



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**DEVELOPMENT OF CARBON MONOXIDE
DETECTOR FOR VEHICLES WITH AUTO WINDOW
ROLL DOWN AND SAFETY WARNING SYSTEM**

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Power) With Honours.

By

MOHD SYAZWAN BIN JASMAN

B071710186

950428-06-5577

**FACULTY OF ELECTRICAL AND ELECTRONIC ENGINEERING
TECHNOLOGY**

2021

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: Development of Carbon Monoxide Detector for Vehicles with Auto Window
Roll Down and Safety Warning System

Sesi Pengajian: 2021

Saya **MOHD SYAZWAN BIN JASMAN** mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (X)

SULIT*

Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972.

TERHAD* Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan.

TIDAK TERHAD

Yang benar,

Disahkan oleh penyelia:



MOHD SYAZWAN BIN JASMAN

Alamat Tetap:

LOT 6705, JALAN ENGGANG,
KAMPUNG SERI CHEEDING,
42700 BANTING,
SELANGOR DARUL EHSAN.


Tarikh: 13 JANUARY 2021



PUAN NURUL KAUSAR BINTI AB

MAJID

Cop Rasmi Penyelia



NURUL KAUSAR BINTI AB MAJID
Jurutera Pengajar
Jabatan Teknologi Kejuruteraan Elektrik
Fakulti Teknologi Kejuruteraan
Elektrik dan Elektronik
Universiti Teknikal Malaysia Melaka

Tarikh: 13 JANUARY 2021

*Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini

DECLARATION

I hereby, declared this report entitled Development of Carbon Monoxide Detector for Vehicles with Auto Window Roll Down and Safety Warning System is the results of my own research except as cited in references.

Signature:



APPROVAL

This report is submitted to the Faculty of Electrical and Electronic Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Power) With Honours. The member of the supervisory is as follow:

Signature: 

Supervisor: 
PUAN NURUL KAUSAR BINTI AB
MAJID

Signature: 

Co-supervisor: 
PUAN INTAN MASTURA BINTI
SAADON

ABSTRACT

Nowadays, the incidence of carbon monoxide (CO) gas leakage in vehicles has increased. The leaking of the vehicle exhaust system will lead to a high risk and harm to humans. Hazardous gas can affect human quality of life, such as the respiratory and blood systems, where it will harm driver and passenger brains due to a lack of oxygen in bloodstream. It primarily impacts the driver who has been driving and traveling on a long trip by way of a vehicle. The driver is supposed to have a rest and take a nap in their vehicle. Normally, the air conditioner (AC) is switched on during hot season, which ensures that the engine is often turned on which allows CO gas leakage to the vehicle. This project was created at reasonable cost to solve this issue by detecting CO gas using the MQ-7 sensor. To make this system more effective, Arduino UNO is used as a microcontroller to control both the process which are input and output. The LCD display is being used to display the concentration of CO gas in the vehicle at a ppm value. LEDs and buzzers operate as an alarm device. GSM and GPS technology are used to send a warning message with a real-time tracking device, where the location could be reported to an authorised person on longitude and latitude. In addition, this system is designed with a power window motor that automatically roll down the window when the concentration of CO gas is at danger. So, the concentration of CO gas in the vehicle can be controlled and this will avoid CO gas poisoning and death to the user.

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEDICATION

This was dedicated to my beloved father, Mr. Jasman Bin Ngisok, my beloved mother, Mrs. Saripah Binti Md. Sidek and my siblings, Mohd Shafiq, Nurul Syahirah, Mohd Syahmi and Mohd Syakirin. Praise be to Allah, S.W.T., that I am part of this supportive family. Thank you for your advice and best wishes.



ACKNOWLEDGEMENTS

Praise be to Allah, Most Benevolent and Most Merciful. It is by His grace and pleasure that this project has been successfully accomplished. I would like to take this opportunity to express my sincere gratitude to my project supervisor, Puan Intan Mastura Binti Saadon, and to my co-supervisor, Puan Nurul Kausar Binti Ab Majid for their time, patience, advice, moral support, and inspiration during the project period.

My thanks go to Mr. Gabriele C. Ramos from Philippines. He was a graduate student in Bachelor of Science in Industrial Technology with a major in Electrical Machine and Control, and work as Senior Test Engineering Supervisor at Allegro Microsystems Philipines Inc. His experience and skills in coding of GPS tracker system give a solid support to done my Bachelor Degree Project (BDP).

