UNIVERSITI TEKNIKAL MALAYSIA MELAKA

IN-VEHICLE CARBON MONOXIDE DETECTION WITH AUTO WINDOW ROLL DOWN

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Engineering Technology (Telecommunication) (Hons.)

by

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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TAJUK: **In-Vehicle Carbon Monoxide Detection With Auto Window Roll Down**

SESI PENGAJIAN: **2016/17 Semester 2**

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electronics Engineering Technology (Telecommunications) with Honours. The member of the supervisory is as follow:

……

(Project Supervisor)

ABSTRAK

Gas karbon monoksida (CO) merupakan gas yang tiada warna, tiada rasa dan beracun serta susah untuk dikesan. Penyedutan CO yang berlebihan memberi impak kepada kesihatan manusia. Hal ini terutamanya menjejaskan pemandu yang terpaksa melalui perjalanan panjang dan terpaksa berehat dalam kenderaan mereka. Penghawa dingin kenderaan kebiasaannya dihidupkan, begitu juga enjin kereta. Hal ini menyebabkan kebocoran CO di dalam kenderaan dan akan membawa kematian kepada orang ramai. Oleh itu, satu sistem yang berkos rendah direkacipta iaitu "Dalam Kenderaan Sistem Pengesanan Karbon Monoksida dengan Sistem Penurunan Tingkap Secara Automatik (InVCO)" dijadikan kepentingan bagi mencegah kejadian itu berlaku. Tujuan projek ini adalah untuk membangun satu sistem amaran untuk mengesan CO dalam kenderaan dengan menggunakan MQ-7 CO gas sensor. Arduino Uno digunakan sebagai pengawal mikro untuk mengawal keseluruhan sistem dalam menjadikan sistem ini lebih praktikal. Paparan sistem LCD digunakan untuk memaparkan kepekatan gas CO di dalam kenderaan dalam nilai ppm manakala LED serta buzzer berfungsi sebagai sistem amaran. Tingkap kuasa motor digunakan untuk menurun tingkap secara automatik bagi mengurangkan kepekatan CO di dalam kenderaan. Dalam projek ini, kepekatan CO dibahagikan kepada dua peringkat dengan mengikut bacaan voltan keluaran daripada sensor. Sistem ini akan memberi satu amaran semasa CO berada di tahap berbahaya dengan mengaktifkan signal melalui LCD, LED dan buzzer dan kemudian menurun tingkap secara automatik bagi mengelakkan keracunan karbon monoksida.

ABSTRACT

Carbon monoxide (CO) gas is a colourless, tasteless and poisonous gas and difficult to detect. Excessive inhalation of CO impacts directly to human health. This mainly affect drivers who have to endure long journeys and have to resort to rest in their vehicles. Air-conditioner (AC) in vehicle is normally turned on during hot weather, which means the engine is also turned on and causing CO leakage into the vehicle. Many people died in car related directly to carbon monoxide poisoning. Therefore, designing a low cost "In-Vehicle Carbon Monoxide Detection System with Auto Window Roll Down (InVCO)" becomes essential to prevent such incident to happen. This purpose of this project is to develop CO gas alert system in detecting CO inside vehicle by using MQ-7 CO gas sensor. To make the system more practical, Arduino Uno is used as a microcontroller to control the whole system. LCD display is used to show the CO concentration inside vehicle in ppm value while LED as well as buzzer are functioned as the alert system. In addition, power window motor is set up to roll down the window automatically to reduce the CO concentration in vehicle. In this project, CO concentration is categorized into two levels according to output voltage of the sensor. This system would automatically give a warning once the hazardous level of CO is detected by activating signals through LCD, LED and buzzer and then roll down the window automatically in order to avoid the carbon monoxide poisoning.

DEDICATION

To my beloved parents, my supervisor and my friends.

ACKNOWLEDGEMENT

Firstly, I would like to thank to my supervisor, madam Izadora binti Mustaffa for her excellent guidance, encouragement, constant support, suggestion, patience and help to complete my project. She has contributed towards my understanding and I have learnt a lot from her. She motivated and inspired me to work in this report.

