RASPBERRY PI BASED CYBER PHYSICAL SYSTEM FOR VEHICLE MONITORING OVER INTERNET

BY

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ABSTRACT

This paper is about an embedded system design and a development project for academic purpose. The project will offer the methodology, concept, design and development flow of an embedded system to students who are interested in it. This will be practiced by the building of an embedded system using a mini computer. Since Raspberry's technology is well suited for beginners and students to learn and practice building a simple system, it is therefore implemented in the project by the use of Raspberry Pi 3B+. From a design perspective, the emphasis is on the embedded system design process. The design flows start by problem abstraction, hardware – software architecture, system related family of design referencing, modular design, software mapping, user interface design and refinement. It is crucial to abstract the problem and uses the appropriate hardware and software to create a system that truly solves the problem. Emphasis is also made on the importance of designing the PCB's board for hardware components to be shouldered on and connects to the computer. Therefore, an EDA tool such as EAGLE which is used in this project is important in incorporating into the design flow and aids the system to have a low noise and interference, ease of testing and repair plus compact design. With the help of an EDA tool, the project outcome will be sleeker and easier to have a checkup on sensors and connections and also for aesthetic purposes. Moving on, the system will have to connect to a platform, mobile application in this case, to transfer and store data collected from the sensors. The platform will be able to display the data for users to refer. With each type of data collected such as temperature, humidity and gas quality, it is displayed in the app with texts and numbers. For latitude and longitude, the platform will be displaying them with a map and pin widget for users to refer. It is done so to ease the users to understand the condition inside the vehicle and also the whereabouts of the vehicle. With the display features designed and completed, the alarm features have to be implemented to alarm users when there is a dangerous event occurred inside the vehicle. The system is built to have a buzzer and will buzz when there are unwanted events happened like high temperature, high humidity and dangerous gases detected when users is in the vehicle. When the users' parked vehicle is moved, the platform should also send a message through notification on users' phone to alert them that their vehicle is moved and there is a possible vehicle theft happening.

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V	Voltage
mm	milimeter
GHz	Giga Hertz

LIST OF ABBREVIATIONS

AC	Air Conditioner
ADC	Analog-to-Digital Converter
BT	BitTorrent
CAGR	Compound Annual Growth Rate
DC	Direct Current
DSI	Display Serial Interface
FICT	Faculty of Information and Communication Technology
GPIO	General-Purpose Input/Output
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System for Mobile communication
GUI	General User Interface
HAT	Hardware Address Translation
HDMI	High-Definition Multimedia Interface
IoT	Internet of Things
JSON	JavaScript Object Notation
NS2	Network Simulator 2
OBU	On-Board Unit
OEM	Original Equipment Manufacturers
OS	Operating System
PCB	Printed Circuit Board
SUMO	Simulation of Urban Mobility
SVMS	Smart Vehicle Monitoring System
UART	Universal Asynchronous Receiver Transmitter
US	United State
USB	Universal Serial Bus

Chapter 1

Introduction

This section will discuss the motivation and background of my research, the contribution to the field and the thesis plan.

1.1 Problem Statement and Motivation

Nowadays, car theft is a thing not only in Malaysia but is happening globally. [1] showed that a rate of 246.0 per 100,000 people's motor vehicles were stolen in 2020 and is the peak rate since 2009 in the US. A reason for vehicle theft is to scrap off the parts as stated by [2]. As prices of OEM and aftermarket vehicle parts are becoming more valuable in the markets, the rate of car theft will also be increased.

Figure 1.1 is the graph of Asia Pacific Automotive Aftermarket size value expected expansion at a CAGR of 3.8% starting from 2021 to 2028 based with the actual value of expansion on 2018 to 2020.