I would like to thank all the technical staff of the PSM Laboratory and technicians for their cooperation and assistance in implementing the hardware of the project. My heartfelt appreciation goes also to my colleagues, who shared a lot of technological information with me and inspired me to try more information.

Finally, to my beloved family, who have always been here to inspire, motivate and offer their full support anytime I need it.

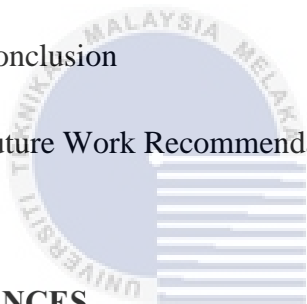
TABLE OF CONTENTS

	PAGE
TABLE OF CONTENTS	xi
LIST OF TABLES	xv
LIST OF FIGURES	xvi
LIST OF APPENDICES	xviii
LIST OF ABBREVIATIONS	xvii
CHAPTER 1 INTRODUCTION	1
1.1 Background	1
1.2 Problem Statement	2
1.3 Objective	3
1.4 Scope of Project	3
1.5 Thesis Outline	4
CHAPTER 2 LITERATURE REVIEW	5
2.1 Introduction	5
2.1.1 Impact of Carbon Monoxide (CO) Gas on The Human Body System.	5
2.1.2 Source of Carbon Monoxide (CO) Gas	7
2.2 Overview of Existing Project System	8
2.2.1 Car Indoor Gas Detection System	8
2.2.2 Wireless Sensor Network Application for Carbon Monoxide Monitoring	8
2.2.3 Air Quality Monitoring System Based on IoT Using Raspberry Pi	9

2.2.4	Comparison Table with Existing Project	9
2.3	Microcontroller	10
2.3.1	Arduino	12
2.3.2	Raspberry Pi	13
2.3.3	Contrast of Arduino and Raspberry Pi	15
2.4	Carbon Monoxide (CO) Gas Sensor Technologies	16
2.4.1	Colorimetric Sensor	17
2.4.2	Metal Oxide Semiconductor Sensor	18
2.4.3	Electrochemical Sensor	19
2.4.4	Infrared Sensor	20
2.4.5	Comparison of Sensor Technologies	20
2.5	Power Window Motor	22
2.6	Liquid Crystal Display (LCD)	23
2.7	Summary	24
CHAPTER 3 METHODOLOGY		25
3.1	Introduction	25
3.2	Development of Carbon Monoxide (CO) gas detector	26
3.2.1	Design project circuit using proteus	26
3.2.2	Development of Carbon Monoxide (CO) gas detector system	26
3.2.2.1	Program coding development	28

3.2.2.2	Arduino UNO	29
3.2.2.3	Rechargeable battery	31
3.2.2.4	MQ-7 Carbon Monoxide (CO) gas sensor	31
3.2.2.5	Liquid Crystal Display (LCD)	32
3.2.2.6	Power Window Motor	32
3.2.2.7	Buzzer module	33
3.2.2.8	Light-Emitting Diode (LED)	33
3.2.2.9	Two-Channel Relay module	34
3.3	Development of alert monitoring system	34
3.3.1	Calculation of Carbon Monoxide (CO) gas concentration	35
3.4	Summary	38
CHAPTER 4 RESULT AND DISCUSSION		39
4.1	Introduction	39
4.2	Analysis of Carbon Monoxide (CO) gas detector	39
4.2.1	Carbon Monoxide concentration (PPM) against Vout (V)	41
4.2.2	Carbon Monoxide (CO) gas concentration (PPM) against Time Taken (minutes) for normal air condition	44
4.2.3	Carbon Monoxide (CO) gas concentration (PPM) against Time Taken (minutes) for cigarette smoke in a closed room	45
4.2.4	Carbon Monoxide (CO) gas concentration (PPM) against Time Taken (minutes) for car fumes on car exhaust	47

4.2.5	Carbon Monoxide (CO) gas concentration (PPM) against Time Taken (minutes) for three condition	49
4.3	Analysis of alert monitoring system	50
4.4	Cost estimation	52
4.5	Problem Encountered and Solution	53
4.6	Summary	53
CHAPTER 5 CONCLUSION AND FUTURE WORK		54
5.1	Introduction	54
5.2	Conclusion	54
5.3	Future Work Recommendation	56
REFERENCES		57
APPENDICES		60



