LOW-COST IOT BASED CARBON MONOXIDE (C0) MONITORING SYSTEM

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LOW-COST IOT BASED CARBON MONOXIDE (CO) MONITORING SYSTEM

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This report is submitted in partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering with Honours

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DECLARATION

I declare that this report entitled "LOW-COST IOT BASED CARBON MONOXIDE (CO) MONITORING SYSTEM" is the result of my own work except for quotes as cited in the references.

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Date : 15 JUNE 2021 ………………………………….

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Bachelor of Electronic Engineering with Honours.

Signature : ....

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Date : 27 JUNE 2021

DEDICATION

This thesis were dedicated to all who put their hard work in making this project works. Family, friends and lectures who help direct or indirectly. Thank you so much for the guidance and idea that were shared to inspire me to complete this project

ABSTRACT

This project describes a low-cost project for detecting and informing the user of carbon monoxide in the environment using the MQ-7 sensor, a loudspeaker (active buzzer), and the ESP-8266 integrated circuit. The prototype will display the level of carbon monoxide in the surrounding environment in real time on your mobile device using the smartphone application Blynk. If the carbon monoxide concentration surpasses 25 particles per million, a loudspeaker will sound and an alarm will be sent to the mobile device, directing the passengers to exit the vehicle, as this quantity of carbon monoxide can be dangerous or lethal to human health. The purpose is to monitor regions where dangerous levels of carbon monoxide are possible and to ensure that individuals can evacuate in time to avoid harming their health. Following that, the issue with this project is that the leading cause of mortality in Malaysia is carbon monoxide gas leakage, which occurs as a result of society's lack of awareness regarding the presence of carbon monoxide in automobiles. The second issue is that industrial vehicles lack carbon monoxide detectors that would alert or warn the driver or passenger. Thirdly, the corporation has to have a new cost for this project, which is in industrial vehicles, due to the high cost and engineer difficulty redesigning the new features. Three primary objectives underpin this endeavour. To begin, develop and

build a carbon monoxide monitoring device with an oxygen and heart rate sensor embedded. Second, this project integrates a sensor, an alarm system, and a GPS system with a Blynk-based IoT system. Apart from that, determining the amount of carbon monoxide that enters the human body via the air.

ABSTRAK

Projek ini menerangkan projek kos rendah untuk mengesan dan memberitahu pengguna karbon monoksida di persekitaran menggunakan sensor MQ-7, pembesar suara (buzzer aktif), dan litar bersepadu ESP-8266. Prototaip akan memaparkan tahap karbon monoksida di persekitaran sekitarnya secara real time pada peranti mudah alih anda menggunakan aplikasi telefon pintar Blynk. Sekiranya kepekatan karbon monoksida melebihi 25 zarah per juta, pembesar suara akan berbunyi dan penggera akan dihantar ke peranti mudah alih, yang mengarahkan penumpang keluar dari kenderaan, kerana kuantiti karbon monoksida ini boleh membahayakan atau mematikan kesihatan manusia. Tujuannya adalah untuk memantau wilayah di mana kadar karbon monoksida berbahaya mungkin dan untuk memastikan bahawa individu dapat mengungsi tepat pada waktunya untuk mengelakkan membahayakan kesihatan mereka. Berikutan itu, masalah dengan projek ini adalah bahawa penyebab utama kematian di Malaysia adalah kebocoran gas karbon monoksida, yang berlaku akibat kurangnya kesedaran masyarakat mengenai kehadiran karbon monoksida di dalam kereta. Isu kedua ialah kenderaan industri kekurangan alat pengesan karbon monoksida yang akan memberi amaran atau amaran kepada pemandu atau penumpang. Ketiga, syarikat mesti mempunyai kos baru untuk projek ini, yang *terdapat dalam kenderaan industri, kerana kos yang tinggi dan kesukaran jurutera merancang semula ciri-ciri baru. Tiga objektif utama menyokong usaha ini. Untuk memulakan, mengembangkan dan membina alat pemantauan karbon monoksida dengan sensor oksigen dan denyut jantung tertanam. Kedua, projek ini mengintegrasikan sensor, sistem penggera, dan sistem GPS dengan sistem IoT yang berasaskan Blynk. Selain itu, menentukan jumlah karbon monoksida yang memasuki tubuh manusia melalui udara.oksigen dan denyut jantung. Kedua, dalam projek ini adalah menggabungkan sensor, sistem penggera dan GPS dengan sistem berasaskan Blynk IoT. Selain itu, menganalisis kepekatan kebocoran karbon monoksida melalui udara ke dalam tubuh manusia..*

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"In the name of Allah, Most Gracious, Most Merciful." First and for most, praise to Allah S.W.T, for Her blessing that gave us to complete our full assignment report. We want to express our deepest gratitude and appreciation to Dr Anis Suhaila Binti Mohd Zain, our experienced lecture for giving us mental and physical supports. Besides, being a perfect mentor that offers us an excellent opportunity to complete this assignment can never be forgotten. Without proper guidance from her, this assignment might not be completed in time and not forgotten to all teammates who never refuse to give a hand regarding some of the assignment's details.

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LIST OF SYMBOLS AND ABBREVIATIONS

CO	:	Carbon Monoxide
%	:	Percent
OSHA	:	Occupational Safety and Health Administration
NIOSH	:	National Institute for Occupational Safety and Health
Ppm	:	Particle per Molecule
GPS	:	Global Positioning System
O2	:	Oxygen
IoT	:	Internet of Thing
BPM	:	Beat per Minutes
I/O	:	Input/Output
V	:	Voltage
A	:	Current
Bps	:	Beat per Second

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

This chapter was explaining the overview of the low-cost carbon monoxide monitoring system. This chapter also consists of the problem statement. It is explaining the problem that was facing and needed to be solved. The problem statement comes out with the planning solution that needs to be achieved to ensure this project's success. This chapter also states the scope of this project and project significance related to Blynk software to make the automated carbon monoxide control system and how much concentration carbon monoxide to avoid from the human body is needed. Lastly, this chapter also gives an overview of all chapters in this report.

1.1 Project Overview

Even in low concentrations, carbon monoxide (CO) is highly toxic. It has several effects, all of which lead to a reduction in oxygen metabolism and, as a result, general ischemia [3]. Experiments with rats revealed that necrosis and apoptosis (PCD) play a role in carbon monoxide poisoning-induced brain cell death [4]. As a result, we must be aware of CO (carbon monoxide) dangers to humans.

CO is a colorless, odorless, and tasteless gas, making it a threat that is difficult to detect. It is caused by incomplete hydrocarbon combustion [5]. CO poisoning significantly impairs hemoglobin's ability to transport oxygen [6]. CO causes tissue hypoxia when inhaled, primarily affecting areas with high blood flow and oxygen demand, such as the brain and heart [5]. CO poisoning causes about 40,000 visits to the emergency room in the United States alone each year [7]. It is a leading cause of morbidity and mortality in the United States. Clinically, the illness can progress quickly from nausea and vomiting to loss of consciousness and death. Patients commonly experience nonspecific headaches, dizziness, weakness, confusion, shortness of breath, chest pain, and visual disturbances [8]. The thrombotic tendency increases due to CO poisoning, as does the risk of deep poisonous thrombosis [9].

Wireless sensor networks (WSN) are now being used in health care to track heart problems, breathing problems, panic responses, and stress levels [10]. To prevent CO poisoning, this IoT (Internet of Things) technology can be used to monitor the environment in a home or office. For occupationally exposed workers, the Occupational Safety and Health Administration (OSHA), the National Institute for Occupational Safety and Health (NIOSH), and the Iranian Ministry of Health have recommended time weighted permissible exposure limits (PEL-TWA) of 50 ppm, recommended exposure limits (REL-TWA) of 35 ppm, and occupational exposure limits (OEL–TWA) of 25 ppm [11].

Implementing a CO detector to meet these standards is a viable solution for reducing or eliminating deaths caused by CO poisoning. This project aims to develop a low-cost CO detector that will alert the user in the event of a high CO concentration in the air via a sound and light alarm in a mobile application, preventing fatal consequences and improving safety and quality of life.

1.2 Problem Statement

In Malaysia, transportation has been identified as one of the major contributing factors to air pollution. This corresponds to the increasing numbers of vehicles in major cities in Malaysia from year to year [5]. From a health perspective, carbon monoxide reduces oxygen flow in the bloodstream and is particularly dangerous to heart disease persons. First, the prominent factor death cases in Malaysia cause by carbon monoxide gas leakage because society lacks awareness of the present carbon monoxide in vehicles. Other than that, industrial vehicles do not produce any carbon monoxide detector features to warn or notify the driver and passenger. Finally, the company needs to have a new cost in industrial vehicles because it is high cost and the engineer challenging to redesign the new features.

1.3 Objective

1. To design and fabricate the carbon monoxide, monitoring system embed with oxygen and heart rate sensor.
2. To integrate the sensor, alarm system and GPS with Blynk IoT based system.
3. To analyze the concentration of carbon monoxide leakage through air into the human body.

1.4 Scope of Work

- **Task 1: Develop and fabricate circuit**

This task involves develop and fabricate of carbon monoxide sensor, oxygen sensor, and heartrate sensor. In Carbon monoxide sensor this project using type sensor MQ-7. The sensor been chosen because have sensitivity to detect carbon monoxide from 10ppm- 1000ppm. Other than that, the two-hardware element have different function, for oxygen sensor features to know the oxygen level inside the cabin vehicle. After that, for developing and fabricate the heart rate sensor to identify the human in cabin vehicle are in condition awake or sleep. Last but not least, the three elements of sensor will be connected through a micro controller Arduino.

- **Task 2: Installing the input on microcontroller.**

This task involve connection the input device which is the carbon monoxide sensor, heart rate sensor, oxygen sensor and GPS tracker. The sensor connectivity testing is important to sense and measure the carbon monoxide leaked, oxygen level and identify the condition human in cabin vehicle. This will also involve the process of initialization of the sensor before is activated for sensing and measurement.

- **Task 3: Installing the output on microcontroller.**

    This task involve connection the output device which Buzzer alarm and. The connectivity testing is important to analyzing the is operation in good condition and have any error coming.

- **Task 4: Create embedded source code to read the input sensor.**

    In this task, the embedded source code for carbon monoxide, oxygen, heartrate from the sensor and the GPS tracker need to be create. The source code use to functional the input and give a data. This will involve the connectivity of three element sensor, GPS tracker,buzzer alarm and Nodemcu ESP8266.

- **Task 5: Sign into Blynk IoT platform.**

    This task requires a connection from ESP8266 with Blynk IoT platform for real time monitoring of three element sensor which is carbon monoxide, oxygen, and heart rate sensors also the GPS tracker. When data captured form the input, it will be sent directly to platform for real time monitoring. Then, the frequencies of data collected will depend on Blynk and ESP8266 capability to captured, send and show the data.

- **Task 6 : Analyzing the data feedback.**

  This task involves analyze the data concentration feedback coming from the input sensor and analyze performance the hardware part and software part.

1.5 Project Significance

This project reports content is organized into six chapter, which consists of an introduction, literature review, methodology, result and analysis, discussion, conclusion and future work.

Chapter 1 briefly explain the overview of this project. This chapter covers the problem statement, objective, scope of the project and project significance. Chapter 2 shows the literature review of carbon monoxide detection system. It contains the overview of this project including IoT monitoring technology. Chapter 3 were construct with discussion of methodologies used for the entire work. A full explanation for the hardware design and development, hardware sensors placement, software design and development. Chapter 4 presents the results and the discussion for techniques found in the literature review. A detailed discussion was explained on the implementation of the project. Chapter 5 summarizes the entire project implementation, contribution to research and suggests future work in this field.

CHAPTER 2

BACKGROUND STUDY

2.1 Introduction

Carbon monoxide (CO) is a colorless, odorless, tasteless gas that creates carbon-containing gasoline or propane fuel by incomplete combustion. Headaches, dizziness, drowsiness, or nausea can be the initial signs of CO poisoning. If sustained or elevated exposure is endured, symptoms can lead to vomiting, loss of consciousness, and collapse. Without any signs, if the degree of exposure is severe, loss of consciousness can occur. If elevated exposures persist, coma or mortality can occur.[8-12]. The display of symptoms varies greatly from person to person. It can appear faster in prone individuals, such as young or older people, people with pre-existing lung or cardiac disorders, or people residing at high altitudes. Table 1, shows the detailed is of effect when the leaked gases.

Table 2:1: Carbon Monoxide Effects [12]

Effects of Carbon Monoxide at Different Concentration		
PPM	TIME	EFFECTS
35	6 - 8 hrs	Headache & dizziness with constant exposure.
50	8 hrs	Permissible Exposure Level - in any 8 hour period per OSHA
100	2 - 3 hrs	Slight headache
200	2 - 3 hrs	Slight mild frontal headache, discomfort, loss of judgment, loss of vision, irritability. Should not be exposed to this level.
400	1 - 2 hrs	Frontal headache & nausea. Life threatening after 3 hours
800	45 minutes	Dizziness, nausea, & convulsions insensible. Collapse within 2 hours & possible death
1600	20 minutes	Headache, tachycardia, dizziness, & nausea. Confusion. Staggering. Death < 2 hours
3200	5 - 10 minutes	Headache, dizziness & nausea. Unconscious 10-15 minutes. Death within 30 minutes
6400	1 - 2 minutes	Headache, dizziness & nausea. Convulsions, respiratory arrest. Death < 20 minutes
12800	2 minutes	Unconsciousness after 2-3 breaths. Death < 3 minutes

By binding to hemoglobin to form carboxyhemoglobin, CO penetration reduces the blood's capacity to transport oxygen to the tissues (COHb). CO binds to hemoglobin at the same site as oxygen and with an affinity 245 times higher[12]. The presence of CO in the blood will also interact with the intake of oxygen and transmission to the body. The half-life of bloodborne CO at sea level and average pressure is roughly 5 hr until ingested into the bloodstream and exposure has ended. The ambient carbon monoxide degree (in parts per molecule), as shown in Table 2:2.

Table 2:2: Carbon Monoxide concentration [12]

Level of carbon Monoxide	Source
0.1 ppm	Natural atmosphere level
0.5 to 5 ppm	The average level in homes
5 to 15 ppm	Near properly adjusted gas stove in homes
100 to 200 ppm	Exhaust from automobiles in the city
5000 ppm	Exhaust from a home wood fire
7000 ppm	Undiluted warm car exhaust without a catalytic converter

2.2 Intracellular effects of carbon monoxide

The strong affinity of CO for Hb and consequent decrease of O2 delivery have become the foundation of standard concepts for CO pathophysiology. Recently released literature shows the likelihood of metabolic pathways that are not necessarily correlated with COHb elevation oxygen distribution failure. Much of this study was carried out in culture with cells and with animals from the laboratory. It is necessary to remember what amounts of CO are likely to exist in vivo to be relevant to human sensitivity to environmental contaminants. Lung parenchyma is a specific case where, without the drop of concentration correlated with Abound CO, cells will be subjected to ambient CO. Just a fraction of COHb can dissociate to elevate extravascular CO amounts elsewhere in the body. When the COHb concentration is from 0.8 to 3.8 percent [30,31], this elevation is in the range of approximately 2-10 nmol. COHb values in laboratory rats near steady-state conditions are similar to human values [32]. Recent animal research indicates that recently established biochemical pathways have detrimental physiological consequences, increasing the scope for human relevance. However, vigilance is also needed since there has not been direct proof of the emergence of these processes in humans.

It is uncertain if CO vascular tone disruptions are a generic, structural reaction. The consequences of factors such as exposure length were not adequately studied. A well-established reaction triggered by exposure to CO is cerebral vasodilation. The process is connected to impairment of O2 transmission at large CO concentrations, on the order of 500-2000 ppm. A portion of the reported changes in cortical blood pressure, though, was independent of O2 supply disturbances. Elevations in cerebral blood flow tended to be regulated by other, possibly molecular, pathways in an area where cellular oxidative metabolism was not affected by CO. Animals subjected to extremely large amounts of CO (e.g., 3000-10,000 ppm) have reduced blood supply in the brain, which leads to CO-mediated tissue injury [13-15]. The process is based on hypoxic stress-induced by CO.

2.2.1 Inhibition of hemoprotein function

A variety of hemoproteins present in cells may be blocked by carbon monoxide, such as myoglobin in the heart and skeletal muscles, neuroglobin in the brain, cytochrome c oxidase, cytochrome P450, dopamine b hydroxylase, and tryptophan oxygenase. Inhibition of these enzymes may have detrimental consequences on the functioning of cells.

2.2.2 Myoglobin

Carbon monoxide functions as a competitive inhibitor and thus relies on the partial pressures of both CO and O2 for biological results. The cellular hemoprotein with the largest relative preference for CO over myoglobin for O2 (Mb). Mb-facilitated oxygen diffusion can be hindered by carbon monoxide, but physiological compromise is seen only for large concentrations of COMb. In isolated cardiac myocytes, sustained at a physiologically significant oxygen concentration, when COMb surpassed 40 percent, high-energy phosphate output was seen to be inhibited. It has been calculated that the development of adequate COMb to impair oxidative phosphorylation in vivo needs at least a 20-40 percent COHb amount.

2.2.3 Neuroglobin

Like heart and skeletal muscle, brain tissue often has strong energy output demand for oxygen; however, a specialized brain globin family was not previously known in vertebrates2 before the existence of a neuroglobin (Nb) in man and mouse was seen in a recent sequence of publications[15-18]. In the human brain, with the strongest signals in the frontal lobe, subthalamic nucleus, and thalamus, a prevailing RNA expression pattern has been identified. Recombinant human Nb has an approximately oxygen affinity.

Neuroglobin is a protein that is structurally isolated from most human globin's and certain invertebrates' neuroglobins. This aberration produces a higher oxygen affinity for human Nb, rendering it difficult to decide if Nb will satisfy the kinetic and equilibrium criteria to operate under established physiological conditions in facilitated oxygen transport or storage, as seen for Mb. Nb can instead be, as are other globin's, a scavenger or sensor for CO, NO, or O2. Since Nb is expressed in lower concentrations in hypoxia-sensitive areas of the brain, some researchers claim that the specialized Nb structure favors facilitated distribution of O2 under conditions of high demand for oxygen and avoids rapid O2 rebinding, such that mitochondria are favorably used.

2.3 Effects of Carbon Monoxide on Cardiovascular Function

Effects of CO In healthy individuals, patients with coronary artery heart disease and patients with non-coronary heart disease were tested for myocardial activity by Ayers, who recorded that increasingly growing COHb saturation of 9% over 30-120 sec in patients with no evidence of coronary heart disease resulted in increased coronary blood flow, increased oxygen extraction ratio, and increased coronary blood flow (20). The substantial rise in COHb did not result in a substantial increase in coronary blood flow in patients with coronary heart disease. The coronary sinus strain decreased dramatically, and substantial declines in the lactate extraction ratio and the pyruvate extraction ratio were observed as the oxygen extraction ratio of the myocardium improved. Ayers concluded that the inhalation of CO by a patient with coronary heart disease, unable to react to anoxic stress by increasing coronary blood flow, may result in a potentially serious situation.