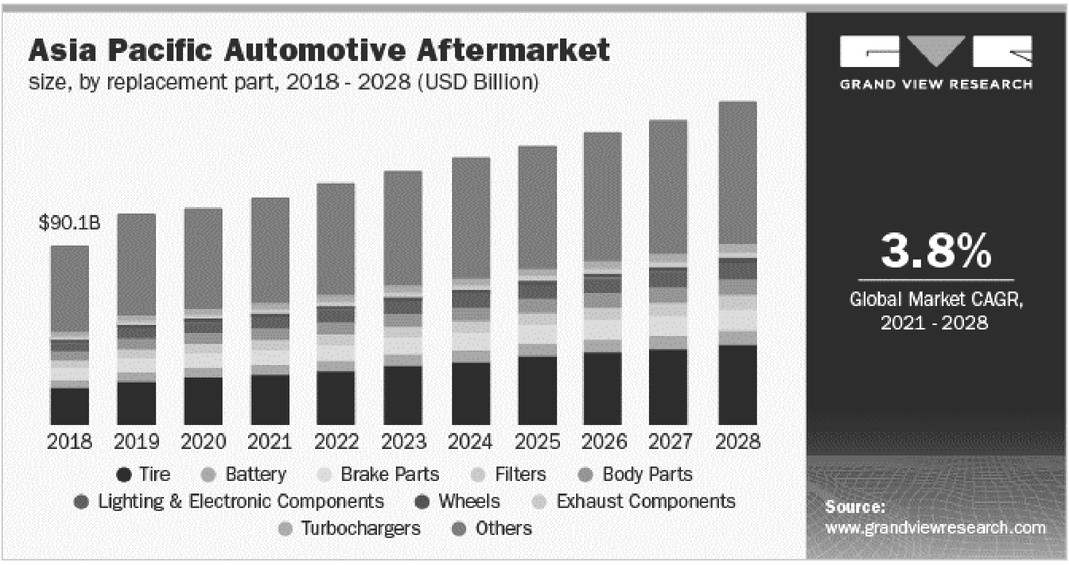

Figure 1.1 Graph of Asia Pacific Automotive Aftermarket size

A report by [3] researched that an expected expansion of CAGR of 3.8% on the market size value of aftermarket parts globally by researching historical data from 2017 to 2019. Furthermore, the deaths from carbon monoxide in the car is also growing tremendously over the years.

Carbon monoxide is a harmful gas and is difficult to detect without any detector. The cause of carbon monoxide leakage can be from the vehicle's air conditioner where carbon monoxide produced from the engine can be entered. When a human inhaled such poisonous gas, [4] stated that one will show symptoms of headache, nausea, vomiting, fatigue and dizziness as one's body will start to feel weak due to lack of oxygen in the body. [4] also mentioned that prolonged seizure confusion, disorientation, visual disturbance and fainting and would also cause blood vessels in the eyes to burst open with the medical term as retinal hemorrhages. Moreover, the case of having a hot temperature in the vehicle is a hazardous warning when there are flammable items in the vehicle which will eventually causes a vehicle fire. Research done by [5] stated that 16% of 1.3 million fires reported to US fire departments is accounted by vehicle fires. [5] also revealed that 15% of vehicle fire caused deaths and 10% of it caused injuries.

Figure 1.2 is the graph of highway vehicle fires by leading item first ignited from the year 2013 to 2017. Flammable or combustible liquid, gas filter or piping has the highest car fire death than other leading item categories.

