editor for coding, a message area for displaying errors and feedback, and a toolbar with buttons for common functions like verifying, uploading, and saving code. Additionally, it offers a library manager that provides pre-written code for specific tasks, allowing developers to integrate functionalities like controlling sensors, motors, or communication modules with ease.

The software is cross-platform, meaning it can run on Windows, macOS, and Linux operating systems. The Arduino IDE also features a built-in serial monitor, which is useful for real-time communication between the computer and the Arduino board. This allows developers to test and debug their code by viewing data output from the board. Its simplicity and extensive community support make the Arduino IDE an ideal tool for both beginners and experienced developers working on various electronics and IoT (Internet of Things) projects.

The Arduino IDE is highly versatile, supporting a wide range of Arduino boards, including the Arduino Uno, Mega, Nano, and various third-party compatible boards. One of its key features is its ability to seamlessly integrate with external hardware through its serial communication tools, allowing developers to send and receive data during program execution. The platform simplifies hardware programming by offering built-in functions, such as digitalWrite(), analogRead(), and delay(), which abstract away low-level complexities. Moreover, the IDE's plugin system allows users to install additional board definitions and libraries, making it adaptable for advanced applications, such as wireless communication, robotics, and environmental monitoring. With its combination of user-friendliness, flexibility, and rich community-driven resources, the Arduino IDE has become an essential tool for prototyping and bringing innovative hardware projects to life.

Project Coding :

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <BlynkSimpleEsp8266.h>
#include <Servo.h>
#include <ESP8266WiFi.h>
```

Figure 4. 2 Including Libraries

a) Wire.h: Allows communication with I2C devices (like the LCD screen).

b) LiquidCrystal_I2C.h: Controls the LCD display.

c) BlynkSimpleEsp8266.h: Connects the system to the Blynk app for remote monitoring.

d) Servo.h: Controls a servo motor.

e) ESP8266WiFi.h: Connects the ESP8266 microcontroller to Wi-Fi.

```
#define BLYNK_TEMPLATE_ID "TMPL6dgoZXQUj"
#define BLYNK_TEMPLATE_NAME "CO monitoring"
#define BLYNK_AUTH_TOKEN "bjY4fqYBmtBBvjGZST0LlkUxrh7msSCP"
```


Figure 4. 3 Defining Blynk

a) These lines store the template ID, name, and authentication token for Blynk.

b) This allows the ESP8266 to communicate with the Blynk app.

```
const char* ssid = "Syi Anuar`s iPhone";
const char* pass = "insyirah";
```

Figure 4. 4 Wi-Fi Credentials

a) These lines store the Wi-Fi name (ssid) and password (pass).

b) The ESP8266 will use this information to connect to Wi-Fi.

```
int gasSensorPin = A0; // Gas sensor is connected to analog pin A0
int buzzerPin = 12;      // Buzzer is connected to digital pin 12
int servoPin = 13;       // Servo motor is connected to digital pin 13
```

Figure 4. 5 Defining Hardware Pins

a) The **gas sensor** detects carbon monoxide (CO) and is connected to analog pin A0.

b) The **buzzer** sounds an alert when CO levels are high.

c) The **servo motor** adjusts ventilation (e.g., opens a window) and is connected to pin 13.

```
LiquidCrystal_I2C lcd(0x27, 16, 2);
```

Figure 4. 6 Setting Up LCD Display

a) The LCD is connected using **I2C protocol**.

b) It has **16 columns and 2 rows** (16x2 display).

c) The address 0x27 is the LCD’s unique identifier.


```
bool prevGasState = false;
BlynkTimer timer;
bool startMeasurement = false;
```

Figure 4. 7 Variables for Sensor & Timer

a) prevGasState: Stores whether the gas level was high or low in the last reading.

b) timer: A **Blynk timer** that helps schedule tasks at regular intervals.

c) startMeasurement: Controls when gas measurement starts.

```
const float RL = 10.0;    // Load resistance in kilo-ohms
const float R0 = 10.0;    // Sensor resistance in clean air (needs calibration)
const float VOLT_RESOLUTION = 5.0; // Operating voltage
const int ADC_RESOLUTION = 1023.0; // 10-bit ADC (Analog to Digital Converter)
```

Figure 4. 8 MQ7 Gas Sensor Calibration Values

a) These values help convert the **sensor's voltage readings** into **CO concentration (PPM - Parts Per Million)**.

b) R0 is a reference value that should be measured during sensor calibration.