Ayers' prediction has been confirmed accurate by two other classes of investigators (20-23). These authors have shown convincingly that patients with progressive coronary artery disease and angina pectoris have dramatically reduced their exercise resistance after sensitivity to low CO concentrations necessary to raise their COHb saturation to 5%. This author will go a step forward than the investigators in analyzing these results by implying that no CO concentration does not have a significant and detectable untoward impact on a diseased cardiovascular system. Every proximity to this pervasive gas could negatively influence the ordinary course of their condition, would stress-specific individuals with severe coronary heart disease(24).

In summary, the significant impact of CO on humans comes from anoxic stress, which is secondary to a decrease in the ability of the blood to hold oxygen. Safe individuals are highly susceptible to some anoxic stress, compensating rapidly through - heart output and flow to vital organs. Human beings with severe coronary conditions may not be appropriately compensated and are more susceptible to the adverse effects of CO.

2.4 Monitoring Design

Internet of things (IoT) is an Ecosystem of linked, internet-accessible physical items. It is an embedded technology that helps communicate with the inner and outer world of the object (25). It also allows devices on objects to monitor, recognize and comprehend a scenario or environment without relying on human assistance. IoT can also be described as a setting for data exchange in which items are attached in everyday lives to wired and cellular networks (26). Computer hardware system, mechanical and digital machines, object or people with unique identifiers and the possibility of transferring data over a network without interaction between humans and humans or computers.

IoT is used not only in consumer electronics and appliances, but also in a range of other areas such as smart cities, healthcare, smart homes, and industrial safety. With the increasing presence of Wi - Fi and 4G-LTE wireless Internet access, developments. towards ubiquitous information and communication networks are already evident [27]. IoT approach is taken in this work which envisions a near future where everyday objects will be armed with microcontrollers and transceivers for digital communication. Figure 1 shows the basic diagram for IoT using cloud:

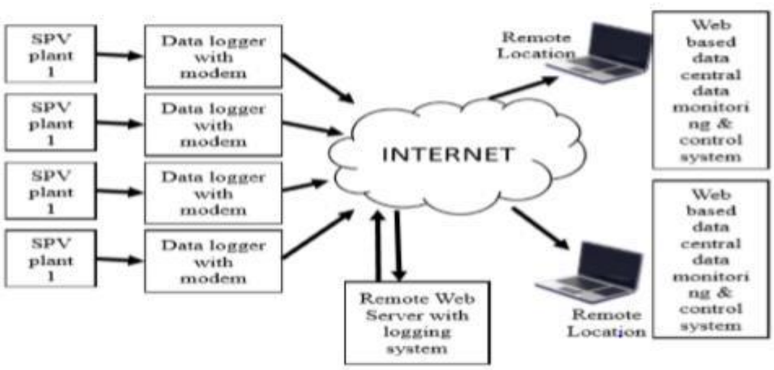

Figure 2.1: Basic diagram for IoT using cloud [27].

Remote monitoring eliminates the hazard associated with the traditional wiring system and make data measurement and monitoring process much easier and cost effective and IoT based system take a giant leap towards monitoring by intelligent decision making from web [28]. IoT based remote monitoring system it will be easier to supervise the overall performance of a solar plant by a web-based approach. Physical items are no longer disconnected from the virtual world but can be controlled remotely through Internet service[28].

2.5 Previous Invention identification of problem

Table 2:3: Previous Invention identification of problem

No	Invention title and Inventor Citation	Invention Description	Weakness
1	Investigation on Carbon Monoxide Monitoring and Alert System for Vehicles	This project continuously detects the quantity of volatile gases and displays their concentrations. Additionally, it delivers an automatic alert when the CO content exceeds the normal level, allowing the ventilation system to be activated instantly. A text message (SMS) is sent to the authorised user through GSM in order to automatically activate the power windows and purge the automobile cabin of carbon monoxide..	The system lack ability to notify the location incident case. The system lack to know how much oxygen level in cabin vehicle. The system does not detect the heartrate and condition user in vehicle.
	Mobile Carbon Monoxide Monitoring System Based on Arduino-Matlab for Environmental Monitoring Application	This article proposes a mobile carbon monoxide monitoring system based on the Arduino-Matlab graphical user interface for measuring the carbon monoxide content (GUI).	The system lack to know how much oxygen level in cabin vehicle. The system does not detect the heartrate

		The purpose of this project is to design, develop, and implement a real-time mobile carbon monoxide sensor system and interface for monitoring carbon monoxide contamination levels in the real world.	and condition user in vehicle. This project does elaborate the gases outside vehicle only.
	Rogers, S. A. (2007). U.S. Patent No. 7,218,218. Washington, DC: U.S. Patent and Trademark Office.	A child seat monitoring device contains a pressure sensor that is used to determine the location of the force acting on the sensor. The pressure sensor is discretely positioned into the cushion of a child car seat. Electrically, a primary processor is connected to the pressure sensor.	The system lacks ability to notify the driver if the toddler is left in the vehicle for far distance This system does not detect the carbon monoxide leakage from the air conditioning system.
	Hules, F. J., & Hoshide, B. A. (2008). *U.S. Patent No. 7,348,880*. Washington, DC: U.S. Patent and Trademark Office. .	A device and process are provided for warning an occupant who may be placed in a fluctuating temperature environment. The gadget can be used inside a car to transport a baby, a child, a human, or an animal or pet. In one example, when a safety system receives data indicating that an occupant sensor detects the presence of an occupant and a temperature sensor detects a predetermined temperature, a protection response is initiated.	This system does not detect the carbon monoxide leakage from the air conditioning system. The system lack ability to notify the location incident case. The system lack to know how much oxygen level in cabin vehicle. The system does not detect the heartrate and condition user in vehicle.

CHAPTER 3

METHODOLOGY

This chapter described the project's execution and decision-making procedures. The materials and equipment that will be utilized in this project are discussed in this chapter. The function of the materials and equipment will also be discussed in depth in this chapter. The hardware and functioning of the project's entire system are also discussed in this chapter.

3.1 Introduction

This chapter discusses the methodology used to design, integrate, and instal the proposed project's system. The technique for this project is separated into two sections: (a) hardware system design and development; and (b) software system design and development. In the hardware system design and development section, the project methodology is explained from the conceptual idea to the realization of the hardware system; in the software design and development section, an internet of things (IoT) architecture is implemented to collect required data, and a cloud-based user interface is designed and developed to monitor all the data or output produced by the hardware system.

3.2 Project Methodology

This section explains about the detail on how the progress of carbon monoxide (CO) detection with configuration data feedback from IoT system for in vehicle environment application and bad air pollution area by referring hardware device, software configuration and the design project. The details are explaining as below:

3.2.1 Hardware Devices

The project will use Carbon Monoxide Sensor, Oxygen sensor, Heart Rate Sensor and GPS tracker as the input. Other features as an output which is alarm buzzer. By detection the leaked gases the carbon monoxide sensor as the main function on this project, the carbon monoxide sensor will absorb the leaked gases from 10ppm until 1000ppm. For the oxygen sensor and the heart rate sensor functioning to support and identify when having incidentally in vehicle After that, for the output used the buzzer alarm for alert notify the person. Finally, for GPS tracker functioning give information place to the receiver that the receiver will know the location when having the incident.

3.2.2 Software Configurations

For the monitoring system, it starts when NodeMCU-ESP8266 has been connected to the Wi-Fi. When the application has initiated an NodeMCU-ESP8266 Wi-Fi module, it will establish the internet. If there is an error, it will send the message back to NodeMCU-ESP8266. The Carbon Monoxide Sensor's input, Oxygen sensor, Heart Rate Sensor and GPS tracker will send all the data and generate the information via Serial Communication principal. All the data will then be saved and sent to the Blynk platform to monitor the reading of all input.

3.2.3 Designing the Project

The low-cost micro-controller which is NodeMCU-ESP8266 will be used along Carbon Monoxide Sensor, Oxygen sensor, Heart Rate Sensor and GPS tracker to integrate the prototype with IoT system to ease the user to monitor the real-time data for the output produce. The IoT platform that will be used is Blynk IoT platform

3.3 Operating Project Flowchart

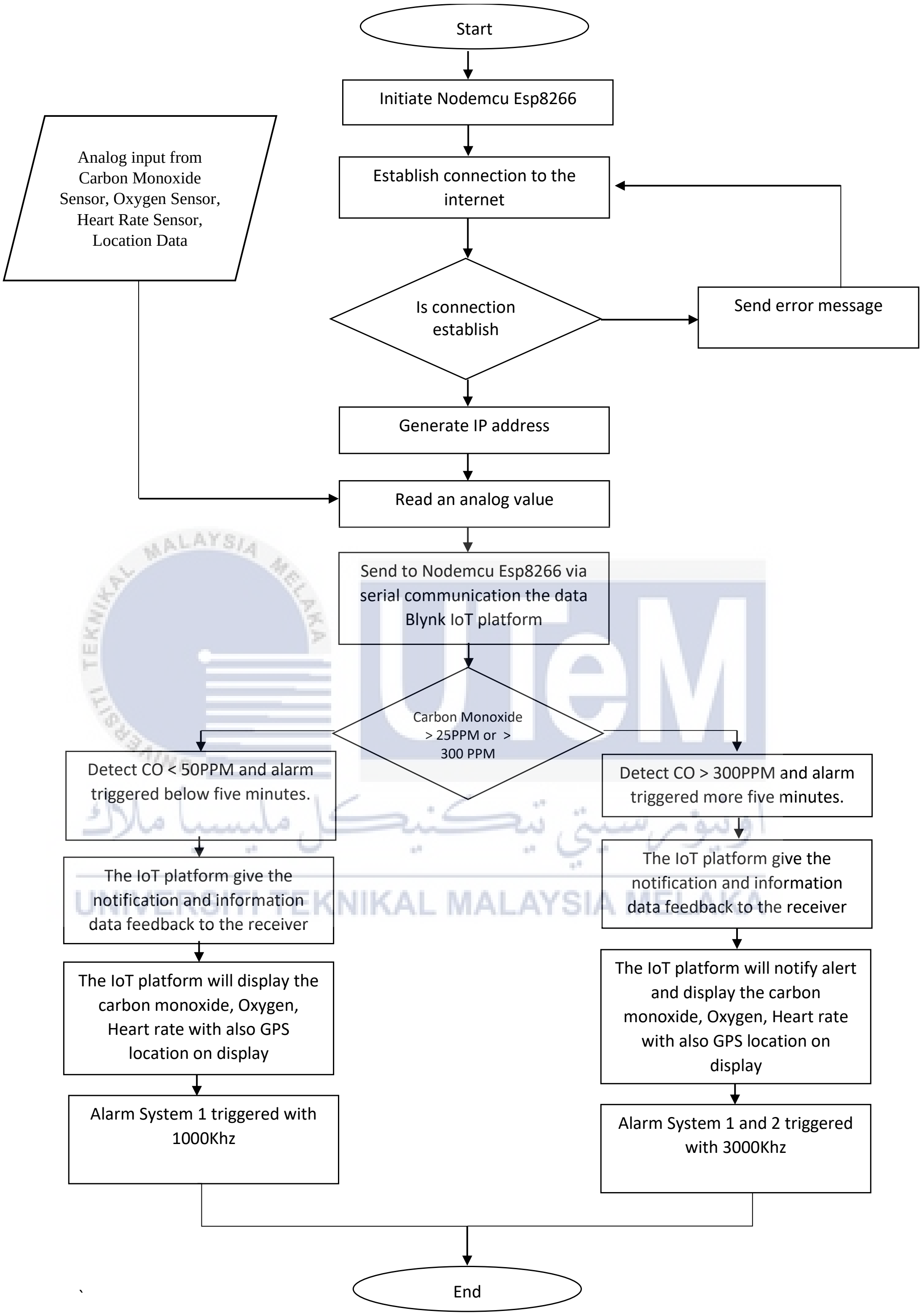

Figure 3.1: Flowchart for Monitoring System

The flowchart for the monitoring system and the operation of carbon monoxide detection is shown in Figure 2 above (CO). It begins when the NodeMcu ESP8266 is initiated and connected to the phone. The ESP8266 will then attempt to connect to the internet. If there is an error, the message is returned to the ESP8266. Sensor input will be sent to the ESP8266, which will generate data via the Serial Communication principle. The data will then be sent to the Blynk platform, which will monitor the reading of all input in real-time. Following that, the operation begins in two conditions: when the carbon monoxide detects more than 25 PPM and less than 300 PPM of the volume molecule, and when the heart rate is less than 90bpm. The IoT platform will send the notification and information data feedback to the receiver via smartphone. The IoT platform will also display the carbon monoxide, oxygen, heart rate, and GPS location on the smartphone device display. In addition, the alarm system will activate the buzzer with a frequency of 1000kHz for five minutes. Second, when the carbon monoxide detects a high level of more than 300 PPM of the volume molecule, the heart rate exceeds 120bpm. The IoT platform will alert and display the carbon monoxide, oxygen level in the surrounding vehicle, and a person's heart rate in the vehicle. Following that, the microcontroller decided to call and deliver the message to the receiver, who was connected to the Blynk IoT platform. In contrast, the microcontroller triggered the two buzzer alarm system to alert people in a vehicle.

3.4 Research Hardware

The hardware used in this project is described in sub-section below.

3.4.1 NodeMCU-ESP8266

Figure 3.2:Microcontroller NodeMCU-ESP8266

This project's primary controller is the NodeMCU-ESP8266, a simple circuit platform based on an I/O port that implements a processing language. It is written in the Lua scripting language. The platform is built on eLua's open-source projects. Many projects, such as lua-JSON and spiffs, are used on the platform. This NodeMCU-ESP8266 kit includes firmware for Microcontroller WiFi SoC chips as well as ESP-8266 hardware modules. The carbon monoxide sensor, pulse oximeter sensor, and GPS tracker are controlled by the NodeMCU-ESP32 for cloud data collection and storage. NodeMCU is an open-source Internet-of-Things (IoT) platform. The NodeMCU-ESP8266 is an open-source microcontroller that can be controlled both physically and digitally. The tables below detail the features of the NodeMCU-ESP8266

Table 3:1: The Characteristic of NodeMCU-ESP8266[31]

Type microcontroller	NodeMCU- ESP8266
Operating voltage	2.2v ~ 3.6v
Operating current	Average:80 ma
Operating temperature	-40~+85
Wi-Fi frequency range	2.4~2.5ghz
Module interface	SD card, UART, SPI, SDIO, I2C, LED PWM, Motor PWM, I2S, IR
	GPIO, capacitive touch sensor, ADC, DAC, LNA pre-amplifier
Flash memory	4Mbyte
Clock speed	40mhz

3.4.2 Carbon Monoxide Sensor

3.4.2.1 Fabrication Carbon Monoxide Sensor

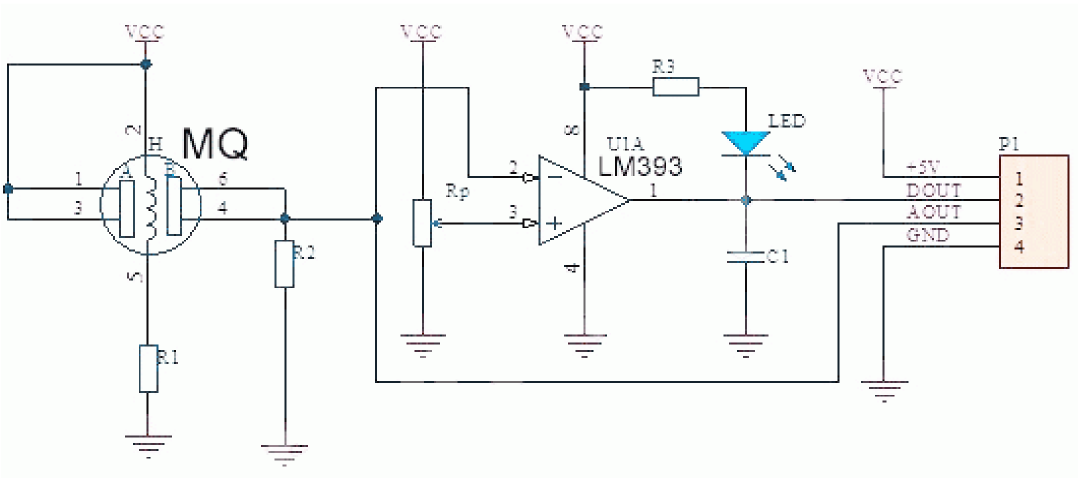

Figure 3.3: Circuit Carbon Monoxide Sensor

To accomplish the first objective, a carbon monoxide sensor circuit utilizing the MQ7 detector was constructed. The sensitive substance of the MQ-7 gas sensor is SnO2, which has a reduced conductivity in clean air. It detects CO at low temperatures by cycling between high and low temperatures (heated by 1.5V). As the gas concentration increases, the conductivity of the sensors increases. It purifies the other gases adsorbed at low temperatures by heating them to high temperatures (heated by 5.0V). Please use a primary electro circuit to convert conductivity changes to a signal representing the gas concentration.