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LIST OF ABBREVIATIONS

°C	-	Celsius
°F	-	Fahrenheit
A	-	Ampere
AC	-	Air-Conditioner
ADC	-	Analog-To Digital Converter
CDC	-	Center for Disease Control and Prevention
CO	-	Carbon Monoxide
COHb	-	Carboxyhaemoglobin
CPU	-	Central Processing Unit
DAC	-	Digital-To-Analog Converter
DC	-	Direct Current
GUI	-	Graphical User Interface
Hb	-	Haemoglobin
I/O	-	Input/Output Ports
IDE	-	Integrated Development Environment
InVCO	-	In-Vehicle Carbon Monoxide Detection System with Auto Window Roll Down
L298N	-	Motor Driver
LCD	-	Liquid Crystal Display
LPG	-	Liquefied Petroleum Gas
MQ-7	-	Carbon Monoxide Gas Sensor
NTP	-	Normal Temperature and Pressure
PCB	-	Printed Circuit Board
PPM	-	Part Per Million
PWM	-	Pulse Width Modulation
SnO_2	-	Tin Oxide
V	-	Volt

CHAPTER 1
INTRODUCTION

1.1 Introduction

Idling is an activity when drivers run the engine and the vehicle stopped. This normally happens when drivers are halted at the red light, waiting while stopped outside the house, or otherwise rest inside vehicle with the engine turned on. As the longer the time of idling, carbon monoxide (CO) gas is then produced due to incomplete combustion of fuels and leak into the vehicle. Long exposure of CO leakage brings carbon monoxide poisoning and could pose harm or even death to the drivers and also passengers inside the vehicle. The fact that CO cannot be detected by human senses makes it more dangerous.

To prevent excessive inhalation of CO inside vehicle, a project titled "In-Vehicle Carbon Monoxide Detection with Auto Window Roll Down (InVCO)" is proposed to solve this problem by generating an alarm signal and activate the vehicle's window to roll down when the concentration of CO exceeds a dangerous level in vehicle. This main component of this project is Arduino Uno which functions to control all inputs and outputs of InVCO for CO detection inside vehicle. This project used MQ-7 CO gas sensor which can detects up to 2000 ppm so making it ideal for CO detection system. LCD display is used to display the CO concentration inside vehicle whether it is high or low level of concentration. As the concentration of CO exceeds a predetermined level, the outputs which are LED and buzzer will triggered as well as roll down the vehicle's window automatically by activating power window motor in order to alert drivers and also passengers to avoid carbon monoxide poisoning inside vehicle.

1.2 Problem Statement

Drivers who have to endure the long journeys and have to resort sleeping in their vehicle, thus may not realize the presence of carbon monoxide inside the vehicle since CO is odourless, colourless and tasteless. During the car is idling, the exhaust fumes which contains CO could flow into the vehicle through the leakage of vehicle. High content of CO inside vehicle can make the driver and passengers pass out due to the interaction between CO and red blood cells. And this may bring some symptoms to them like headaches, dizziness, tiredness and even death. According to the statistic 1999-2010 from United State, there were around 5149 death cases identified with carbon monoxide pollution, whereby 60% of the cases were brought about by fumes of the vehicle (Center for Disease Control and Prevention (CDC), 2014). Therefore, through research and design wise, a project titled ”In-Vehicle Carbon Monoxide Detection with Auto Window Roll Down (InVCO)” is important to be created to detect large amount of carbon monoxide gas and roll down vehicle’s window automatically. This is particularly helpful to the drivers who much of the time go for long excursion and required a rest inside their vehicle.

1.3 Objective

The purposes for this project are:

1) To study the existing carbon monoxide detection system.
2) To design a carbon monoxide detection system and automatic window roll down system in vehicle.
3) To develop a carbon monoxide detection system to avoid carbon monoxide poisoning in vehicle.