```
const float a = 99.042;  // From MQ7 sensor datasheet
const float b = -1.518;  // From MQ7 sensor datasheet
```

Figure 4. 9 Parameters for CO Calculation

a) These values come from the MQ7 **sensor datasheet**.

b) They are used to calculate **CO concentration from sensor readings**.

```
void setup() {
  Serial.begin(9600);  // Start Serial Monitor for debugging

  lcd.begin();          // Initialize LCD
  lcd.backlight();      // Turn on LCD backlight

  pinMode(buzzerPin, OUTPUT);  // Set buzzer pin as OUTPUT
  servo.attach(servoPin);      // Attach servo motor to pin
  servo.write(0);              // Start servo at 0 degrees

  // Connect to Wi-Fi
  WiFi.begin(ssid, pass);
  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }
  Serial.println("\nConnected to Wi-Fi");

  // Connect to Blynk
  Blynk.begin(BLYNK_AUTH_TOKEN, ssid, pass);

  // Delay gas sensor reading for 75 seconds after startup
  timer.setTimeout(75000L, []() {
    startMeasurement = true;
    lcd.clear();
    lcd.print("Normal");

    // Check gas sensor every 1 second
    timer.setInterval(1000L, checkGasSensor);
  });
}
```

Figure 4. 10 Setup Function

a) **Start serial communication** for debugging.

b) **Initialize the LCD display**.

c) **Set up the buzzer and servo motor**.

d) **Connect to Wi-Fi** (waits until the connection is successful).

e) **Connect to Blynk** for remote monitoring.

f) **Wait for 75 seconds** before taking gas sensor readings (sensor needs time to warm up).

g) **Check CO levels every second**.

```
void checkGasSensor() {
  if (!startMeasurement) return;  // Don't start until 75s delay is over

  int gasValue = int(getMQ7PPM());  // Get CO concentration (PPM)
  Serial.println(gasValue);         // Print PPM value for debugging
  Blynk.virtualWrite(V0, gasValue); // Send PPM value to Blynk app

  bool isGasHigh = (gasValue > 100); // If CO level > 100 PPM, it's dangerous

  if (isGasHigh != prevGasState) { // If the gas level has changed
    prevGasState = isGasHigh;

    if (isGasHigh) {
      digitalWrite(buzzerPin, HIGH); // Turn on buzzer
      servo.write(180);              // Move servo to 180° (open vent)
      lcd.clear();
      lcd.print("High CO");
      lcd.setCursor(0, 1);
      lcd.print("concentration");
      Blynk.logEvent("gas_alert", "High CO concentration detected!");
    } else {
      digitalWrite(buzzerPin, LOW); // Turn off buzzer
      servo.write(0);               // Move servo to 0° (close vent)
      lcd.clear();
      lcd.print("Normal");
    }
  }
}
```

Figure 4. 11 Gas Sensor Reading Function

1. If gas measurement hasn't started yet, the function does nothing.

2. Reads the CO level using getMQ7PPM().

3. Sends data to Blynk so users can monitor it remotely.

4. Checks if CO is above 100 PPM (dangerous).

5. **If CO is high**:

    a) Turns on **buzzer**.

    b) Moves **servo motor to 180°** (opens vent).

    c) Displays **"High CO" warning** on LCD.

    d) Sends an **alert to Blynk app**.

6. **If CO goes back to normal**:

    a) Turns **off buzzer**.

    b) Moves **servo back to 0°** (closes vent).

    c) Displays **"Normal"** on LCD.

```
void loop() {
  Blynk.run();   // Runs Blynk functions
  timer.run();   // Runs the scheduled tasks (like checking gas levels)
}
```

Figure 4. 12 Main Loop

a) This continuously runs the **Blynk app** and **gas sensor checks**.