Table 3:2; The Specification of Carbon Monoxide Sensor

Model No.			MQ-7
Sensor Type			Semiconductor
Standard Encapsulation			Plastic
Detection Gas			Carbon Monoxide
Concentration			10-10000ppm CO
Circuit	Loop Voltage	V_c	≤10V DC
	Heater Voltage	V_H	5.0V±0.2V ACorDCHigh 1.5V±0.1V ACorDCLow
	Heater Time	T_L	60±1SHigh90±1SLow
	Load Resistance	R_L	Adjustable
Character	Heater Resistance	R_H	31Ω±3ΩRoom Tem.
	Heater consumption	P_H	≤350mW
	Sensing Resistance	R_s	2KΩ-20KΩ(in 100ppm CO)
	Sensitivity	S	Rs(in air)/Rs(100ppm CO)≥5
	Slope	α	≤0.6(R_{300ppm}/R_{100ppm} CO)
Condition	Tem. Humidity		20±265%±5%RH
	Standard test circuit		V_c:5.0V±0.1V V_HHigh: 5.0V±0.1V V_HLow: 1.5V±0.1V
	Preheat time		Over 48 hours

3.4.2.2 Calibration Carbon Monoxide Sensor

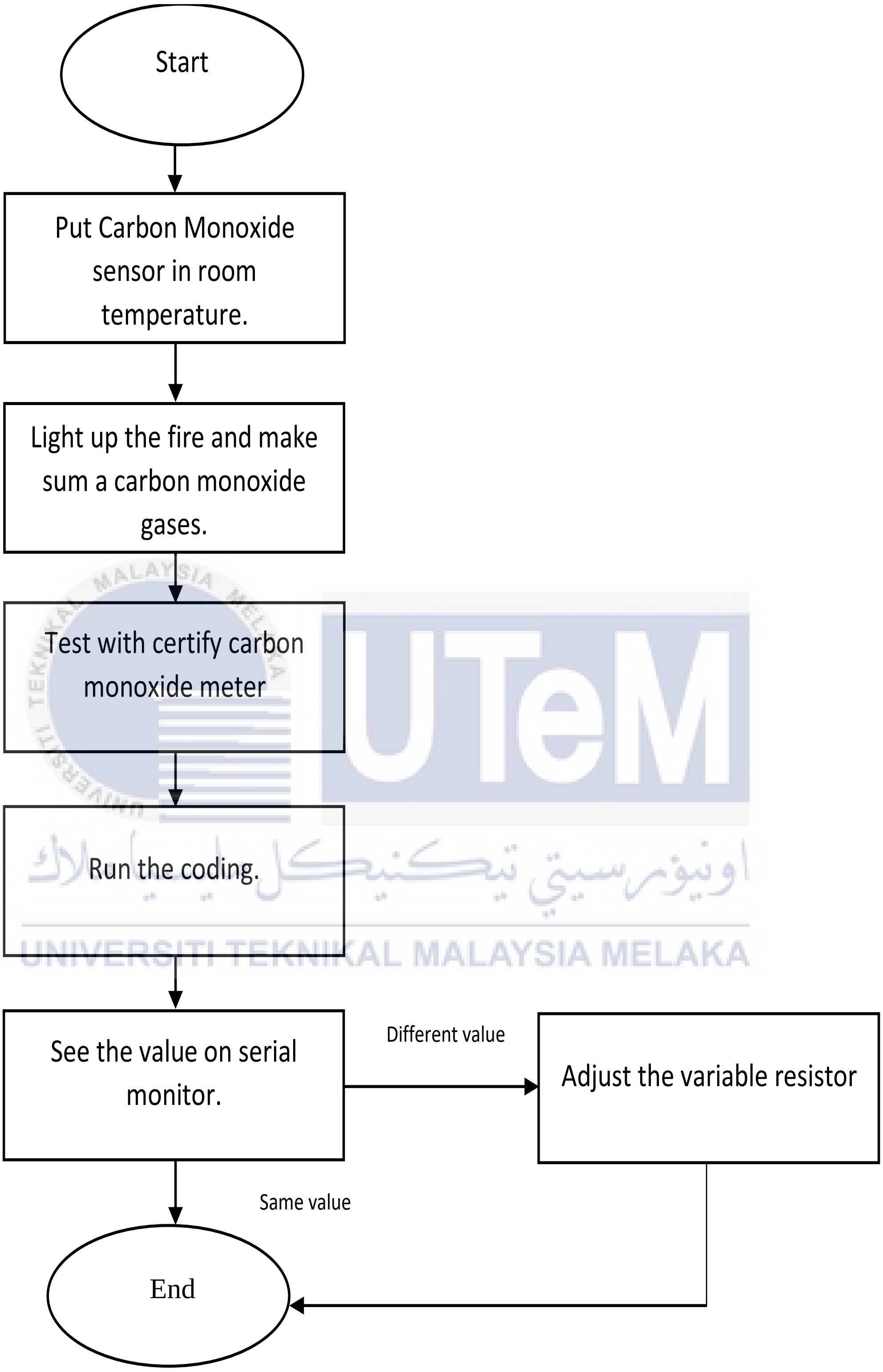

Figure 3.4: Flowchart for Calibration Carbon Monoxide Sensor

The flowchart for the monitoring system and the calibration of carbon monoxide detection is shown in Figure 2. (CO). It begins when the NodeMcu ESP8266 is turned on and connected to a power source. Next, bring the carbon monoxide sensor to room temperature to ensure that the calibration is based on accurate data. After that, the sensor detector must fire up the paper for the sensitivity of carbon monoxide detection testing to ensure the detector absorbs the gases. Aside from that, the carbon monoxide meter was used to compare the value from the Arduino IDE's carbon monoxide detector. When the data from the Arduino IDE does not match the data from the carbon monoxide meter, the variable resistor must be adjusted to adjust the threshold parameter.

3.4.3 MAX30100 Pulse Oximeter Sensor

Figure 3.5: MAX30100 Pulse Oximeter Sensor

The MAX30100 Pulse Oximeter Sensor is a dual-purpose sensor that measures both pulse oximetry and heart rate. Two LEDs, a photodetector, improved optics, and low-noise analogue signal processing are used to detect pulse oximetry and heart rate signals. The MAX30100 is compatible with 1.8V and 3.3V power sources and may be turned down via software with very minimal standby current, ensuring that the power supply remains connected at all times. The integrated LEDs, photo sensor, and high-performance analogue front-end simplify the design of the MAX30100 pulse oximeter sensor, which is a comprehensive pulse oximeter and heart rate sensor solution. Apart from that, the MAX30100 pulse oximeter sensor features sophisticated functionality that enhances measurement performance through a high signal-to-noise ratio, robust motion artefact resilience, integrated ambient light cancellation, high sample rate capabilities, and quick data output capability. On this project, the MAX30100 pulse oximeter sensor circuit is placed as shown in Figure 3.6 and in Figure 3.7 as shown as a block diagram of system pulse oximeter sensor.

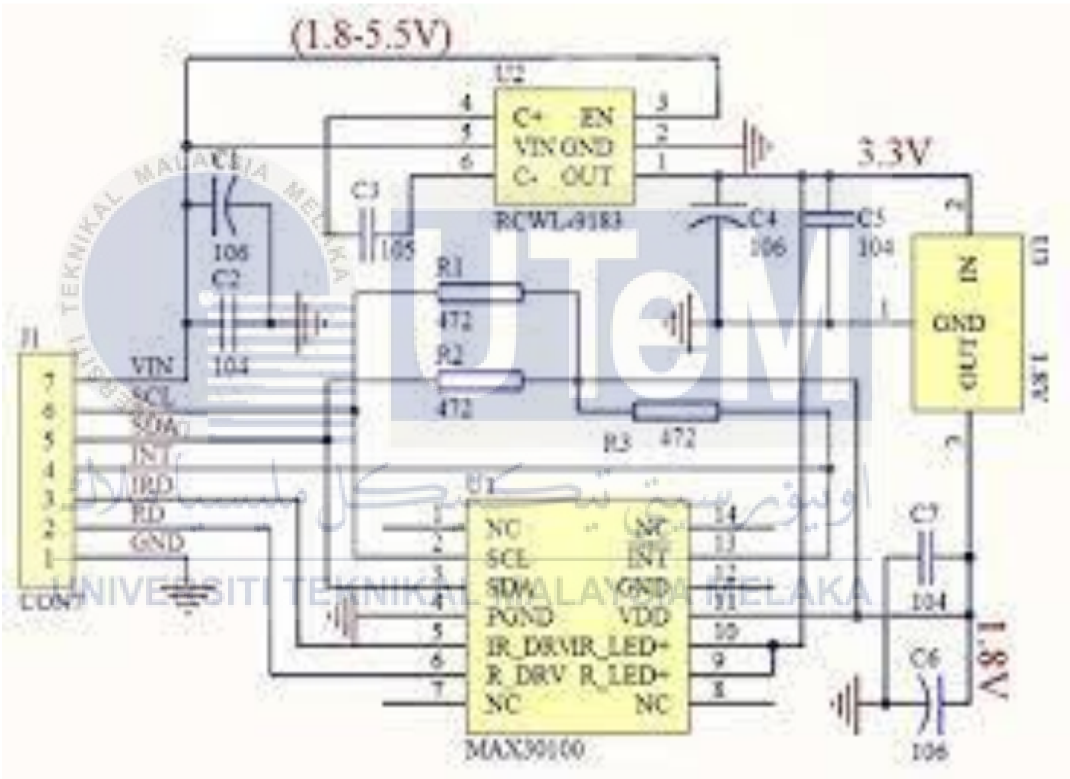

Figure 3.6: MAX30100 Pulse Oximeter Sensor Circuit

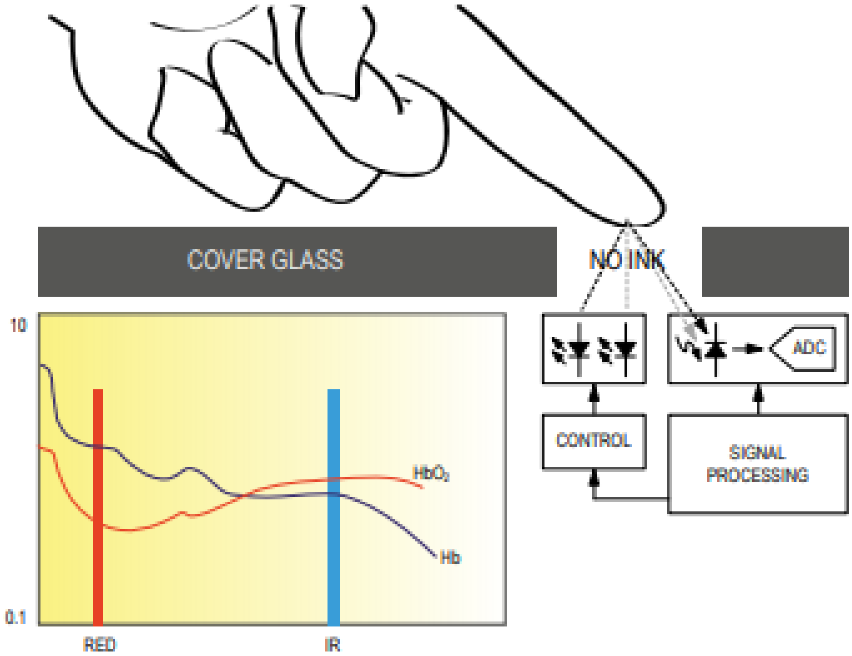

Figure 3.7: System pulse oximeter sensor block diagram

3.4.3.1 Calibrate Pulse Oximeter Sensor

As shown in the diagram, the Pulse Oximeter Sensor is connected. The GND NodeMCU ESP8266 will receive the pin Ground (GND) pulse oximeter sensor, while the 3.3V VCC NodeMCU ESP8266 will receive the Voltage Common Collector (VCC) pulse oximeter sensor. Otherwise, the pins SDA and SCL will be connected to NodeMCU ESP8266 pins D1 and D2 shown in Figure 3.8. The pulse oximeter sensor is calibrated with a pulse oximeter portable meter, as shown in the Figure 3.9.

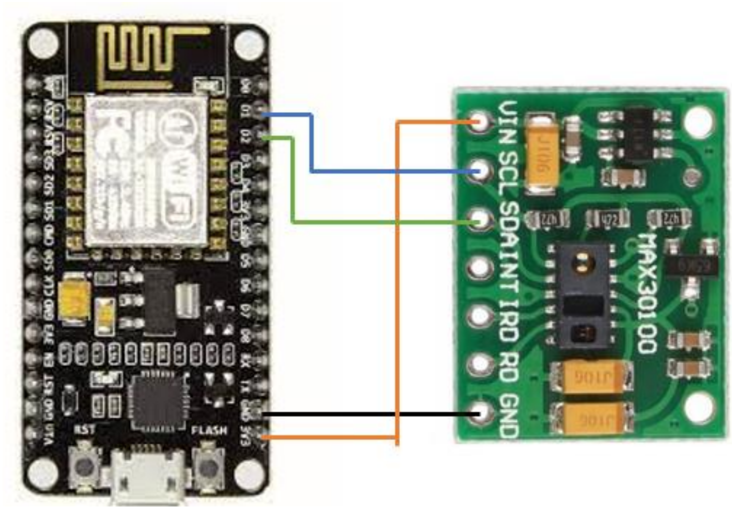

Figure 3.8: Connection circuit for calibration

Figure 3.9: Calibration with portable pulse oximeter meter

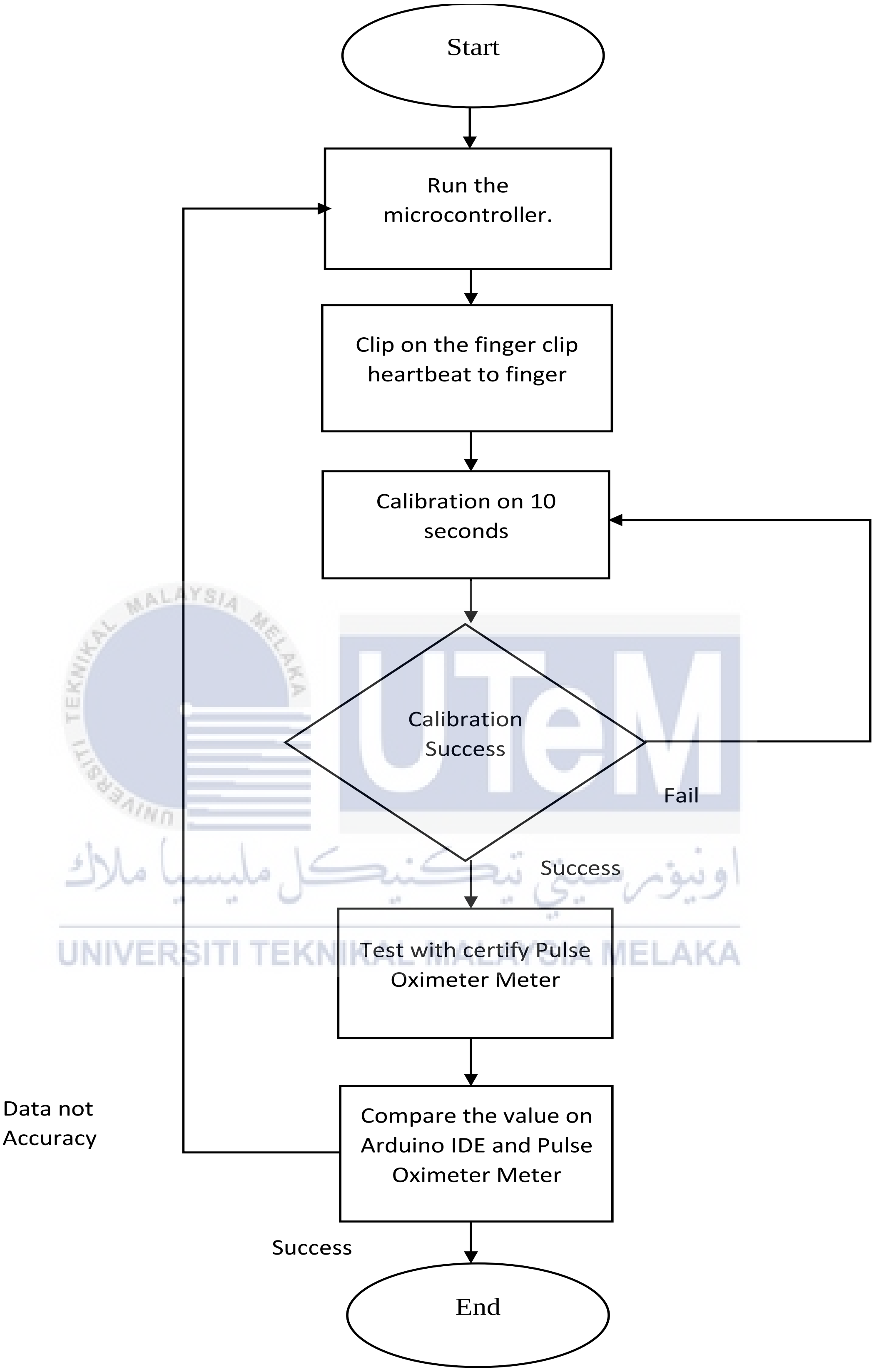

Figure 3.10: Flowchart for Calibration Pulse Oximeter Sensor

The flowchart for the monitoring system and the calibration of carbon monoxide detection is shown in Figure 2. (CO). It begins when the NodeMcu ESP8266 is turned on and connected to a power source. Next, bring the carbon monoxide sensor to room temperature to ensure that the calibration is based on accurate data. After that, the sensor detector must fire up the paper for the sensitivity of carbon monoxide detection testing to ensure the detector absorbs the gases. Aside from that, the carbon monoxide meter was used to compare the value from the Arduino IDE's carbon monoxide detector. When the data from the Arduino IDE does not match the data from the carbon monoxide meter, the variable resistor must be adjusted to adjust the threshold parameter.

3.4.4 Alarm System

3.4.4.1 Fabricate Circuit Alarm System

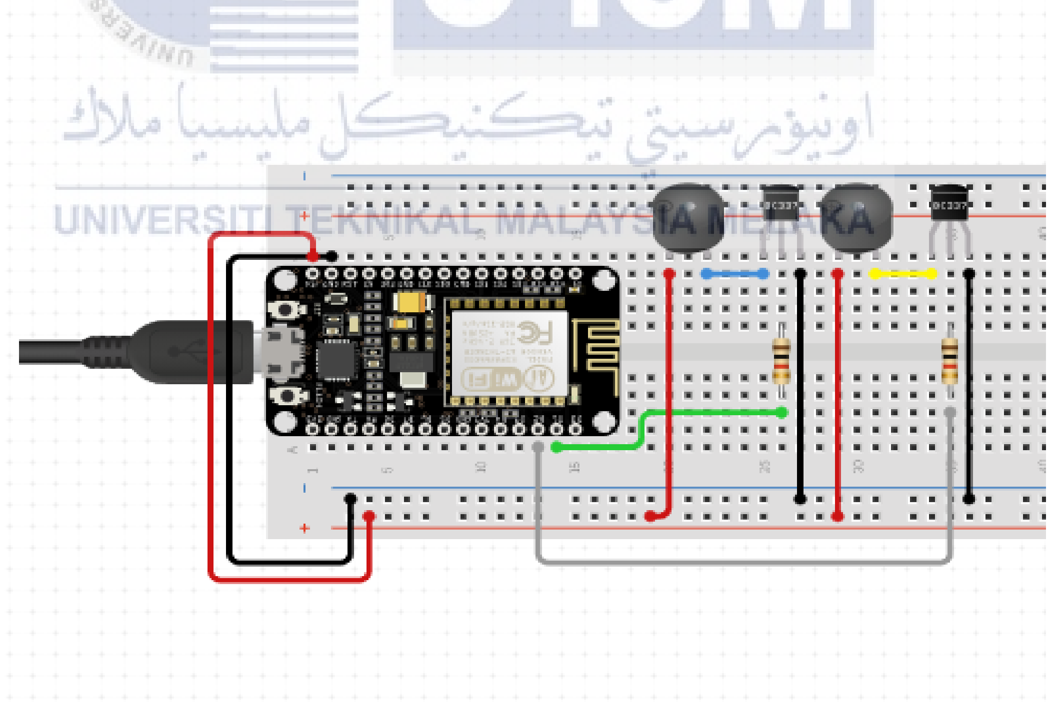

Figure 3.11: Fabrication circuit alarm system.

Figure 2 depicts the construction of an alarm system using the NodeMCU ESP8266. Analog alarm system with analogue buzzer, BC 547 NPN transistor element, and 1kohm resistor was used in this fabrication. When power is applied to the base pin of a BC 547 NPN transistor, current flows from the collector to the emitter.

3.4.5 Global Position System (GPS) Tracker Neo-6M

Figure 3.12: Global Position System (GPS) Neo – 6M Module

GPS receivers work by calculating their distance from a number of satellites. They are pre-programmed to know the exact location of the GPS satellites at any given time. In the form of radio signals, satellites transmit information about their position and current time to the Earth. The satellites are identified by these signals, which tell the receiver where they are. A u-blox NEO-6M GPS chip is at the heart of the module. The chip is about the size of a postage stamp, but it packs a lot of functionality into its small frame. It can track up to 22 satellites on 50 channels and achieves the highest level of sensitivity in the industry, -161 dB tracking, while drawing only 45 milliamps from the power supply. The chip's Power Save Mode is one of its best features (PSM). By selectively switching parts of the receiver ON and OFF, it allows for a reduction in system power consumption. This reduces the module's power consumption to just 11mA, making it suitable for power-constrained applications such as GPS wristwatches. The NEO-6M GPS chip's necessary data pins are broken out into 0.1″ pitch headers. This includes the pins needed for UART communication with a microcontroller. The module supports baud rates ranging from 4800bps to 230400bps, with 9600 being the default.