1.4 Scope of Project

This project is implemented through both hardware and software. For the hardware part, components such as Arduino microcontroller, CO gas sensor, buzzer, LCD display, LED as well as DC motor are used in the circuit designing. The function of Arduino microcontroller is used to control the whole activity in the detection system. CO sensor is used to detect the presence of CO while the buzzer is triggered when CO is detected. LED indicators are implemented to inform the user in which state is system in. LCD display will show the reading of sensor while DC motor is used to demonstrate the window roll down once the CO is detected. For the software part, Arduino integrated development environment (IDE) is used to program the system that easy to read and understand.

1.5 Thesis Outline

This report consists of five chapters. All these chapters discuss about the implementation of this project, which is about In-Vehicle Carbon Monoxide Detection with Auto Window Roll Down. Chapter 1 introduces the overview of this project that include introduction, objectives, problem statement, work scope and thesis outline of this project.

Chapter 2 consists of the overview of existing projects which related to the application of carbon monoxide detector that has been researched. The information about several components, equipment and technology used will be discussed in detail.

The methodology used to implement this project will be explained in Chapter 3. A block diagram will illustrate the whole function of system. The flow chart of algorithms used as well as the operation of InVCO will be mentioned in this chapter.

The result obtained regarding to the performance of InVCO will be discussed. Also, there will be discussion on the analysis based on the result as well as the overall project discussion and summarization of the system work.

Last but not least, Chapter 5 concludes the overall progress from the beginning until the end of this project as well as recommendation for project enhancement in term of future work.

1.6 Summary

The development of project "In-Vehicle Carbon Monoxide Detection with Auto Window Roll Down (InVCO)" is necessary to detect the CO concentration in vehicle and reduce the CO concentration by automatically rolling down the window. This system emits a sounding alarm as well as indicator when the CO concentration reached dangerous level.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

Carbon monoxide (CO) is a colourless, odourless, tasteless, invisible and poisonous gas that can be fatal when inhaled into human body. This poisonous gas results from the incomplete combustion of fossil fuels. Many people use these fuels (i.e., coal, gasoline, kerosene, natural gas, oil, propane and wood) around the globe (Vacanti et al., 2011). CO gives no signal of its presence, therefore it is known as the "silent killer". Carbon monoxide poisoning becomes the most common type of fatal air poisoning in many places, especially vehicles. Recently the number of vehicles in use increases, the pollution level from carbon monoxide fumes will also increase.

2.1.1 Effect of Carbon Monoxide on the Human Body

Carbon monoxide causes harmful effects to human body. During inhalation, CO reacts with haemoglobin (Hb) in blood and produces carboxyhaemoglobin (COHb). This blocks the transport of oxygen to human's heart and brain. In addition, red blood cell picks up carbon monoxide quicker than oxygen. Therefore, the higher inhalation of CO can affect the health by reducing the oxygen supply to the body's organ. Hence, carbon monoxide can cause death at the high level of CO concentration. Table 2.1 summarizes some health effects due to prolonged exposure to various concentrations of carbon monoxide in ppm (Flachsbart, 2007).

Table 2.1: Concentration of carbon monoxide and signs after inhalation

Concentration	Effects and Symptoms
0 ppm	Fresh air
9 ppm	Maximum indoor air quality level
10-34 ppm	Possible health effects with long-term exposure
35 ppm	Headache and dizziness within 6-8 hours of constant exposure
100 ppm	Slight headache after 2-3 hours
200 ppm	Slight headache within 2-3 hours ; loss of judgment
400 ppm	Serious headache within 1-2 hours
800 ppm	Dizziness, nausea and convulsions with 45 min Continued exposure: Death within 2-3 hours
1,600 ppm	Headache, increased heart rate, dizziness, and nausea within 20 min Continued exposure: Death in less than 2 hours
3,200 ppm	Headache, dizziness and nausea in 5-10 min Continued exposure: Death within 1 hour
6,400 ppm	Headache and dizziness in 1-2 min Continued exposure: Death in less than 20 minutes
12,800 ppm	Unconsciousness after 2–3 breaths Continued exposure: Death in less than 3 minutes

2.1.2 Source of Carbon Monoxide from Vehicle

Carbon monoxide emission can be produced in many factors, such as gasoline formulation or from exhaust, compression, condition of the engine and coolant temperature. Many research papers agreed that vehicle's exhaust is the main source of CO emission (Chunkul et al, 2008). CO can reach a lethal concentration in 10 minutes in an enclosed area. This happened when incomplete combustion process in the engine occurs.