اونيورسيتي تيكنيكل مليسيا ملاك

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

LIST OF TABLES

TABLE	TITLE	PAGE
Table 2.1:	Concentration of CO gas and symptoms after inhalation.	6
Table 2.2:	Comparison between the components and the method of irrigation used in the various existing project systems.	10
Table 2.3:	Specification of Raspberry Pi Model B.	15
Table 2.4:	The relationship between the Arduino UNO and Raspberry Pi Model B.	16
Table 2.5:	List of four sensor technologies for domestic applications.	21
Table 2.6:	Specifications of power window motor.	23
Table 3.1:	Specifications of Arduino UNO.	30
Table 4.1:	Relationship between MQ-7 output voltage and CO concentration in PPM.	41
Table 4.2:	Experiment result based on conditions.	43
Table 4.3:	The reading of CO concentration that recorded for 10 minutes under normal air condition	44
Table 4.4:	The reading of CO concentration that recorded for 10 minutes during test with cigarette smoke in a closed room.	46
Table 4.5:	The reading of CO concentration that recorded for 10 minutes during test with car fumes on car exhaust.	48
Table 4.6:	Component used with the price.	52

LIST OF FIGURES

FIGURE	TITLE	PAGE
Figure 2.1:	Schematic vehicle sampling site.	7
Figure 2.2:	Block diagram of microcontroller.	12
Figure 2.3:	Pin diagram of Arduino UNO ATmega328.	13
Figure 2.4:	The pin diagram of Raspberry Pi Model B.	14
Figure 2.5:	(a) Schematic of the CO sensing setup. (b) UV-vis spectrum of sensing probe on silica paper during continuous exposure of CO.	17
Figure 2.6:	Metal Oxide semiconductor CO sensor structure.	18
Figure 2.7:	Electrochemical CO sensor.	19
Figure 2.8:	NDIR sensor.	20
Figure 2.9:	Basic DC motor connection.	22
Figure 2.10:	Structure and dimensions of power window motor.	23
Figure 2.11:	LCD pin diagram.	24
UNIVERSITI TEKNIKAL MALAYSIA MELAKA		
Figure 3.1:	Overall flowchart of PSM/BDP.	25
Figure 3.2:	Proteus simulation circuit for MQ-7 sensor	26
Figure 3.3:	Block diagram of “Development of Carbon Monoxide Detection for Vehicle with Auto Window Roll Down and Safety Alert System”	27
Figure 3.4:	Program coding development	28
Figure 3.5:	Arduino UNO board pin labelling	30
Figure 3.6:	Rechargeable battery	31
Figure 3.7:	MQ-7 Carbon Monoxide (CO) gas sensor	31
Figure 3.8:	16 x 2 LCD display	32
Figure 3.9:	Power window motor with frame	32
Figure 3.10:	Buzzer module	33

Figure 3.11:	LED	33
Figure 3.12:	Two-channel relay module	34
Figure 3.13:	SIM808 GSM GPS module	35
Figure 4.1:	Overall simulation project circuit using proteus.	40
Figure 4.2:	Completed prototype.	40
Figure 4.3:	Graph of PPM against Vout.	42
Figure 4.4:	The result of this project that used to test under normal air condition in a closed room after 10 minutes.	44
Figure 4.5:	Graph of CO concentration (PPM) vs Time Taken (minutes) for normal air condition.	45
Figure 4.6:	The result during test with cigarette smoke in a closed room after 10 minutes.	46
Figure 4.7:	Graph of CO concentration (PPM) vs Time Taken (minutes) for cigarette smoke in a closed room.	47
Figure 4.8:	The result test with car fumes on car exhaust after 10 minutes.	48
Figure 4.9:	Graph of CO concentration (PPM) vs Time Taken (minutes) for car fumes on car exhaust	49
Figure 4.10:	Graph of CO concentration (PPM) vs Time Taken (minutes) for three condition.	49
Figure 4.11:	Alert message from GSM that already sent to authorized person in the state of longitude and latitude	51

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
Appendix A	Datasheet of Arduino UNO.	60
Appendix B	Datasheet of MQ-7 Carbon Monoxide Gas sensor detector.	67
Appendix C	Coding of “Development of Carbon Monoxide Detection for Vehicle with Auto Window Roll Down and Safety Alert System”.	70
Appendix D	Gantt Chart	75