Table 3:3: Specification of Module GPS Neo – 6M [31]

Receiver Type	50 channels, GPS L1(1575.42Mhz)
Horizontal Position Accuracy	2.5m
Navigation Update Rate	1HZ (5Hz maximum)
Capture Time	Cool start: 27s Hot start: 1s
Navigation Sensitivity	-161dBm
Communication Protocol	NMEA, UBX Binary, RTCM
Serial Baud Rate	4800-230400 (default 9600)
Operating Temperature	-40°C ~ 85°C
Operating Voltage	2.7V ~ 3.6V
Operating Current	45mA
TXD/RXD Impedance	510Ω

3.4.5.1 Calibrate Global Position System (GPS)

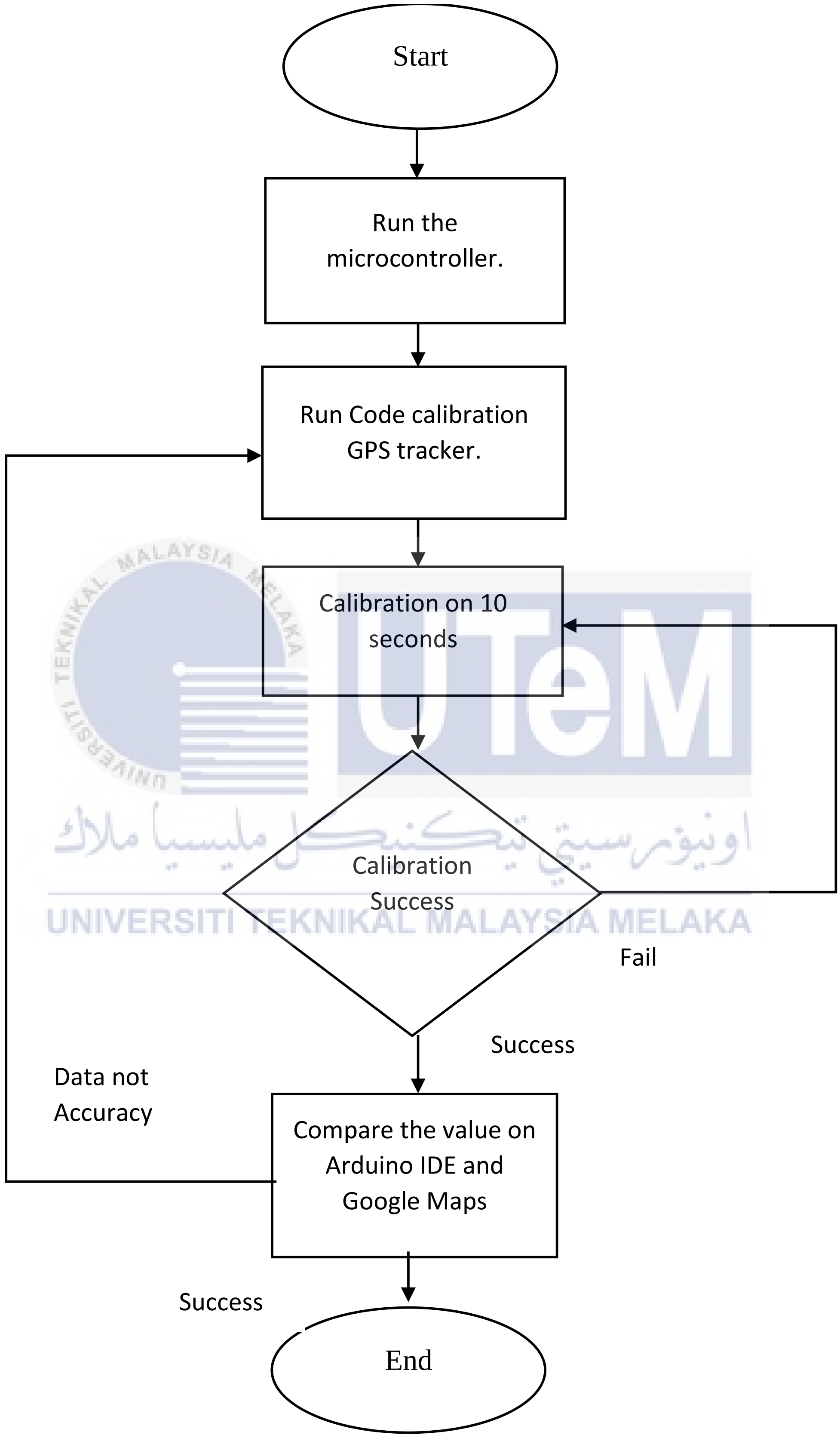

Figure 3.13: Flowchart for Calibration Global Position System (GPS)

The flowchart for the monitoring system and the calibration of the Global Position System is shown in Figure 3.13. (GPS). It starts when the NodeMcu ESP8266 is turned on and connected to the power supply, then the code calibration GPS tracker is run. After running the GPS tracker calibration code, the microcontroller will wait 10 seconds to ensure that the calibration is successful. The data longitude and latitude will be displayed in serial monitor after the calibration is successful. As a result, the next step is to compare the value on the serial monitor Arduino IDE to Google Maps to ensure that the GPS tracker gives the exact same location. When the data longitude and latitude are inaccurate, check the likelihood of a cable connection and make sure the code is using the correct library.

3.5 Hardware Development

3.5.1 Project Circuit

The connection of electronic components is organized using fritzing software to develop the circuit. This software is dragged and dropped from a library, with the components visible on the right panel. It has the ability to create schematic diagrams. It is also simple to refer to when connecting electronic parts for this project shown in figure 3.14 and the component used in table 3.4.

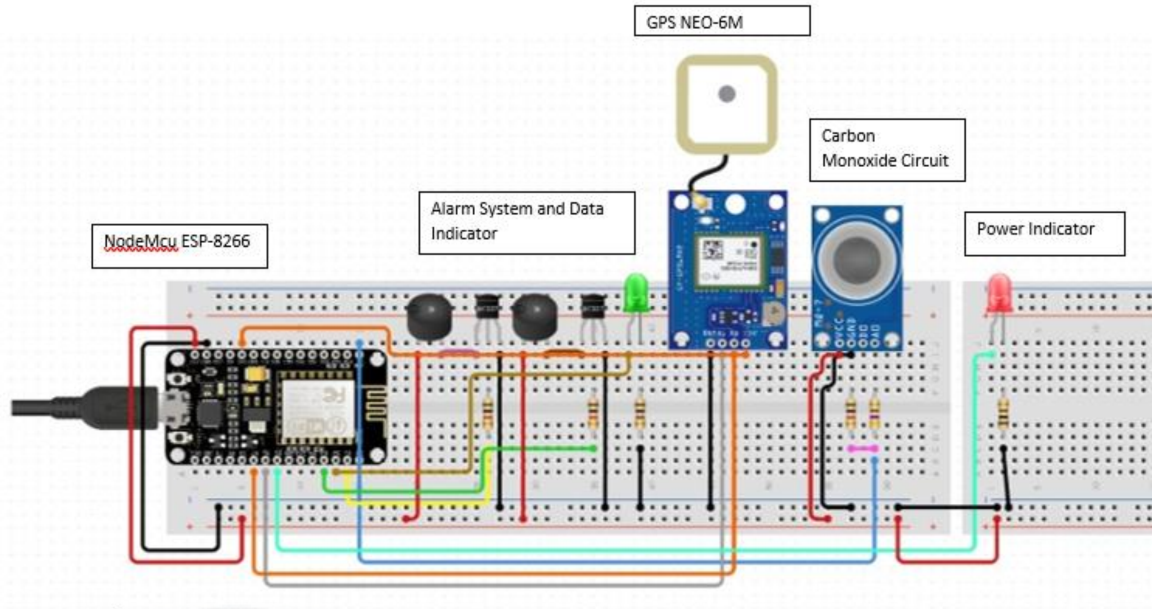

Figure 3.14: Project Hardware connection

Table 3:4: Component Table

Numbering	**Components**
1	NocdeMcu ESP-8266
2	Carbon Monoxide Circuit Sensor
3	Pulse Oximeter Circuit Sensor
4	GPS Neo-6M
5	Buzzer

3.5.2 Project Hardware

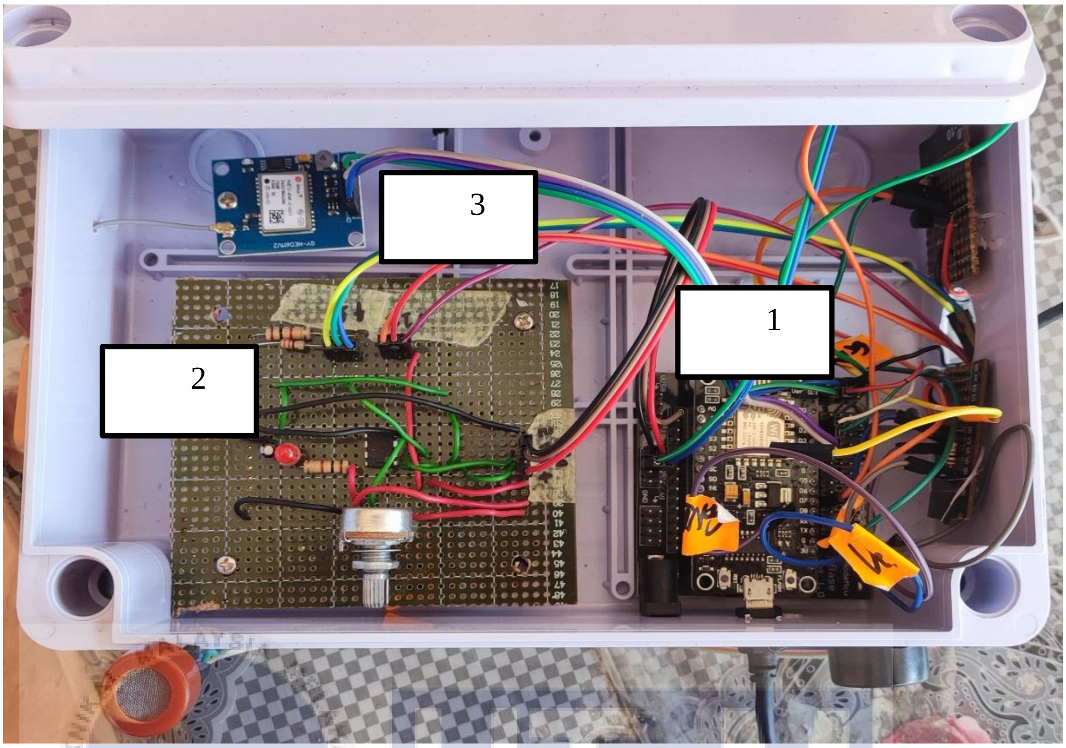

Figure 3.15: Hardware Top View Wiring Circuit

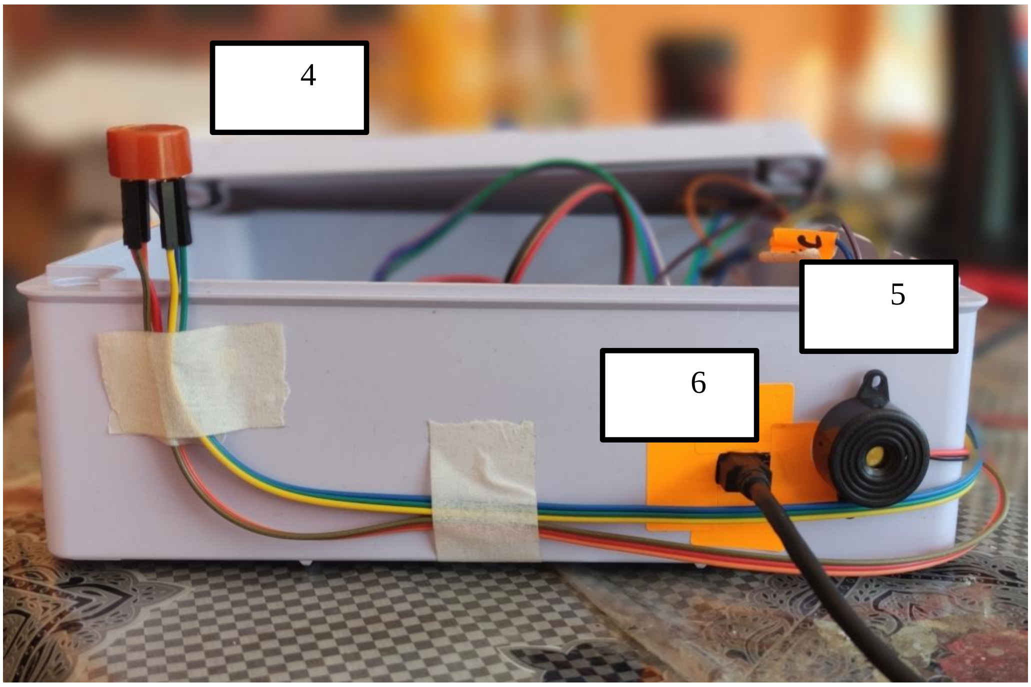

Figure 3.16: Hardware Side View Wiring Circuit

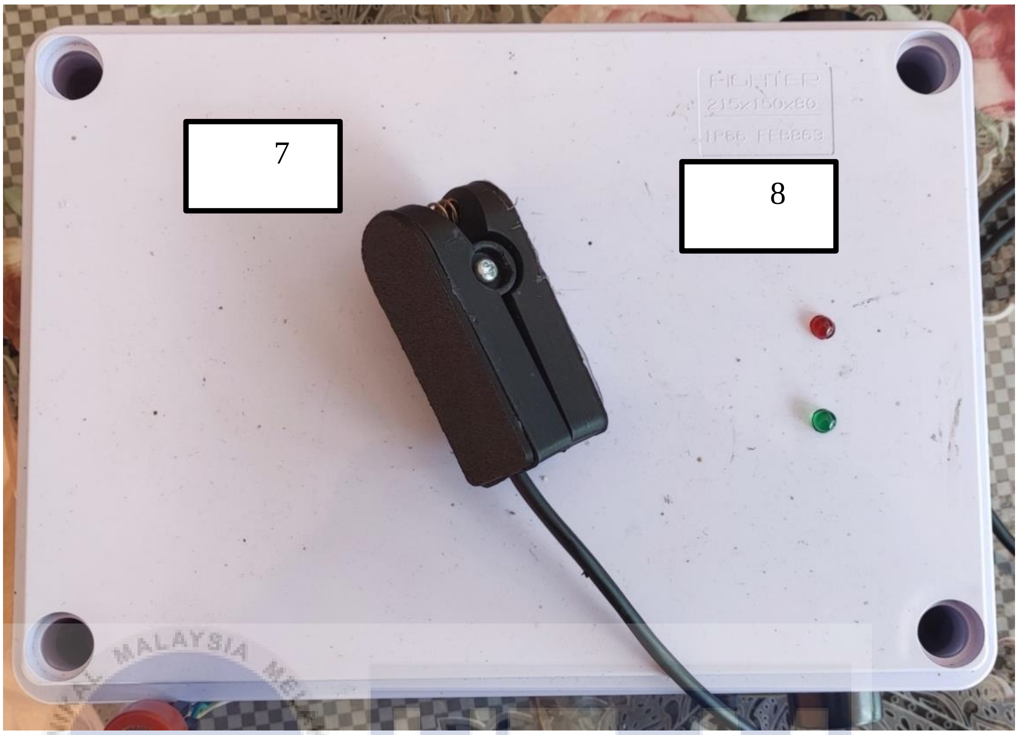

Figure 3.17: Hardware Indicator Power and Data and Pulse Oximeter Circuit

Figure 3.18: Hardware Back View Wiring Circuit

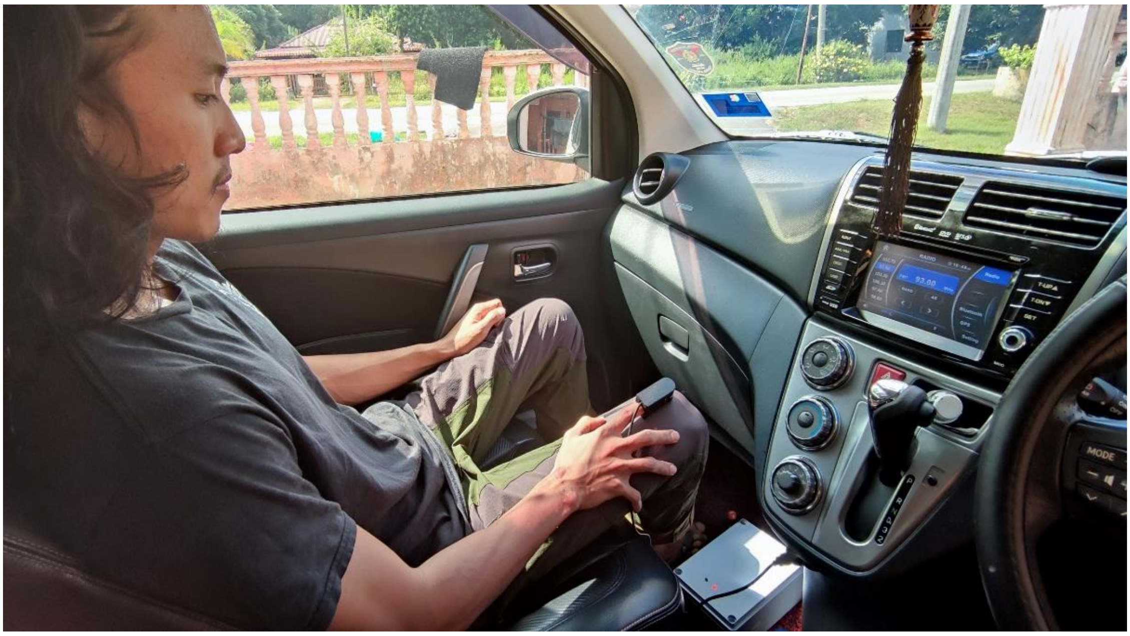

Figure 3.19: Hardware Fully Assemble at Cabin Car

Table 3:5: Hardware Component Table

Numbering	Components
1	NodeMCU Esp-8266
2	Carbon Monoxide Circuit Sensor
3	GPS Neo-6m
4	Pulse Oximeter Sensor
6	Buzzer
7	Pulse Oximeter Sensor Clip Detector
8	Power and Data indicator
9	Antenna
10	Wifi - Moden

3.5.3 Project Location

This figure is suitable in for cabin in vehicle with connection internet for monitoring system.