```
float getMQ7PPM() {
  int adcRaw = analogRead(gasSensorPin);
  float voltage = (adcRaw * VOLT_RESOLUTION) / ADC_RESOLUTION;
  float sensorResistance = ((VOLT_RESOLUTION * RL) / voltage) - RL;
  float ratio = sensorResistance / R0;
  float ppm = a * pow(ratio, b);
  return ppm;
}
```

Figure 4. 13 Function to Get CO Level (PPM)

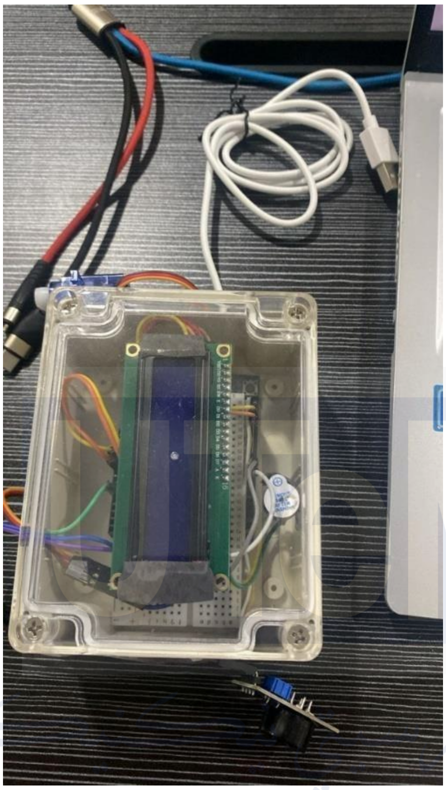
a) **Reads sensor voltage**.

b) **Converts voltage to resistance**.

c) **Uses a formula** to calculate **CO concentration (PPM)**.

Summary for this is this monitors the CO levels systems in a car. It alerts users via buzzer, LCD, and Blynk app. It automatically improves ventilation using a servo motor. It's Wi-Fi connected and remotely accessible.

Image of project:



a)

Figure 4. 14 Project device (Off condition)

b)

Figure 4. 15 Project device (On condition)

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In conclusion, the development of the **Car Cabin CO Level Monitoring and Alert System using Arduino** provides an effective solution for ensuring passenger safety by monitoring carbon monoxide levels in real-time. The integration of the MQ7 gas sensor, ESP8266 microcontroller, and Blynk platform enables accurate detection and efficient communication of hazardous CO levels. This system can prevent potential health risks by alerting users to take prompt corrective action, such as improving ventilation or stopping the engine, thus reducing the risk of CO poisoning in enclosed spaces like car cabins.

The project demonstrates how hardware components, such as a buzzer, servo motor, and LCD, can work in tandem with software to automate safety mechanisms. When high CO levels are detected, the system not only provides audible and visual alerts but also simulates ventilation control using the servo motor. Moreover, the integration with the Blynk app allows users to monitor CO levels remotely, making the system more versatile and user-friendly. Overall, this system showcases the potential of IoT and embedded systems to enhance vehicle safety and protect lives. With further refinements, such as integrating battery backups and improving calibration for various environmental conditions, this system could be widely adopted in vehicles and other enclosed environments prone to CO buildup, offering an affordable and reliable safety solution.

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APPENDICES

Appendix A

```
// Blynk template information
#define BLYNK_TEMPLATE_ID "TMPL6dgoZXQUj"
#define BLYNK_TEMPLATE_NAME "CO monitoring"
#define BLYNK_AUTH_TOKEN "bjY4fqYBmtBBvjGZST0LlkUxrh7msSCP"

#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <BlynkSimpleEsp8266.h>
#include <Servo.h>
#include <ESP8266WiFi.h>



// Wi-Fi credentials
const char* ssid = "Syi Anuar`s iPhone";
const char* pass = "insyirah";

// Gas sensor pin
int gasSensorPin = A0;

// Buzzer pin
int buzzerPin = 12;

// Servo for CO control
Servo servo;
int servoPin = 13; // Adjust to your setup

// I2C LCD
LiquidCrystal_I2C lcd(0x27, 16, 2);

// Variables
bool prevGasState = false;
BlynkTimer timer;
bool startMeasurement = false;
// MQ7 Calibration variables
const float RL = 10.0;  // Load resistance in kΩ
const float R0 = 10.0;  // Sensor resistance in clean air (needs calibration)
const float VOLT_RESOLUTION = 5.0; // Operating voltage
const int ADC_RESOLUTION = 1023.0; // 10-bit ADC