Carbon monoxide has higher possibility to diffuse into the cabin although the exhaust is directed outside the vehicle. This situation is called back diffusion, which means an exhausted gas penetrating inside the vehicle through the backside leaking parts of the vehicle instead of going out through the exhaust pipe (Rahman et al, 2012). This happens when the vehicle is stationary but the engine is running. In fact, CO also can flow into the vehicle by other vehicle especially in the slow traffic (Wolff, 1992). Figure 2.1 shows the schematic vehicle sampling site flow of the exhaust and potential sites for exhaust back diffusion into the rear passenger area (Miller, 2014).

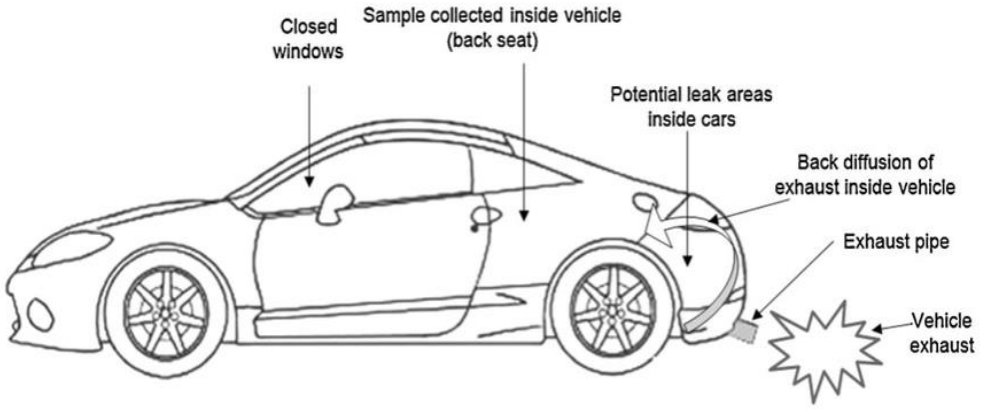

Figure 2.1: Schematic vehicle sampling site (Miller, 2014)

In cold weather, the carbon monoxide emissions from vehicle increase dramatically. This is due to the vehicle require more fuel to turn on the engine since emission control devices such as catalytic converters are less in operating during the cold condition. In United State, vehicle were tested for carbon monoxide emission only at 75°F or 24°C and almost occur during winter season (Agency, 1993).

2.2 Overview of Existing Systems

This section discusses about the previous work that have done which related to this project. Many research has being done in order to find the appropriate way to optimize the use of carbon monoxide detection system.

2.2.1 PIC-Based Carbon Monoxide Monitoring System

This project was created to alert users by detecting carbon monoxide using TGS 2442 gas sensor and generate an alarm signal when the detected gas reach its hazardous level. Powered by Microchip's PIC18F2550, this project enable users not only be alarmed when the carbon monoxide gas reach a dangerous level but also to be aware of the gas concentration level which will be displayed on the system's LCD. Built using a latest carbon monoxide sensor TGS 2442, the system can detect up to 1000 ppm of carbon monoxide level. The alarm signal system consists of LEDs, LCD and buzzer which will triggered according to the gas concentration level detected by the sensor. Through this project, a user-friendly yet reliable alarm system is achieved by using a cheaper yet powerful PIC18F2550 microcontroller (Imran, 2012).

2.2.2 Development of Carbon Monoxide detecting Device using MQ-7 Sensor along with its Statistical Analysis

This work is mainly focuses on analyzing analog and digital output of this sensor with various materials, which gives the different levels of carbon monoxide. The project used ATMEGA16A microcontroller as main controller device of a remote control system. Look up table form used to quantify carbon monoxide concentration. Then corresponding PPM values take from the table and display on LCD accordingly (Ferdousi et al, 2014).