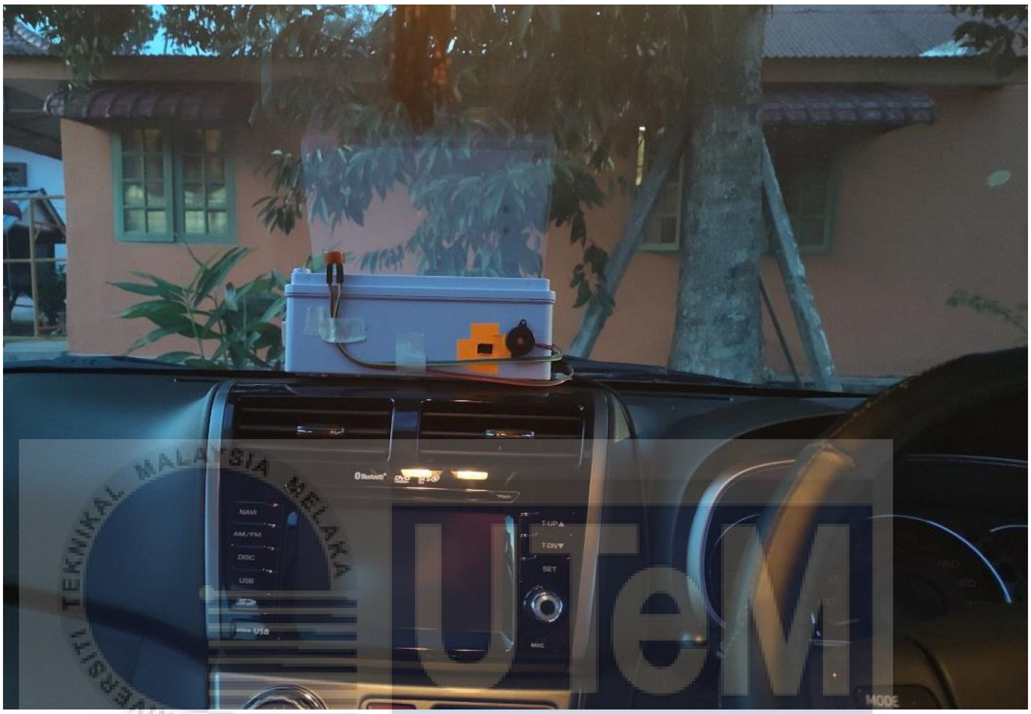

Figure 3.20: Location placement Carbon Monoxide Sensor box

3.6 Software Development

The software used in this project is described in sub-sections below.

3.6.1 Arduino IDE

This project involves the use of software development. The Arduino IDE software is used to write and upload the code that allows the sensor and automation system to work. The code is written in C++ and will be downloaded and run on a microcontroller chip. Carbon Monoxide Sensor, Pulse Oximeter Sensor, GPS, and Alarm System are all part of this code.

3.6.1.1 Wifi Scan

To ensure a connection, the WiFi must first be scanned. Figure 3.17 shows the circuit with the USB cable connected to the NodeMCU ESP8266. The code was uploaded to the NodeMCU ESP8266, and the WiFi connection was displayed in a serial monitor, as shown in Figure 3.18. Blynk is an iOS and Android platform for controlling NodeMCU ESP8266 and the Internet of Things. Figure 3.18 depicts the available WiFi connections in the area.

Figure 3.21: Connection of Scan WiFi

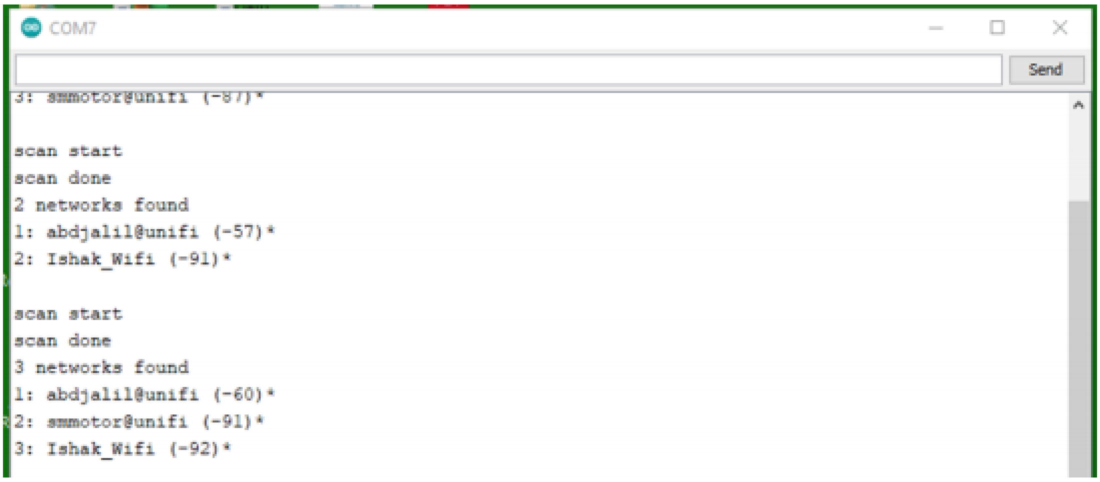

Figure 3.22: Scan Wifi

3.6.1.2 Connection NodeMCU ESP8266 with Blynk IoT Platform

The code for communication between the esp8266 and the Blynk IoT is written in the Arduino IDE, and the connection between them must adhere to the protocol provided by the microcontroller. MQTT is the protocol that is used to establish the connection between them. In the declaration state, the protocol must state.

```
#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>

char auth[] = "oBLLkB351b8aVLmHJuts3vhs6CKmshfT";
char ssid[] = "mazeband";
char pass[] = "Badin0509";
```

Figure 3.23 :Code Connection to Blynk IoT platform

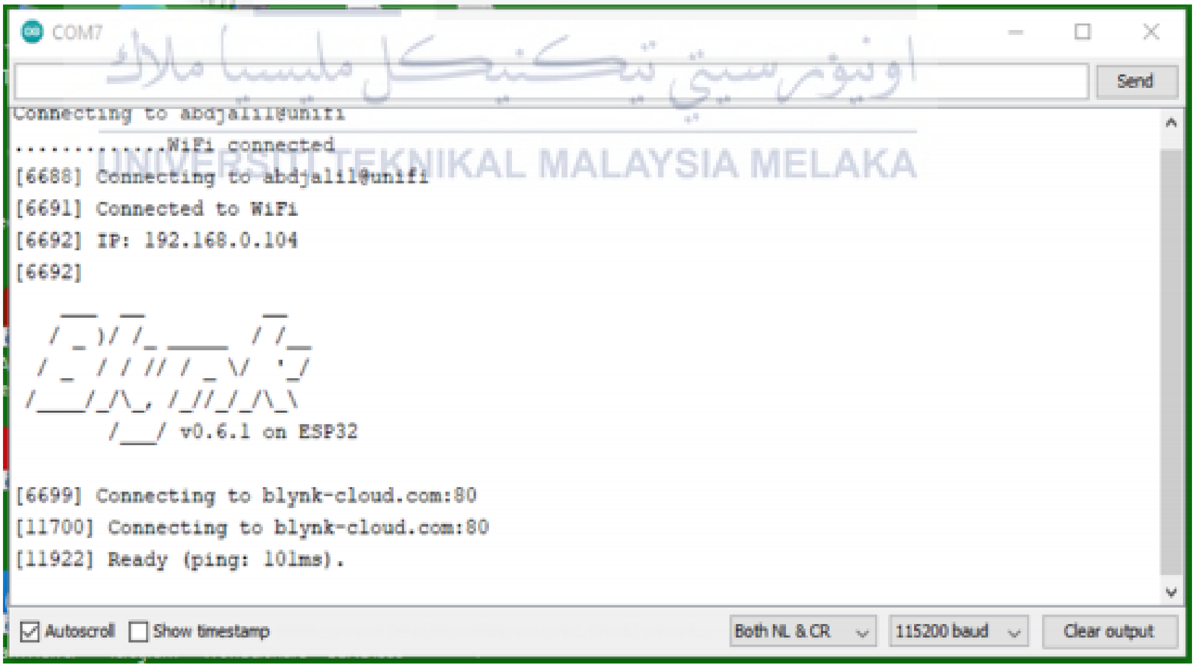

Figure 3.24: Blynk Connection

3.6.1.3 Carbon Monoxide Sensor Code

MQ7 mq7(A PIN, VOLTAGE) is to indicate that sensor Carbon Monoxide is used. The #include MQ7.h> is stated as carbon monoxide type sensor, which is carbon monoxide sensor library is loaded MQ7 mq7(A PIN, VOLTAGE) is to indicate that sensor Carbon Monoxide is used. Carbon monoxide sensor is an analogue sensor, and the carbon monoxide sensor algorithm is multiplication data input from the sensor and display to the application. In the Blynk IoT dashboard platform, the virtual channel is set to channel 0 carbon monoxide sensor value.

Equation 3-1

$$PPM(1) = 100$$

Equation 3-2

$$PPM\left(\frac{R_s}{R_0}\right) = A_0\left(\frac{R_s}{R_0}\right)^{A_1}$$

Equation 3-3

$$A_1 = \frac{\ln(PPM_2) - \ln(PPM_1)}{\ln(R_s/R_{0,2}) - \ln(R_s/R_{0,1})}$$

Equation 3-4

$$A_0 = \exp\{-A_1 \times (\ln(PPM_2) - A_1 \ln(R_s/R_{0,2}))\}$$

```
///Arduino Sample Code
void setup()
{
  Serial.begin(9600); //Set serial baud rate to 9600 bps
}
void loop()
{
int val;
val=analogRead(0);//Read Gas value from analog 0
Serial.println(val,DEC);//Print the value to serial port
delay(100);
}
```

Figure 3.25: Code Carbon Monoxide Sensor

3.6.1.4 Pulse Oximeter Sensor Code

```
#include <Wire.h>
#include "MAX30100_PulseOximeter.h"

#define REPORTING_PERIOD_MS     1000

PulseOximeter pox;
uint32_t tsLastReport = 0;

void onBeatDetected()
{
    Serial.println("Beat!");
}

void setup()
{
    Serial.begin(115200);
    Serial.print("Initializing pulse oximeter..");

    // Initialize the PulseOximeter instance
    // Failures are generally due to an improper I2C wiring,
    // or wrong target chip
    if (!pox.begin()) {
        Serial.println("FAILED");
        for(;;);
```

```
    } else {
        Serial.println("SUCCESS");
    }
     pox.setIRLedCurrent(MAX30100_LED_CURR_7_6MA);

    // Register a callback for the beat detection
    pox.setOnBeatDetectedCallback(onBeatDetected);
}

void loop()
{
    // Make sure to call update as fast as possible
    pox.update();
    if (millis() - tsLastReport > REPORTING_PERIOD_MS) {
        Serial.print("Heart rate:");
        Serial.print(pox.getHeartRate());
        Serial.print("bpm / SpO2:");
        Serial.print(pox.getSpO2());
        Serial.println("%");

        tsLastReport = millis();
    }
}
```

Figure 3.26: Code Pulse Oximeter Sensor

On figure 3.25 show MAX30100_PulseOximeter.h as library to run the pulse oximeter sensor on Arduino IDE. For Pulse Oximeter sensor code setup for calibration on 10 seconds to ensure the data from finger clip pulse oximeter sensor send data correctly. Next, after run the calibration code for pulse oximeter sensor go to void loop for run the variable parameter to display the data heart rate and oxygen level in serial monitor Arduino IDE and send data to Blynk IoT platform for monitoring system.

3.6.1.5 Global Positioning System (GPS) tracker Code

```
#include <TinyGPS++.h>
#include <SoftwareSerial.h>
#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>

static const int RXPin = 13, TXPin = 15;   // GPIO 4=D2(conneect Tx of GPS) a
static const uint32_t GPSBaud = 9600; //if Baud rate 9600 didn't work in your

TinyGPSPlus gps; // The TinyGPS++ object
WidgetMap myMap(V0);  // V0 for virtual pin of Map Widget

SoftwareSerial ss(RXPin, TXPin);  // The serial connection to the GPS device

BlynkTimer timer;

float spd;       //Variable  to store the speed
float sats;      //Variable to store no. of satellites response
String bearing;  //Variable to store orientation or direction of GPS

char auth[] = "oBLLkB351b8aVLmHJuts3vhs6CKmshfT";           //Your Project
char ssid[] = "mazeband";                                    // Name of yo


char pass[] = "Badin0509";                                  // Corresponding

//unsigned int move_index;         // moving index, to be used later
unsigned int move_index = 1;       // fixed location for now


void setup()
{
  Serial.begin(115200);
  Serial.println();
  ss.begin(GPSBaud);
  Blynk.begin(auth, ssid, pass);
  timer.setInterval(5000L, checkGPS); // every 5s check if GPS is connected, only
}

void checkGPS(){
  if (gps.charsProcessed() < 10)
  {
    Serial.println(F("No GPS detected: check wiring."));
      Blynk.virtualWrite(V4, "GPS ERROR");  // Value Display widget  on V4 if GPS
  }
}

void loop()
```

```
{
    while (ss.available() > 0)
    {
      // sketch displays information every time a new sentence
      if (gps.encode(ss.read()))
        displayInfo();
  }
  Blynk.run();
  timer.run();
}

void displayInfo()
{
  if (gps.location.isValid() )
  {
    float latitude = (gps.location.lat());     //Storing the La
    float longitude = (gps.location.lng());

    Serial.print("LAT:  ");
    Serial.println(latitude, 6);  // float to x decimal places
    Serial.print("LONG: ");


    Serial.println(longitude, 6);
    Blynk.virtualWrite(V1, String(latitude, 6));
    Blynk.virtualWrite(V2, String(longitude, 6));
    myMap.location(move_index, latitude, longitude, "GPS_Location");
    spd = gps.speed.kmph();               //get speed
       Blynk.virtualWrite(V3, spd);

       sats = gps.satellites.value();    //get number of satellites
       Blynk.virtualWrite(V4, sats);

       bearing = TinyGPSPlus::cardinal(gps.course.value()); // get th
       Blynk.virtualWrite(V5, bearing);
  }

 Serial.println();
}
```

Figure 3.27: Code Global Positioning System (GPS) tracker

On Figure 3.26 Libraries such as TiniGPS++.h included in code for run the calibration the data GPS. Next, setup the variable for Tx, Rx and GPS baud rate to connect NodeMCU ESP8266, for Tx pin connected to GPIO 15 which is in D5 microcontroller, for Rx pin connected to GPIO 13 which is in D4 microcontroller and the GPS baud rate was setup on 9600. After that, in to void loop the code run to collect the data from GPS Module also display the data on serial monitor and send data to Blynk IoT platform for monitoring system.

3.6.1.6 Alarm system for Carbon Monoxide detection Code

```
#include <Wire.h>
#define BLYNK_PRINT Serial
#include <Blynk.h>
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
#include "Wire.h"
#include <TinyGPS++.h>
#include <SoftwareSerial.h>
#include "MQ7.h"
#define A_PIN 0
#define VOLTAGE 5
#define Buzzer 13
void setup()
{
  Serial.begin(115200);
  Blynk.begin(auth, ssid, pass);
  pinMode(Buzzer, OUTPUT);
    timer.setInterval(1000L, sensor);
  timer.setInterval(300000L, exitprogram);
  // every 5s check if GPS is connected, only really needs
}

void loop()
{
```

```
  Blynk.run();
  timer.run();
}

void sensor()
{
  CO = mq7.readPpm();
  Serial.print("PPM = "); Serial.println(CO);
  Blynk.virtualWrite(V3, CO);
}

  void condition1()
  {
    if (CO >= 25 )
    {
      digitalWrite(Buzzer,HIGH);
      delay(500);
      digitalWrite(Buzzer,LOW);

      led.on();


     {
       digitalWrite(Buzzer,LOW);

       led.off();

     }
   }

   void condition2()
   {
     if (CO >= 300 )
     {
       digitalWrite(Buzzer,HIGH);

       led.on();

     }

     else
     {
       digitalWrite(Buzzer,LOW);

       led.off();
```


Figure 3.28: Alarm system carbon monoxide detection code

On Figure 3.28 the alarm system carbon monoxide detection code are included the TinyGPS++.h , Max30100_PulseOximeter.h and MQ7.h. Next in void setup declaration for pin buzzer one buzzer two declared in GPIO 0 and GPIO 2 and the pin GPIO for buzzer one and buzzer two setup in pinMode as output. Other than that, in void loop start have the two-probability condition which is condition one for the carbon monoxide sensor detect more than 25ppm and less than 300ppm, and next for condition two when the carbon monoxide sensor detect more 300ppm. In condition one when the carbon monoxide detect more than 25ppm and less than 300pm the buzzer one will be triggered five minutes. Finally, for condition two when the carbon monoxide sensor detect more than 300ppm the buzzer one and two will be continuously triggered until the value of carbon monoxide drop until below 25ppm.

3.6.2 Blynk IoT Dashboard Platform

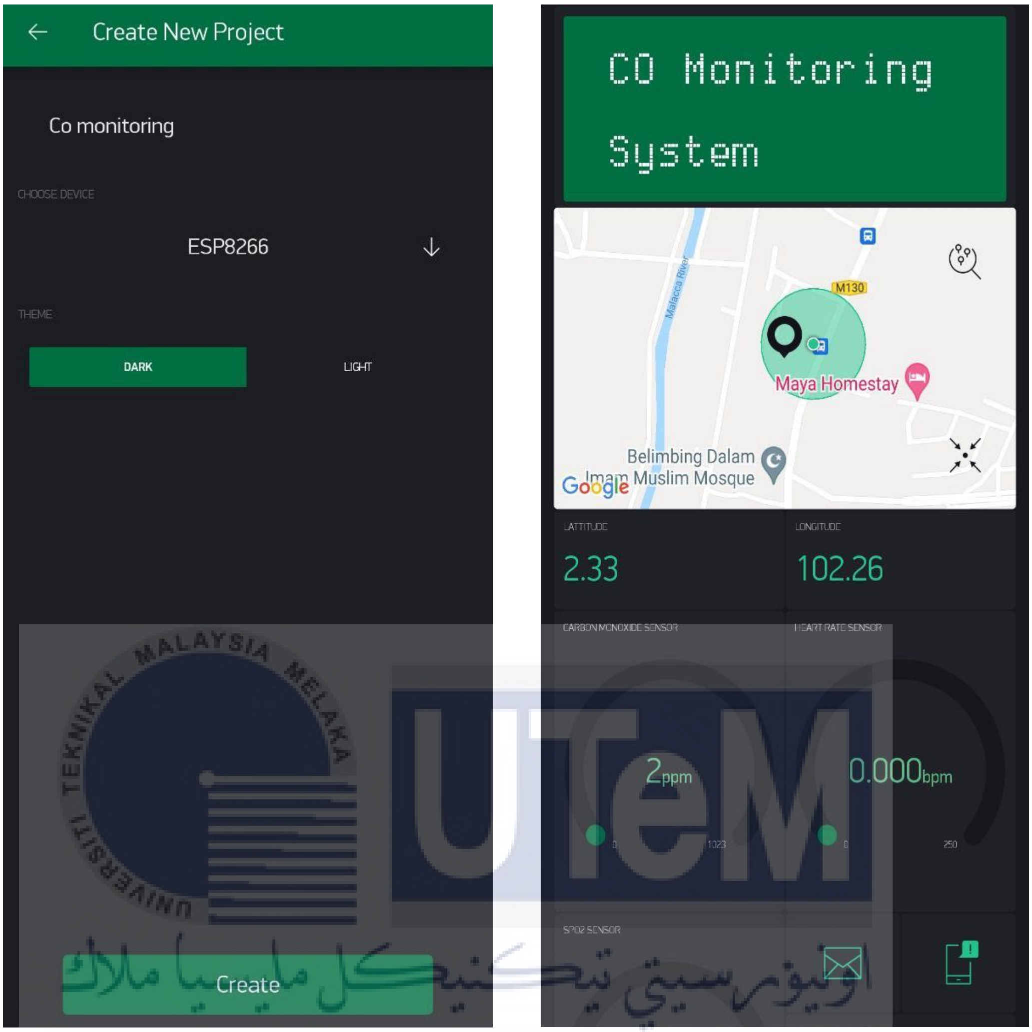

Figure 3.29: Interface Dashboard Blynk IoT platform

The figure 3.29 shows the setup Blynk IoT platform and dashboard Blynk IoT platform of the system. On the top side the dashboard was setup the LCD display for show the status of condition microcontroller. Next below LCD display shown setup of Map location and display value longitude and latitude. Other than that, for the gauge display was setup display Carbon Monoxide (CO) sensor data, Heart rate and Oxygen Level from data from Pulse Oximeter sensor. Finally on bottom dashboard was setup the graph carbon monoxide, heartrate, and oxygen level.