// Parameters for converting sensor resistance to PPM
const float a = 99.042;  // From datasheet curve
const float b = -1.518;  // From datasheet curve
```

```
void setup() {
  // Initialize serial communication
  Serial.begin(9600);

  // Set up I2C LCD
  lcd.begin();
  lcd.backlight();

  // Set up buzzer and servo pins
  pinMode(buzzerPin, OUTPUT);
  servo.attach(servoPin);
  servo.write(0); // Start at 0 degrees

  // Connect to Wi-Fi
  WiFi.begin(ssid, pass);
  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }
  Serial.println("\nConnected to Wi-Fi");

  // Connect to Blynk
  Blynk.begin(BLYNK_AUTH_TOKEN, ssid, pass);

 // Schedule the start of gas sensor measurements after 1 minute 15 seconds
  timer.setTimeout(75000L, []() {
    startMeasurement = true;
    lcd.clear();
    lcd.print("Normal");
    // Set up periodic gas sensor check every 1 second
    timer.setInterval(1000L, checkGasSensor);
  });



}

void checkGasSensor() {
  if (!startMeasurement) return;
  // Read gas sensor value
  int gasValue = int(getMQ7PPM());
 Serial.println(gasValue);
 Blynk.virtualWrite(V0, gasValue);
  // Check if gas level is high
  bool isGasHigh = (gasValue > 100);

  // If gas state has changed
  if (isGasHigh != prevGasState) {
    prevGasState = isGasHigh;
```

```
    // Update buzzer, servo, and LCD
    if (isGasHigh) {
      // Turn on buzzer
      digitalWrite(buzzerPin, HIGH);

      // Set servo to 90 degrees
      servo.write(180);

      // Display "High CO concentration" on LCD
      lcd.clear();
      lcd.print("High CO");
      lcd.setCursor(0, 1);
      lcd.print("concentration");

      // Log event to Blynk
      Blynk.logEvent("gas_alert", "High CO concentration detected!");
    } else {
      // Turn off buzzer
      digitalWrite(buzzerPin, LOW);

      // Set servo to 0 degrees
      servo.write(0);

      // Display "Normal" on LCD
      lcd.clear();
      lcd.print("Normal");
    }
  }
}



void loop() {
  Blynk.run();
  timer.run();
}

float getMQ7PPM() {
  // Read analog value
  int adcRaw = analogRead(gasSensorPin);

  // Convert to voltage
  float voltage = (adcRaw * VOLT_RESOLUTION) / ADC_RESOLUTION;

  // Convert to resistance ratio
  float sensorResistance = ((VOLT_RESOLUTION * RL) / voltage) - RL;
  float ratio = sensorResistance / R0;

  // Convert to PPM using power regression
```

```
  float ppm = a * pow(ratio, b);

  return ppm;
}
```

Appendix B

Figure 5. 1 Image of project when detect the presence of CO gas

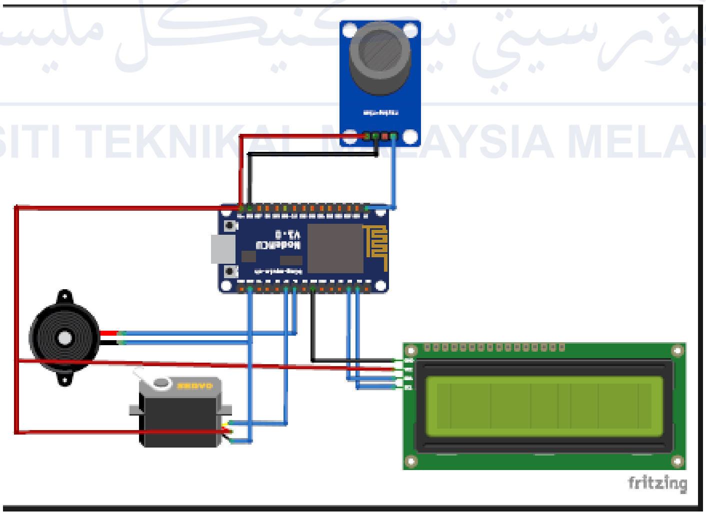

Figure 5. 2 Using Fritzing to do the circuit

Figure 5. 3 Before arrange properly in project casing

Turn it in percent

psm 2 report insyirah

ORIGINALITY REPORT

23%	19%	14%	11%
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