LIST OF ABBREVIATIONS

°C	Celsius
°F.	Fahrenheit
A	Ampere
AC	Air-Conditioner
ADC	Analog-to-Digital Converter
CO	Carbon Monoxide
COHb	Carboxyhaemoglobin
CPU	Central Processing Unit
DC	Direct Current
GUI	Graphical User Interface
GSM	Global System for Mobile Communication
GSM	General Packet Radio Service
GPS	Global Positioning System
Hb	Haemoglobin
I/O	Input/output
IDE	Integrated Development Environment
LCD	Liquid Crystal Display
LED	Light-Emitting Diode
LPG	Liquefied Petroleum Gas
MQ-7	Carbon Monoxide (CO) gas sensor
NTP	Normal Temperature and Pressure

PCB	Printed Circuit Board
PDP	Programmed Data Processor
PIC	Peripheral Interface Controller
PPM	Part Per Million
PWM	Pulse Width Modulation
RAM	Random Access Memory
ROM	Read-Only Memory
SnO ₂	Tin Oxide
V	Voltage



CHAPTER 1

INTRODUCTION

1.1 Background

Carbon monoxide (CO) gas is a colourless, odourless, completely tasteless, toxic gas that can never be detected without the use of advanced technology. Other than that, CO gas is released from organic matter by combustion due to lack of oxygen supply to allow the full of oxidation carbon dioxide (CO₂) gas. Liquefied Petroleum Gas (LPG) injection system sometimes will result in irremediable effects for driver and passenger when the technical problem was happened at LPG system.

Sometimes this technical problem happens because of exhaust system is having a leakage or the exhaust systems is being blocked by any object that can cause CO gas to enter the car cabin. Passengers without being noticed will inhale the CO gas and this will cause fatality. The longer the time idling the more CO gas leak into the vehicle due to incomplete combustion of fuel.

It is nearly impossible for a victim to notice the symptoms of poisoning caused by the leakage of CO gas because CO gas is fast acting, especially when the victim is taking a nap. The leakage of vehicle exhaust system will contribute to a high risk and is harmful to human. The hazardous gaseous will affect the human health such as respiratory and blood system where it can damage our brain because of lack of oxygen in our blood stream.

In order to avoid excessive inhalation of CO gas inside the vehicle, a project entitled "Development of Carbon Monoxide Detector for Vehicles with Auto Window Roll Down and Safety Warning System" is proposed to deal with this issue by developing a safety alarm signal and requiring the vehicle's power window motor to roll down automatically when the concentration of CO gas in the vehicle reaches a dangerous level.

A major part of this project is Arduino UNO as a microcontroller which functions to monitor all inputs and outputs for this system. This project uses MQ-7 as a CO gas sensor that can be detect from 20 ppm to 2000 ppm and is particularly sensitive to CO gas. An LCD display is used to show the concentration of CO gas in ppm within the vehicle, whether at a normal or dangerous level.

LEDs and buzzers operate as a warning device. GSM and GPS systems are used to transmit a warning text via a real-time monitoring device, where the position can be reported to the authorized person in the state of longitude and latitude. In addition, this system is provided with a power window motor to automatically roll window down when the concentration of CO gas is at danger. It will reduce the concentration of CO gas in the vehicle to avoid CO gas toxicity inside the vehicle.

1.2 Problem Statement

Car drivers who have a long drive and tend to take a nap in their car for refreshment may not be aware of the existence of carbon monoxide within the vehicle because carbon monoxide (CO) is odourless, colourless and completely tasteless. When a vehicle is idle with its engine running, the exhaust fumes which contains CO gas could flow into the vehicle through the leakage of exhaust piping system. Liquefied Petroleum Gas (LPG) injection system sometimes will result in irremediable effects for driver and passenger when the technical problem happened at LPG system. High concentration of CO gas inside the vehicle without opening the windows can affect the human health such as respiratory and blood system where it can damage the driver's and passenger's brain because of lack of oxygen in human blood stream. This may bring some symptoms to them like dizziness, headaches, and death. Therefore, a project entitled "Development of Carbon Monoxide Detection for Vehicle with Auto Window Roll Down and Safety Alert System" is important to be designed to detect the concentration of CO gas, and to roll down vehicle's window automatically when the CO gas level is at danger state. GSM and GPS technologies are used to send an alert message with a real-time tracking system where the location will be informed in state of longitude and latitude to the authorized person.

1.3 Objective

The goals of this project are as follows:

1. To design and develop a Carbon Monoxide (CO) gas detection system for vehicle with automatic roll down window using Arduino microcontroller
2. To develop an alert and monitoring system for the Carbon Monoxide (CO) gas detection and using GSM and GPS to send a warning message and location.