3.6.3 Cura Ultimaker

In order to achieve the objective for fabricate finger clip, the finger clip for MAX30100 Pulse Oximeter Sensor fabricate using Cura ultimake. Cura ultimaker is used to simulate and transfer the file from the blender file. Cura ultimaker, simulate the process of the 3d printing and estimate the time for the 3d print to finish. the cura ultimaker manage to transfer the file from .sti file to. gcode file. to transfer the file into. gcode file the software manage to slice the design. Then, the file. gcode is transfer into micro sd card. the 3d printer ender 3 PRO only use the. gcode file to print design.

Figure 3.30: 3D design Finger clip for Pulse Oximeter sensor

Figure 3.31 : Outcome product cura ultimaker

The slice process from this CURA ultimaker software need to configure the printer setting first before slice the 3D design. Users need to ensure type of material of printer use, for this case the material use is PLA type which is the most popular FDM 3D printing material available, and for good reason. It is relatively inexpensive, a breeze to print with, and comes in hundreds of vibrant colors and blends. The size of the PLA use is 0.2mm while the size of the nozzle from the 3D printer is 0.2mm. below are the configuration of the print setting for smart feeder case.

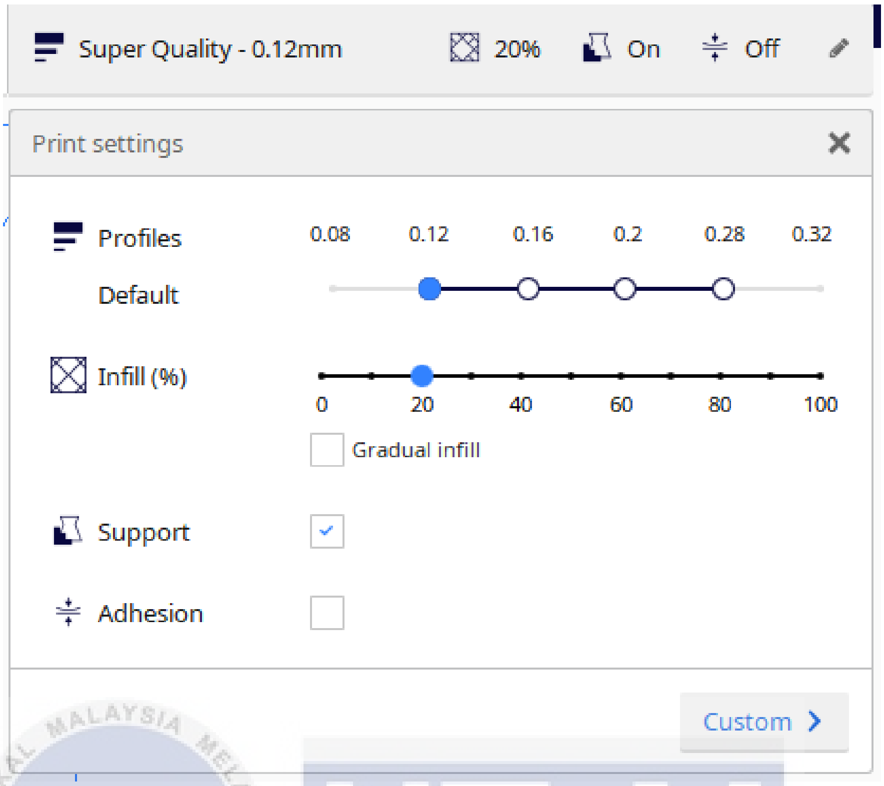

Figure 3.32: Configuration of printing setting

After the configuration of the print setting, then continue to slice process. Slice the 3D design model means taking the 3D design in. stl format and slicing it into individual layers. The software then generates the tool path (.gcode) the printer will use for printing. Most slicing software will have a print preview function to help prevent print failures. The figure below shows the print preview function and estimation time for the print process.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

Prior to the hardware development, overall conceptual hardware system is illustrated to understand the components placement. Once the conceptual design is finalized short technical description is written to explain the fundamental system connectivity and system operation. After that, the hardware development process is initiated. During the hardware development process an overall hardware design connected with all the required sensors are presented and roughly development, detail explanation of each sensor connection and operation is explained, overall system operation also is explained to technically understand the overall system operation. Therefore, this chapter presents, explain and discuss the results of the IoT based data application system for Carbon Monoxide system based on the presented methodologies in Chapter 3.

4.2 Testing Hardware

4.2.1 Carbon Monoxide Sensor

This testing is conducted to show the results between the Carbon Monoxide sensor and the Carbon Monoxide Meter devices. The data from Carbon Monoxide sensor shown in Arduino IDE and Carbon Monoxide meter data in display devices. Both devices are testing on 25 meters at surrounding home area.

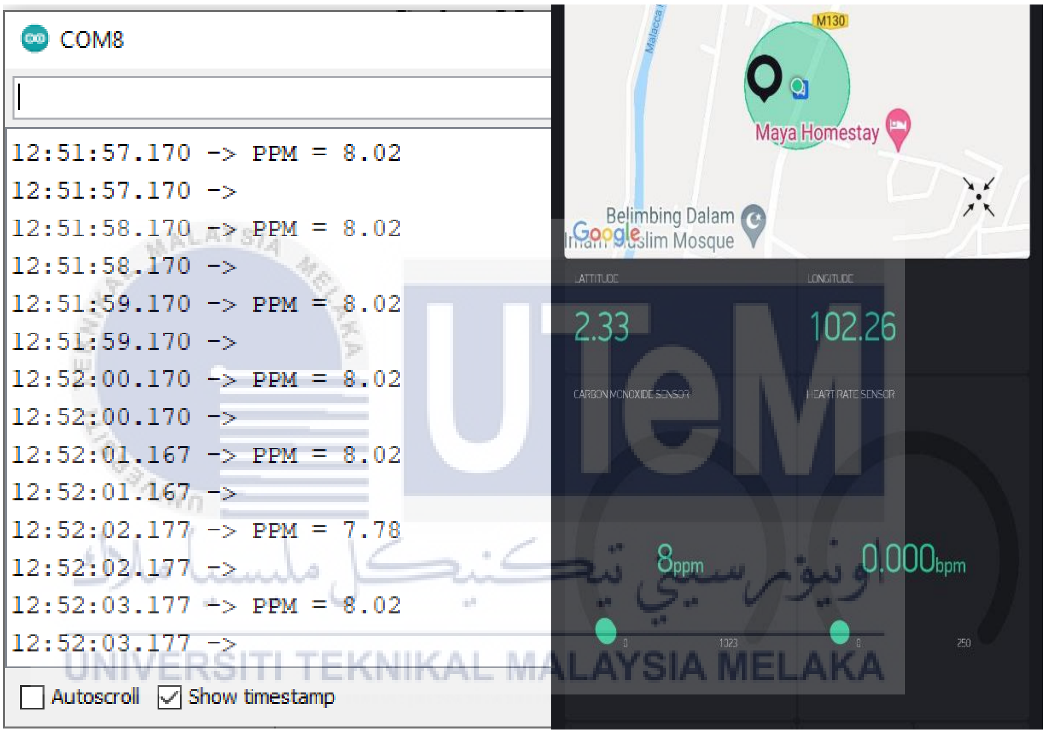

Figure 4.1: Data Carbon Monoxide from Arduino IDE and Blynk IoT Platform

Based on the above result figure 4.1, the data carbon monoxide is testing in room condition with temperature 28’C. The data of carbon monoxide will display on Blynk IoT platform.

4.2.2 Pulse Oximeter Sensor

This testing is conducted to show the results between Pulse Oximeter sensor and the Pulse Oximeter Meter portable device. The data from Pulse Oximeter sensor shown in Arduino IDE and Pulse Oximeter meter data in display devices. Both devices are testing on resting heartrate condition and after five minutes on exercise condition.

Figure 4.2: Data Calibration on Serial Monitor Arduino IDE and Portable Pulse Oximeter Meter

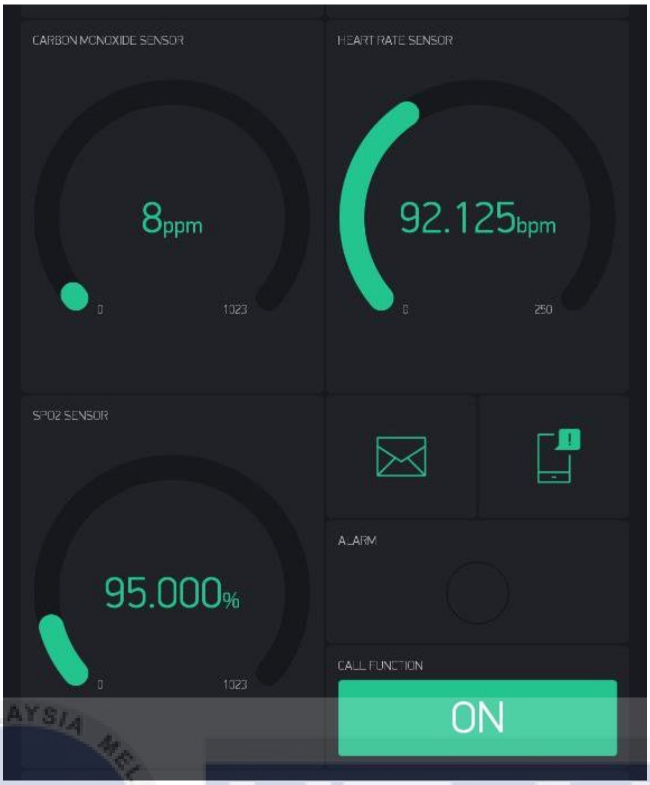

Figure 4.3: Data Observation on Blynk IoT platform

Based on the above result figure 4.2, the data of Pulse Oximeter sensor and Portable Pulse Oximeter Portable Meter. The data will display the heartbeat on resting heartrate which is in 78.42bpm and the oxygen level is 95 percent. Next, for human testing on exercise five minutes the data on serial monitor will display 101.67 bpm for heartbeat and the oxygen level is 96 percent. In Figure 4.3 shown the data of heartbeat and oxygen level display on Blynk IoT platform

4.2.3 Alarm System

This functioning of the automation alarm system for the human aware control it through by condition in Arduino IDE programming and will display the alarm triggered in Blynk IoT application system.

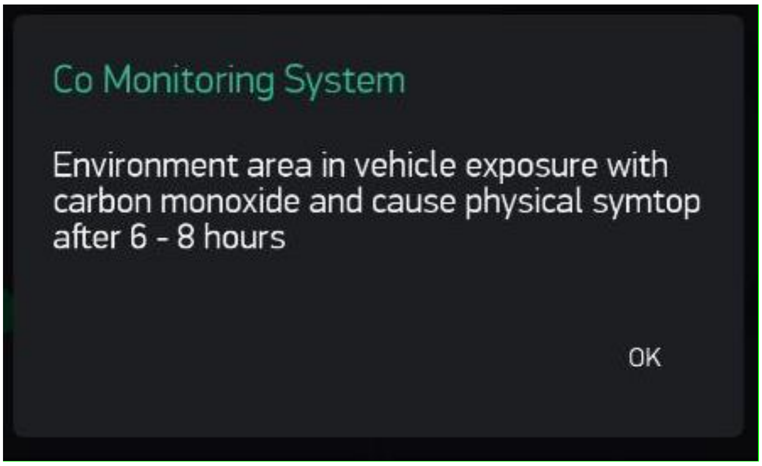

Figure 4.4 : Notification Triggered on above 25ppm

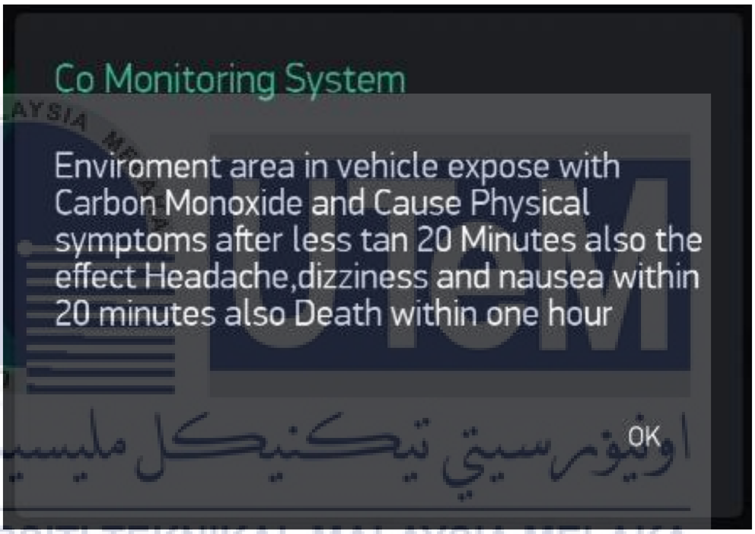

Figure 4.5: Notification Triggered on above 25ppm and 300ppm

Data in Blynk dashboard also can be visualized in term of notification view. According to figure 4.4 and figure 4.5 , the program has been setup in two situation which is the first situation when the carbon monoxide sensor detect above 25ppm the IoT Blynk Platform appear the notification in figure. After that, in situation two when the carbon monoxide sensor detects above 300ppm the IoT Blynk Platform appear the notification in figure 4.5.

4.2.4 Global Positioning System (GPS) Tracker

This functioning of the automation alarm system for the human aware control it through by condition in Arduino IDE programming and will display the alarm triggered in Blynk IoT application system.

Figure 4.6: Comparison data display on Blynk IoT platform and Google Maps

Based on the above result figure 4.6, comparison data longitude and latitude on Blynk IoT platform with Google Maps. Blynk IoT platform will received and display the exactly data on GPS Module from Arduino IDE

4.3 Embedded Software Design and Development

4.3.1 IoT Platform and Monitoring

This part shows how Blynk platform monitor the output of the Carbon Monoxide, Heartbeat and Oxygen Saturation.

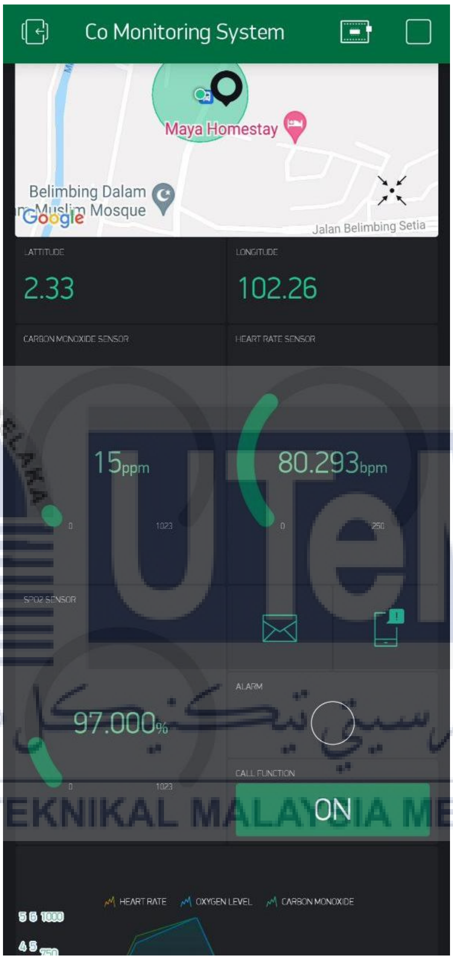

Figure 4.7: Monitoring the system by using Blynk IoT platform

Figure 4.7 shows the Blynk IoT platform dashboard. Here we can see that the dashboard is showing the three parameters which being measured by the sensor used. The parameter which includes Carbon Monoxide for monitor the gas leaked, Heart beat and Oxygen Saturation for monitor the condition of human in car. Another than that, in dashboard Blynk IoT platform include features GPS for tracking the coordinate when the human sniff the Carbon Monoxide.

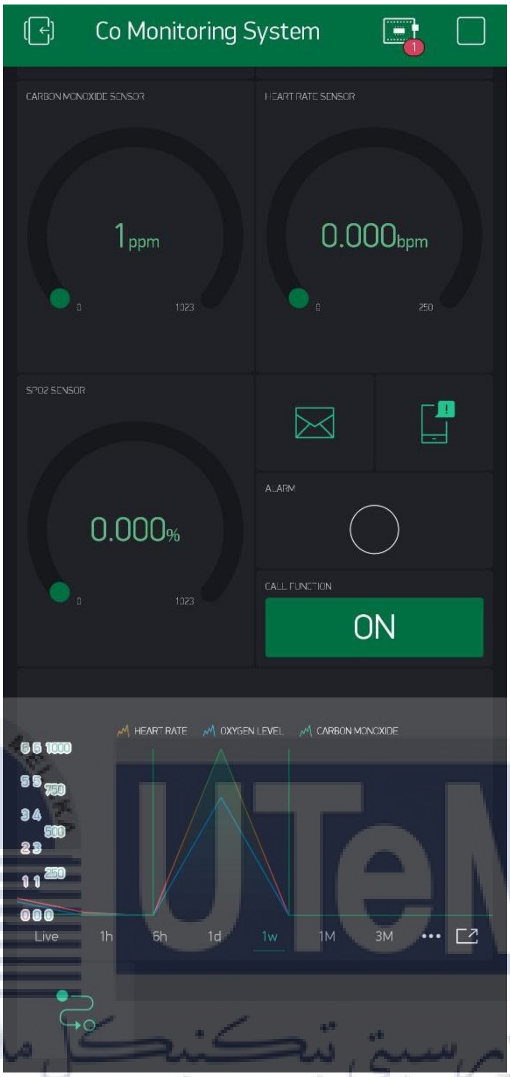

Figure 4.8: Real Time Monitoring by Graphical Type in Blynk

Data in Blynk dashboard also can be visualized in term of graphical view. According to figure 4.8, the y- axis represent the parameter which in this project is Carbon Monoxide (PPM), Heart Beat (BPM) and Oxygen Saturation(SpO2). For the x-axis, it represent the time which can be set to real time monitoring , minute, hours, day, weekly and months. Data in Blynk platform will update every 15 second automatically.

4.3.2 Real Time Data Monitoring System Based on CSV file.

The data store in the Blynk platform can be downloaded in CSV file. Figure shows the data collected from the platform the data will always be updated and stored in very 15 seconds.

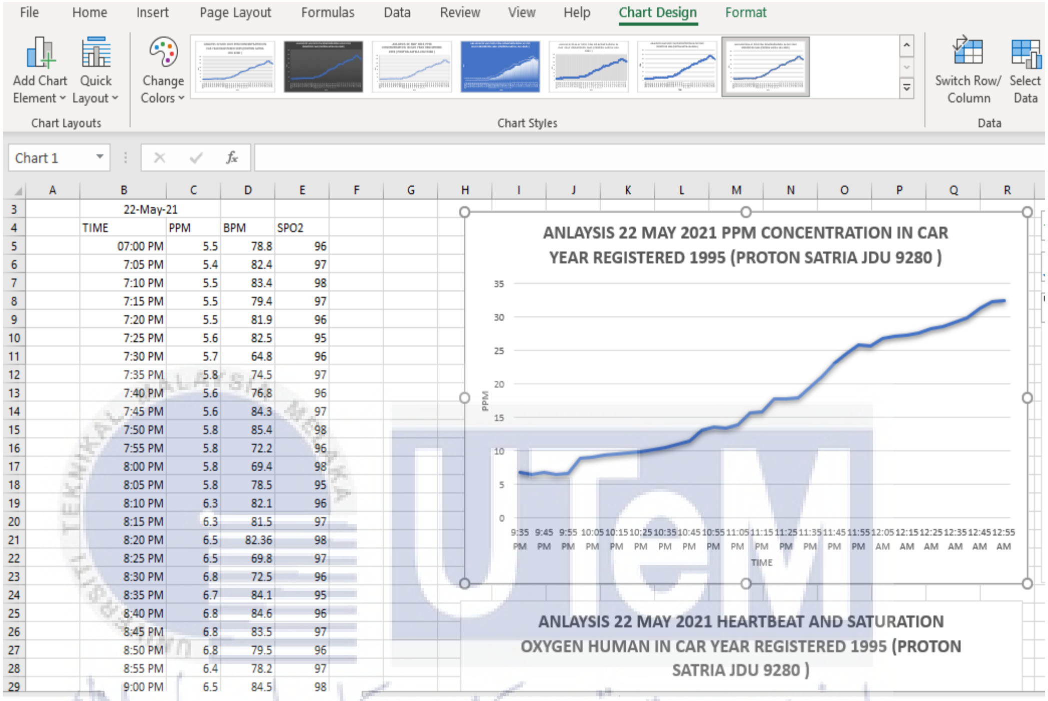

Figure 4.9: Downloaded CSV file from Blynk platform for Carbon Monoxide, Heart beat, Oxygen Saturation.

Raw data from Blynk IoT platform can be directly downloaded in real time monitoring. As be show in figure 4.9 above, the raw data can be downloaded in CSV file which then can be opened using Microsoft Excel. It help ease the burden of user to collect data manually for analysis purpose.

4.4 Analysis Graph Based on Real Time Data

In order to archive the objectives that were set, analysis in graph were made based on real time data that have been captured from Blynk IoT Platform. The data that has been downloaded in csv file were analyzed and were translated into an average value per minute in one hour, before it were put into the graph.

4.4.1 Analysis vehicle registered on 2014

So below are set of graph to analyze the Carbon Monoxide sensor efficiency during experiment on 13 February 2021 with new model vehicle registered 2014 model Perodua Myvi Gen-2

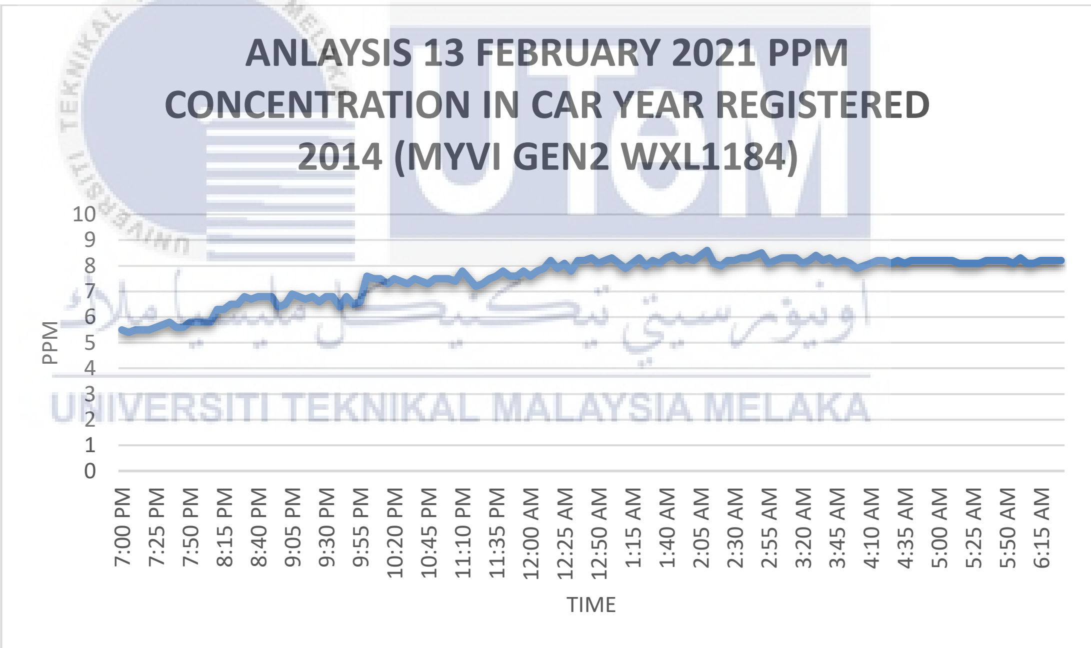

Figure 4.10: Carbon Monoxide leaked data on 11 Hours and 30 Minutes

As can be seen in figure 4.10 The carbon monoxide fluctuation in this vehicle is extremely low because the ventilation of this new model car is a production car with an excellent ventilation system, and another point is that this new model car releases less carbon monoxide gas and has no engine issues.

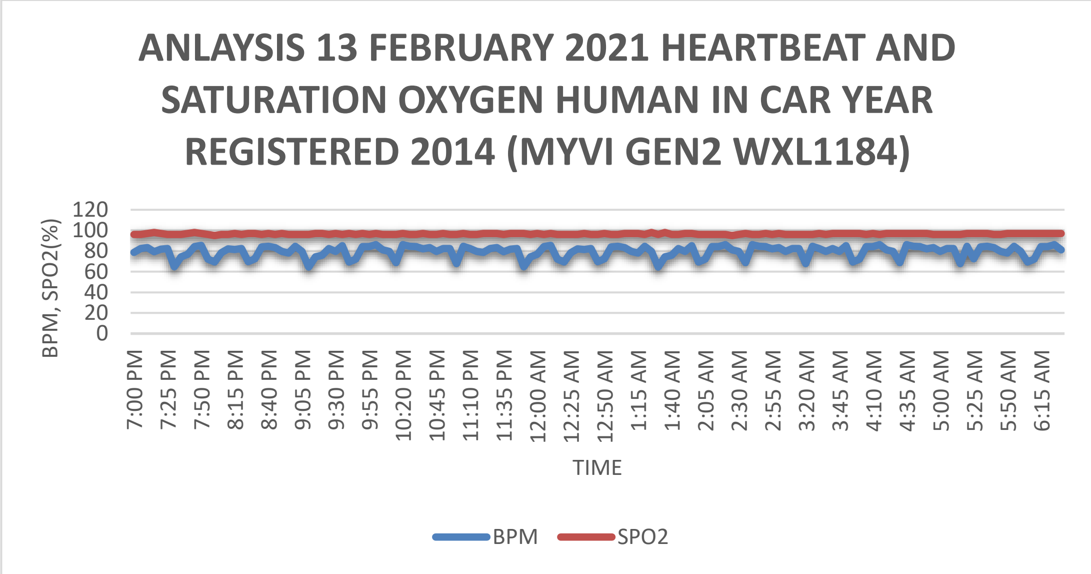

Figure 4.11: Data Heartbeat and Oxygen Saturation experiment on human body

According to the illustration 4.11, this scenario has two criteria, the first of which is the heartbeat, and the second of which is the oxygen saturation level in the human body. To begin, the average heart rate parameter for the human body's lowest heart rate throughout the experiment was 64.8 beats per minute, while the maximum heart rate was 94 beats per minute. Additionally, oxygen saturation reached a maximum of 98 percent in the human body throughout this experiment and a minimum of 96 percent. According to this investigation, the causes causing headaches and mortality are quite low, owing to the little amount of carbon monoxide gas entering the automobile. However, according to NIOSH (National Institute of Occupational Safety and Health) data analysis, a person who inhales carbon monoxide gas leaks below 35ppm still has no internal limb injuries unless the person inhales carbon monoxide gas leaks below 35ppm for an extended period of time, which can cause dizziness and deep symptoms after 8 hours.

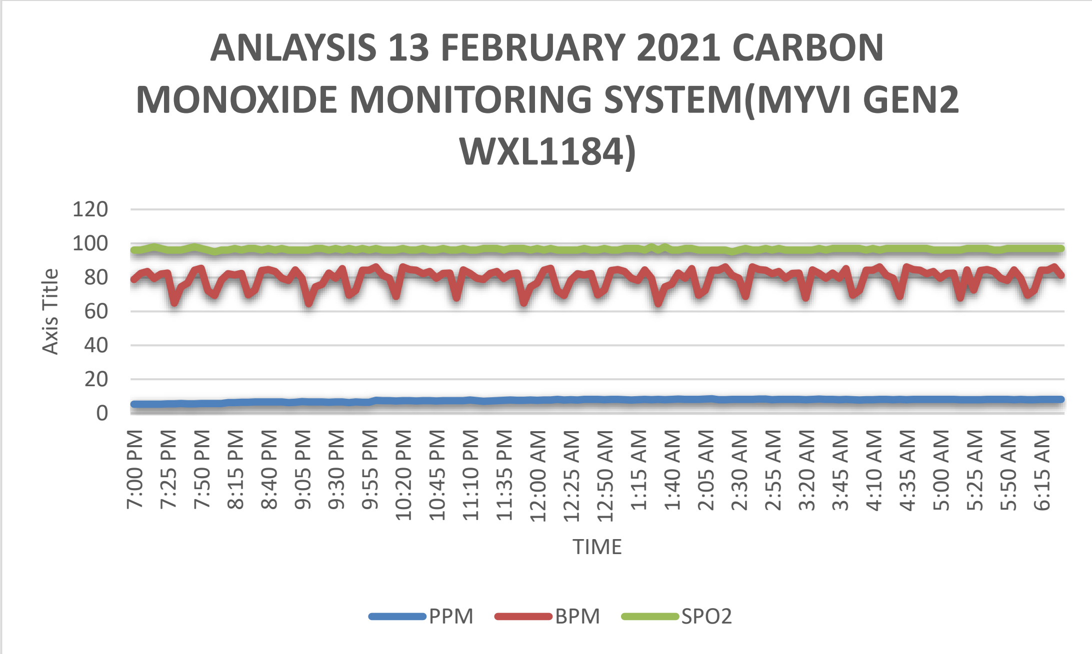

Figure 4.12: Data Carbon Monoxide Concentration, Heartbeat and Oxygen Saturation experiment on human body

According to the illustration 4.12, this condition involves a combination of three parameters: the first is carbon monoxide gas leakage, the second is heartbeat, and the third is oxygen saturation in the human body. in scenarios showing that all three factors contribute to the detection of carbon monoxide gas presence or leakage at a particular moment. Additionally, in this study, the accident that resulted in carbon monoxide gas inhalation is extremely thin since the leakage value is less than 10ppm while the heartbeat and oxygen levels in the body remain steady.

4.4.2 Analysis vehicle registered on 1995

So below are set of graph to analyze the Carbon Monoxide sensor efficiency during experiment on 22 May 2021 with new model vehicle registered 2014 model Perodua Myvi Gen-2.

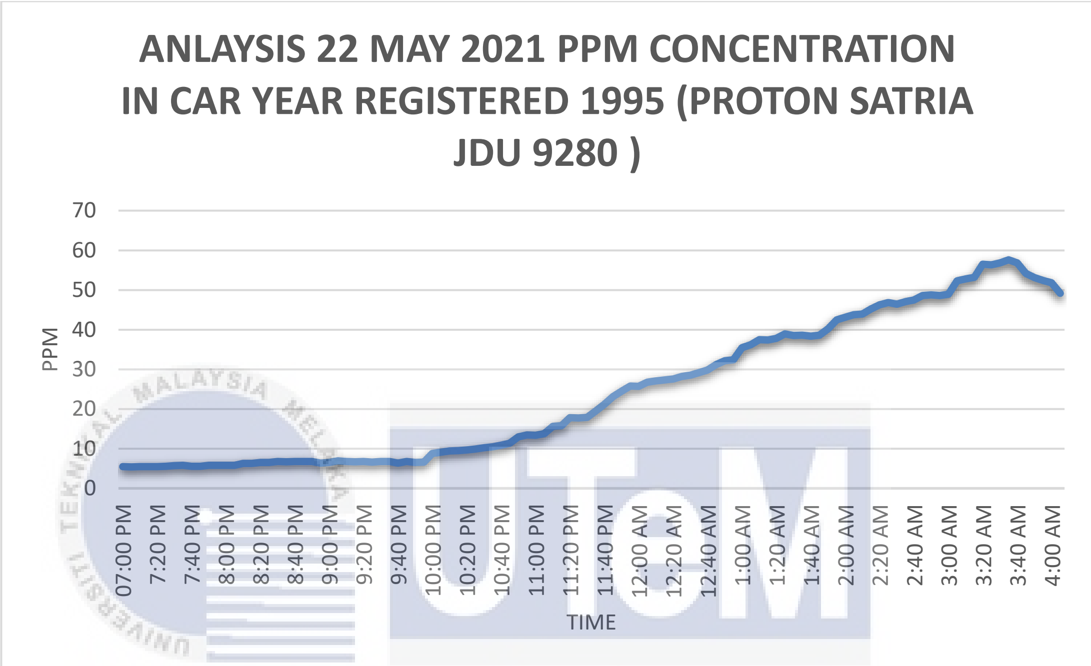

Figure 4.13: Carbon Monoxide leaked data on 9 Hours and 15 Minutes with old model vehicle.

Based on figure 4.13. The efficiency study of the Carbon Monoxide sensor during the tests on 22 May 2021 with the 1995 model Proton Satria is based on this graphical depiction. Carbon monoxide gas leakage into the vehicle is at its lowest point of 5.4ppm and its greatest point of 56.8ppm in this condition. Simultaneously, the rise in carbon monoxide gas leakage begins after three hours of this product being put in the automobile is based on an older vehicle with engine difficulties that may have a significant amount of carbon collected in the engine. Additionally, another element that may be studied is how terrible the vehicle's ventilation system is since this automobile may not get regular maintenance on the ventilation system.

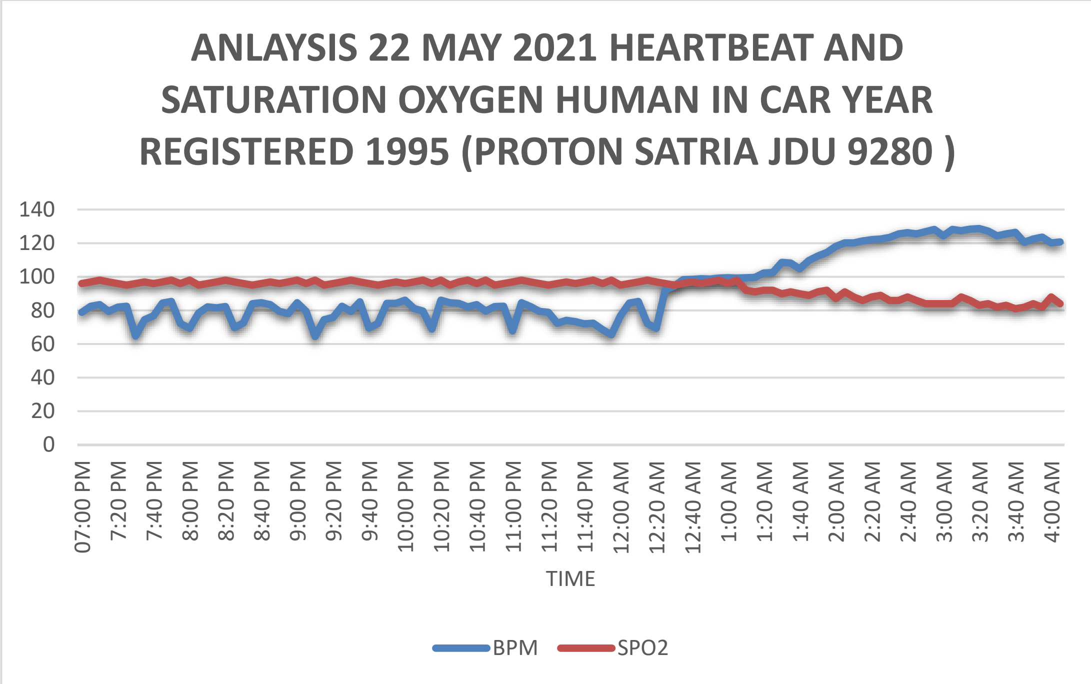

Figure 4.14: Data Heartbeat and Oxygen Saturation experiment on human body using the old vehicle.

According to the figure 4.13, the scenario involving a 1995-vintage car has two criteria: the first is the heartbeat, and the second is the human body's degree of oxygen saturation. To begin, the average heart rate parameter for the human body's lowest heart rate was 64.8 beats per minute, while the maximum heart rate was 127.4 beats per minute throughout the trial. Additionally, during these studies, oxygen saturation reached a maximum of 98 percent and a minimum of 82 percent in the human body. According to this research, can result in headaches and death since the pace at which carbon monoxide enters a vehicle exceeds the pace at which an adult individual inhales carbon monoxide. However, a review of NIOSH (National Institute of Occupational Safety and Health) data indicates that a person who inhales carbon monoxide gas leaks in excess of 35ppm can have dizziness and severe symptoms after 8 hours. At 11:20 pm, the individual is in a state of sleep, as indicated by the graph above, which results in a low heart rate. Meanwhile, after an hour of sleep, the heart rate increased from

65.5 beats per minute to 98 percent and then continued to rise continuously to 128.4 beats per minute and oxygen saturation in the body to 82 percent at 3 a.m. this morning due to this individual inhaling carbon monoxide gas. in a prolonged order and causes dizziness and difficulty breathing. This is because this vehicle's ventilation system is insufficient and requires maintenance.