1.4 Scope of Project

This project is a combination between hardware and software. To achieve 1st objective, components such as Arduino UNO as microcontroller, MQ-7 Carbon Monoxide (CO) gas sensor, buzzer, LCD display, LED and power window motor have been used for the hardware component. The purpose of Arduino UNO is to monitor the overall detector system from the CO gas detection to the safety alert system. The MQ-7 sensor is being used to detect the existence of CO gas while the buzzer triggers a safety alert when the CO concentration is at a dangerous level. LED indicators are used to alert the consumer of the level of CO gas concentration. The LCD display shows the measurement of the concentrations of CO gas in ppm value and the power window motor has been used to automatically demonstrate the roll-down of the vehicle window that Arduino UNO regulates when the concentration of CO gas exceeds a dangerous level. Arduino Integrated Development Environment (IDE) will be used for the software program section of the application.

To achieve the 2nd objective, GSM and GPS systems are used to send a warning message via a real-time monitoring device, where the position can be reported to the authorized person in the state of longitude and latitude.

1.5 Thesis Outline

This report covers five chapters. All these chapters are covered on the implementation of this project operation, which deals with “Development of Carbon Monoxide Detection for Vehicle with Auto Window Roll down and Safety Alert System”.

Chapter 1 presents an explanation of this project scope, including background, problem statement, goal, project scope and project outline.

Chapter 2 consists of a literature review. In this section, it is about discussing related previous journal or article that other researchers have conducted to develop the project. Details on a variety of materials, devices that have been used and technologies will be covered in technical detail in this chapter.

Chapter 3 is the methodology used to implement this project. The method and technique as a reference and apparatus shall be developed with a consistent flow of this study. A block diagram will display the complete purpose of this project scope. The flow chart will be used as well as the method for this project will be explained throughout this chapter.

Chapter 4 focuses on the conclusions of the outcomes of this project. In addition, the analysis discussion focused on the outcome of the project and the findings are explicitly summarized throughout this chapter.

Finally, for the last chapter which is chapter 5 consists of the conclusions and recommendations are discussed in this chapter, with understanding for the whole of research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter would highlight in general the concept of carbon monoxide (CO) gas, the effectiveness of CO gas along the human body and the source of CO gas from the vehicle. This chapter also explains the overview of existing devices, microcontrollers in general and CO gas sensor technologies. In comparison, a variety of previous related works, articles and journals linked to this project will also be discussed.

2.1.1 Impact of Carbon Monoxide (CO) Gas on The Human Body System.

Carbon monoxide (CO) gas has been harmful to the human body system. CO gas is odourless, colourless, and completely tasteless where it is impossible to identify human beings. CO gas is released from organic matter by combustion due to lack of oxygen supply to allow the full of oxidation with carbon dioxide (CO₂) gas. In addition, CO gas becomes significantly lighter in the air. Table 2.1 summarizes some of the effects of long-term exposure to various concentrations of CO gas in ppm. (Agarwal, A., & Kumar, R., 2016).

Table 2.1 Concentration of CO gas and symptoms after inhalation

Concentration of CO gas	Time of exposed	Symptoms
0 ppm	-	Fresh air.
9 ppm	-	Maximum indoor air quality level.
10-35 ppm	8 hours	Headache, dizziness and nausea.
100 ppm	2-3 hours	Slight headache.
200 ppm	2-3 hours	Mild headache, dizziness, fatigue and nausea.
400 ppm	1-2 hours	Loss of judgement, serious headache, sweating.
800 ppm	45 minutes	Unconscious within 2 hours. Dizziness, nausea and convulsions. Death within 2-3 hours.
1,600 ppm	20 minutes	Headache, tachycardia, dizziness and nausea. Death within 1 hour.
3,200 ppm	5-10 minutes	Headache, dizziness and nausea. Death within 30 minutes.
6,400 ppm	1-2 minutes	Headache, dizziness and nausea. Death less than 20 minutes.
12,800 ppm	1-3 minutes	Unconsciousness. Death within 3 minutes.

Once CO gas has been inhaled by the human respiratory system, it interacts with oxygen that carries blood haemoglobin and forms carboxyhaemoglobin (CO-Hb). Haemoglobin is no longer available for transferring blood when CO gas is mixed with haemoglobin. Exposure of CO gas to humans will cause serious brain and heart complications with excess than 20% of carboxyhaemoglobin (CO-Hb) (Bailey Regina, 2020).