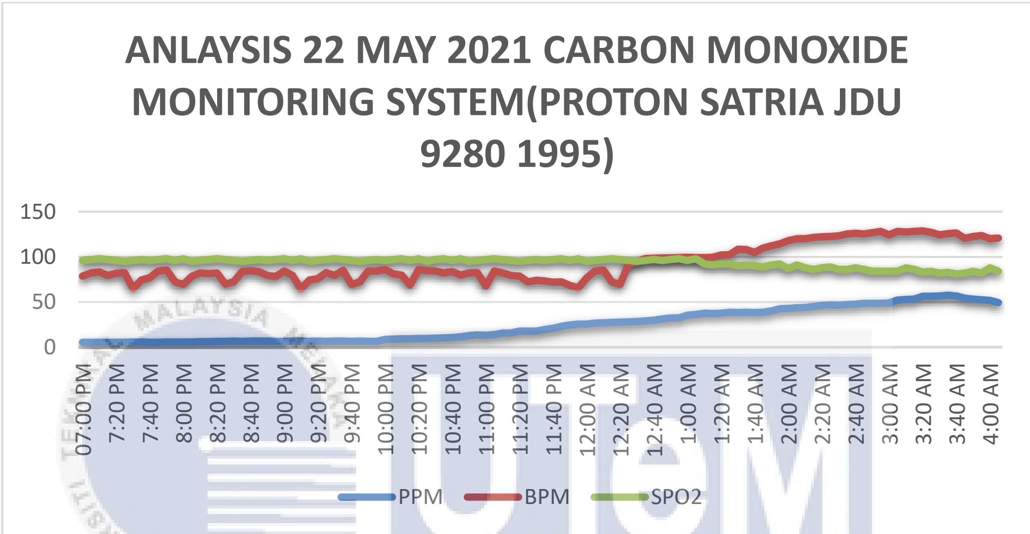

Figure 4.15: Data Carbon Monoxide Concentration, Heartbeat and Oxygen Saturation experiment on human body using old car condition

According to the illustration analysis on May 22, 2021 with the old version registered car condition, this condition involves a combination of three parameters: the first is carbon monoxide gas leakage, the second is heartbeat, and the third is oxygen saturation in the human body. in scenarios that show that all three factors contribute to the detection of the presence or leakage of carbon monoxide gas at a particular moment. Moreover, in this study, accidents resulting in inhalation of carbon monoxide gas are very dangerous because the leakage value exceeds 10ppm and the data continues up to 57.6ppm. Meanwhile the heart rate increases up to 127.bpm and oxygen in the body decreases up to 84 per cent and this can cause a person to experience symptoms of dizziness within 8 hours of inhaling carbon monoxide gas.

4.4.3 Analysis on stress test

So below are set of graph to analyze the stress of Carbon Monoxide sensor efficiency during experiment on 15 May 2021 with model vehicle registered 1995 model Proton Satria 1995.

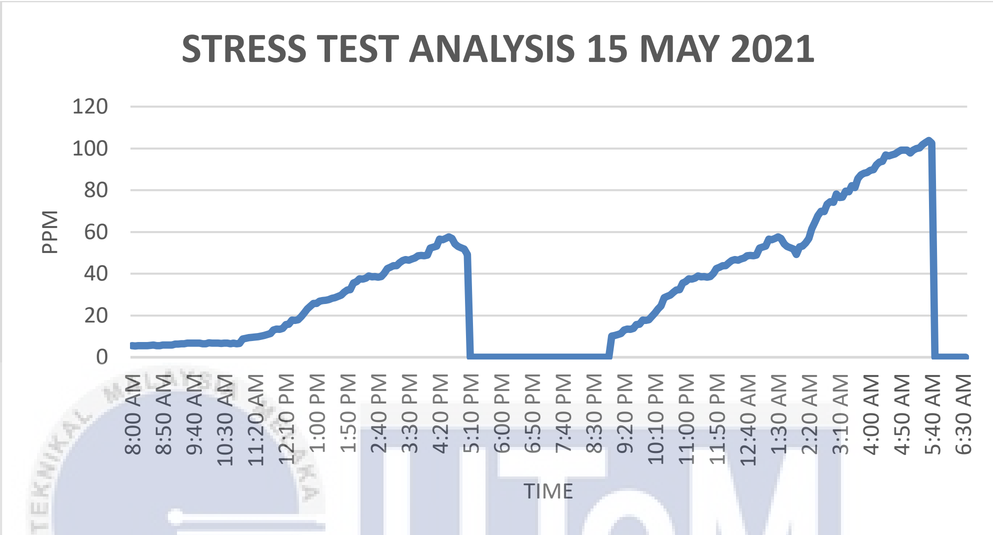

Figure 4.16: Data analysis stress test concentration of Carbon Monoxide

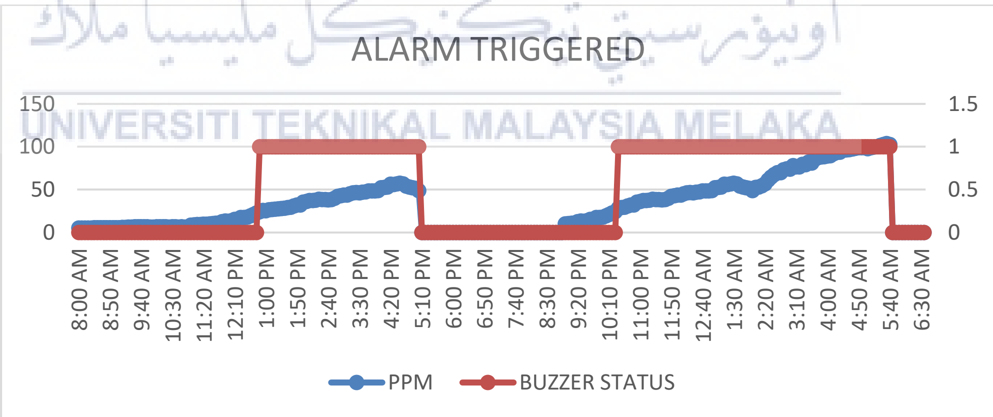

Figure 4.17: Analysis data for alarm triggered on stress test.

Based on the figure 4.15 and figure 4.16 refers to the active buzzer on the carbon monoxide device according to the notice from NIOSH which will turn on the alarm at 30ppm and for this analysis has been programmed if 25 ppm above the alarm will sound and warn the driver or passenger in the car to avoid accidents involving lives.

4.5 Discussion

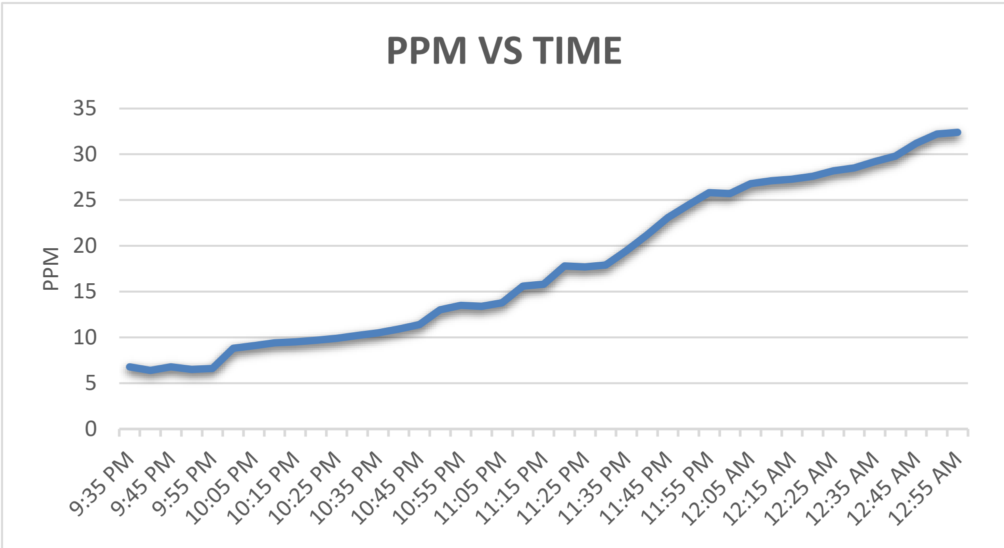

Figure 4.18: Average Pulse per Minutes of Carbon Monoxide detection vs Time for previous project

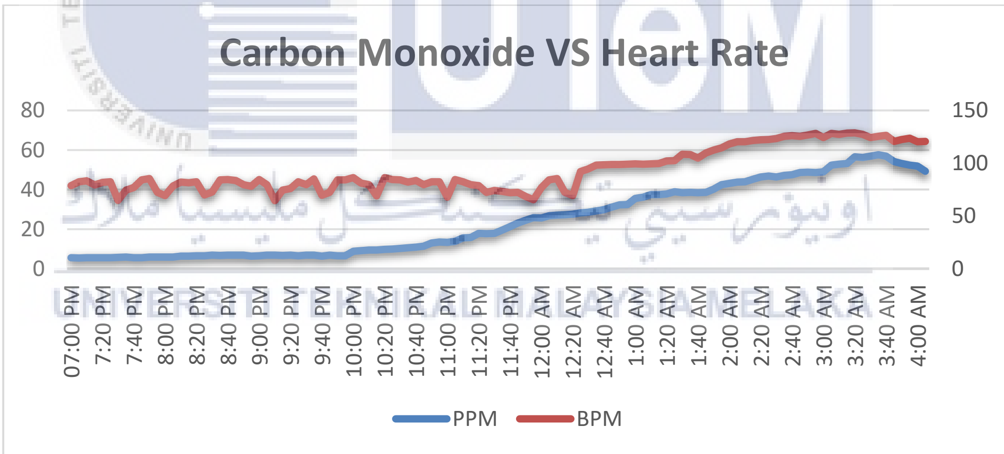

Figure 4.19: Average Pulse per Minutes vs Beat per Minutes for Carbon Monoxide monitoring project

To ensure that there is improvement in this project. Results comparison has been made to compare the average output pulse per minutes of carbon monoxide that has been detected at several time with previous project. One of additional on this latest project has been added of new features with Pulse Oximeter sensor to detect the heat beat person on cabin car.

As it can be seen in figure 4.18 and figure 4.19, the previous project only detect the leak of carbon monoxide and the highest of detection on carbon reach tested is 32.4ppm. While on this project the highest carbon monoxide detection reaches above 57.4ppm and have support another function which is pulse oximeter sensor to detect the heartbeat individual in cabin car. So in this project can be seen when the individual inhaled a lot of carbon monoxide leak than will be effect the breathing and while be effect at another internal organs.

Table 4:1: Comparison table for Carbon Monoxide Monitoring System with previous project

SPECFICATION	CARBON MONOXIDE MONITORING SYSTEM	PROJECT 1
Maximum Output Carbon Monoxide tested	Above 500ppm	Reach only 35.4
Location GPS	Location display on IoT application	None
Heart beat and oxygen level detection	Heart beat and oxygen level display on IoT application	None
Economical Design	Portable	Portable
Monitoring	Blynk IoT platform	None
Integrated features	Alarm system	Display with LCD

CHAPTER 5

CONCLUSION AND FUTURE WORKS

5.1 Conclusion

As a conclusion the project of Low – Cost IoT Based Carbon Monoxide Monitoring System the application has been done successfully designed and tested. The system has been developed by integrating features of entire hardware and software used. In addition, the hardware and software architecture of the system is designed to improved previous system present. Nodemcu ESP-8266 that has been used in he system in one of the tiny modern processors that can control the operation for collecting data from the sensors used. Blynk IoT platform is used as the platform to gather the data form the NodeMCU ESP-8266 and the data were presented in the platform are friendly used to user. The objectives that were set in the beginning of this project were successfully achieved which To design and fabricate the carbon monoxide, monitoring system embed with oxygen and heart rate sensor, to integrate the the Carbon Monoxide sensor, alarm system and GPS with Blynk IoT based system with IoT system for the purpose of collecting data feedback and lastly to analyses the concentration of carbon monoxide leakage through air into the human body.

5.2 Future Works

There is a few changes and improvement that can be implemented to this project. These improvements are:

- Additional more Carbon Monoxide Sensor for efficiency
  - Carbon Monoxide Sensor that were used not efficiency on large vehicle like bus express. Because now carbon monoxide sensor used suitable for a sedan car. The implementation for added more the carbon monoxide sensor is to efficient on large vehicle for to get the faster data from carbon monoxide to prevent the incident human inhaled the gas leaked
- Additionally, the GSM module as new features for calling function.
  - The addition of a GSM module is one of the features that need to be put forward because in this project it has GPS features, and it can track the coordinates of the victim in the event of any incident. Because this GSM module can support and help speed up the victim's family to get information, this GSM feature can make calls and send all data to the victim's exit in the event of an accident that results in the victim inhaling excess carbon monoxide.
- Additionally, the Pulse Oximeter sensor for individual in vehicle.
  - Addition of Pulse Oximeter sensor for individuals in the vehicle due to detect individual heartbeat and amount of oxygen in the body of individuals in the vehicle and with this addition can speed up the system to detect the reaction if the individual inhales carbon monoxide and can be preferred to receive help from the agency health.

5.3 Environment and Sustainability

Consideration to the sustainability and environmental aspects are very essential in designing or producing any new project. Sustainability defines the ability to continues a defined behavior indefinitely. Whereas, environmental means the surroundings or conditions in which a person, animal, or plants lives. Therefore environmental sustainability is the maintenance of the factors and practices hat contribute to the quality of environment on a long-term basis. It is the rates of pollution creation, renewable resource harvest, and nonrenewable resource depletion that can be continued indefinitely. It is very important to discuss about environment and sustainability when developing because it will give direct impact our nature and society.

The aspect of sustainability of this project is economy. This is because the project uses a low-cost item. It did not use much money on it order to build this project. The component that used in this project can be found easily at the electronic or hardware shop. Lastly, the project is sustainable in term of environment. It is safe to use because it is ecofriendly. The project did not produce any chemical. In fact, it is also user friendly in terms of monitoring and handling.

5.4 Health and Safety

Occupational Safety and Health Administration (OSHA) is an organization which play the role to ensure safety of industry and protect worker health and safety. It also uses to ensure safe and healthy working condition for labor by enforcing workplace law and standards. The organization also provides training, education, and assistance in variety industry in order to increase the alertness of workers about the danger and importance of health and safety. Based on the project, there is no safety issues that need to point out. It is because the circuit only operate by using 5V DC in this cases power bank use as power source. The project is safe to use because the circuit is seal with a panel box that gave good electrical insulator. So, there will not harm the user when touching the especially for kids.

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APPENDICES

Appendix A : Coding Microcontroller and Blynk IoT plafrom

```
BPM_CO §
#include <Wire.h>
#include <TinyGPS++.h>
#include <SoftwareSerial.h>
#include "MAX30100_PulseOximeter.h"
#define BLYNK_PRINT Serial
#include <Blynk.h>
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
#include "MQ7.h"
#define A_PIN 0
#define VOLTAGE 5
MQ7 mq7(A_PIN, VOLTAGE);
#define REPORTING_PERIOD_MS 1000
char auth[] = "oBLLkB351b8aVLmHJuts3vhs6CKmshfT";            // You should get Auth Token
char ssid[] = "mazeband";                                    // Your WiFi credentials.
char pass[] = "Badin0509";
static const int RXPin = 0, TXPin = 2;   //GPIO 4=D2(conneect Tx of GPS) and GPIO 5=D1(Con
static const uint32_t GPSBaud = 9600; //if Baud rate 9600 didn't work in your case then use
// Connections : SCL PIN - D1 , SDA PIN - D2 , INT PIN - D0
PulseOximeter pox;
int Buzzer = 13;
float BPM, SpO2;
int CO;
uint32_t tsLastReport = 0;
```

BPM_CO §

```
float BPM, SpO2;
int CO;
uint32_t tsLastReport = 0;
int toggleState_1 = 0;
int a;
uint8_t button;
//unsigned int move_index;         // moving index, to be used later
unsigned int move_index = 1;       // fixed location for now
TinyGPSPlus gps; // The TinyGPS++ object
WidgetMap myMap(V0);  // V0 for virtual pin of Map Widget
WidgetLCD lcd(V8);
SoftwareSerial ss(RXPin, TXPin);  // The serial connection to the GPS device
BlynkTimer timer;
void onBeatDetected()
{
  Serial.println("Beat Detected!");

}
void setup()
{
  Serial.begin(115200);
  ss.begin(GPSBaud);
  Blynk.begin(auth, ssid, pass);
  lcd.clear();
```

```
void setup()
{
  Serial.begin(115200);
  ss.begin(GPSBaud);
  Blynk.begin(auth, ssid, pass);
  lcd.clear();
  lcd.print(0, 0, " CO Monitoring");
  lcd.print(0, 1, " System ");
  pinMode(button, INPUT);
  pinMode(16, OUTPUT);
  pinMode(Buzzer, OUTPUT);
  Serial.println("Calibrating MQ7");
  mq7.calibrate();     // calculates R0
  Serial.println("Calibration done!");
  Serial.print("Initializing Pulse Oximeter..");
  if (!pox.begin())
  {
    Serial.println("FAILED");
  }
  else
  {
    Serial.println("SUCCESS");
    pox.setOnBeatDetectedCallback(onBeatDetected);
  }
```

```
  timer.setInterval(5000L, checkGPS);
  timer.setInterval(1000L, DATATRSFER);
  timer.setInterval(300000L, Hardreset);
}
void checkGPS() {
  if (gps.charsProcessed() < 10)
  {
    Serial.println(F("No GPS detected: check wiring."));
    //Blynk.virtualWrite(V4, "GPS ERROR");  // Value Display widget  on V4 if GPS not de
  }
}

void loop()
{
  while (ss.available() > 0)
  {

    // sketch displays information every time a new sentence is correctly encoded.
    if (gps.encode(ss.read()))
      displayInfo();

  }
  pox.update();
  Blynk.run();
```

BPM_CO §

```
{
  BPM = pox.getHeartRate();
  SpO2 = pox.getSpO2();
      if (millis() - tsLastReport > REPORTING_PERIOD_MS)
  {
    Serial.print("Heart rate:");
    Serial.print(BPM);
    Serial.print(" bpm / SpO2:");
    Serial.print(SpO2);
    Serial.println(" %");

    tsLastReport = millis();
  }
}
void displayInfo()
{
if (gps.location.isValid() )
  {
  float latitude = (gps.location.lat());     //Storing the Lat. and Lon.
  float longitude = (gps.location.lng());
  Blynk.virtualWrite(V9, String(latitude, 6));
  Blynk.virtualWrite(V10, String(longitude, 6));
  myMap.location(move_index, latitude, longitude, "Our_Location98");
  }
```

```
  CO = mq7.readPpm();
  // Serial.print("PPM = "); Serial.println(CO);
  //Serial.println("");   // blank new line
  while (digitalRead(button) == HIGH && pox.begin())
  {
    if (CO > 25)
    {
      digitalWrite(Buzzer, HIGH);
    }
    else if ( CO > 300)
    {
      digitalWrite(Buzzer, HIGH);
    }
  }

'oid DATATRSFER()

  sensorBPM();
  MQ7sensor();
  Blynk.virtualWrite(V1, BPM);
  Blynk.virtualWrite(V2, SpO2);
  Blynk.virtualWrite(V3, CO );
```