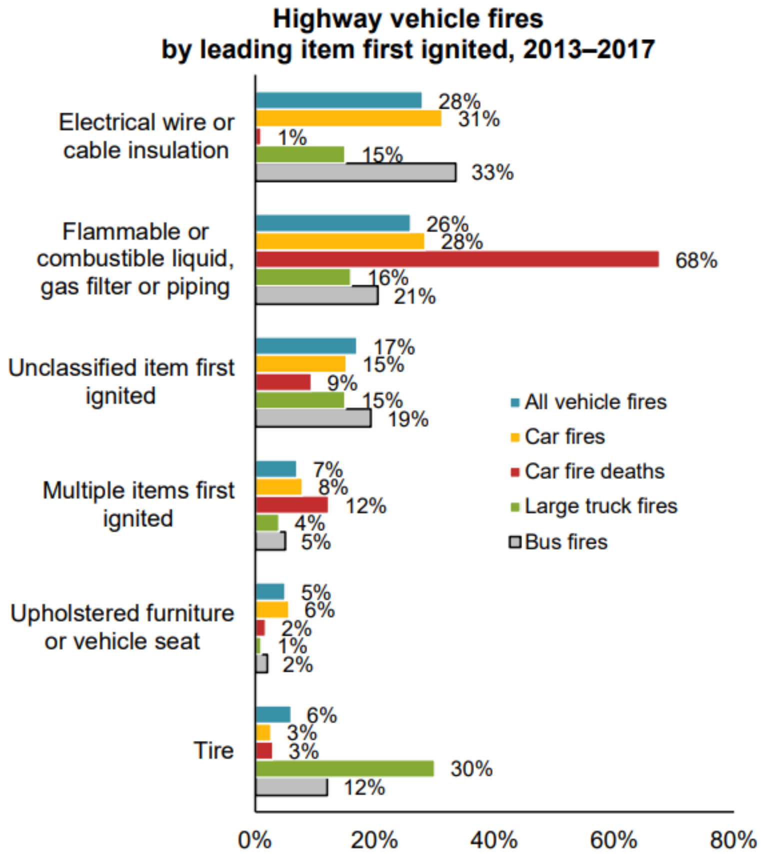

Figure 1.2 Graph of highway vehicle fires by leading item first ignited

From figure 1.2, the graph has shown that there are 5 types of leading ignition item and the most lethal is flammable or combustible liquid, gas filter or piping. It has a shocking 68% of death rate from vehicle fire than other groups of items. Moreover, fogging of mirror is also an issue as driver has a foggy vision and may cause an accident due to it. A fog can be formed because of the water molecule in the air with the temperature drops to a certain degree for vapors to condense and form fog on the windshield at the front or behind it. To prove it, a study from [6] mentioned that the fog is caused by the condensation of warm and humid air inside the car in contact with the cold windscreen. The fog will block off the vision of driver and eventually may cause an accident.

Hence, a vehicle monitoring system is needed to solve these problems detailed above. As vehicle monitoring system is rarely or maybe none being implemented by popular car brands like Toyota, Volkswagen, Mercedes Benz and many more, a vehicle monitoring system is needed to ensure the safety and the assets of the users. The intention of the idea is to recommend and create a prototype for cyber physical system for online vehicle monitoring using Raspberry Pi. Although users are away from their vehicle, the system should still be monitoring the vehicle and will send data to the users over internet. Alert signals will also be implemented to signal users when they are in the vehicle to avoid any dangerous events from happening such as ignition or carbon monoxide leakage. Car theft and a fogged-up mirror will also be prevented as there is any suspicious change of data is detected.

1.2 Objectives

The goal of this project is to develop a Raspberry Pi based cyber physical system for vehicle monitoring over internet. The system will have various functions such as temperature monitoring, humidity monitoring, air quality monitoring and GPS tracking. These data will be sent to Firebase to updates and stores the data. For display, a mobile app is developed to display data like temperature, humidity, gas quality and location to the users. The system should always monitor the environment in the vehicle when it is powered on and should not be turned off unless there are no power supplied. The system has to have an alert system built in as well. Thus, the next aim of the project will be developing an alert function into the system. With data collected from the Raspberry Pi, the mobile app should alert users when there are any unexpected changes of value or even abnormalities in the vehicle, such as when temperature too cold, humidity too high, location changed and so on.

1.3 Project Scope and Direction

The scopes of the project include the development of a functional vehicle monitoring system to monitor the vehicle over internet and a development of a platform which is a mobile application. Firstly, the scope is to develop a functional online vehicle monitoring system with several common functions. Functions such as temperature monitoring, humidity monitoring, air quality monitoring and location monitoring inside the vehicle are implemented in this system but not in the engine compartment as there are already have sensors, alerting system and countering system from the manufacturers. With the system going online, the system will be sending data to a database platform such as Firebase. Next, a mobile application is created and designed to display the data and location to the users. The system also should inform users when there is an unfamiliar reading or data received.

With this scope specified above, the direction of this project is to reduce the number of casualties in a vehicle fire and carbon monoxide poisoning, the probability of vehicle fire and carbon monoxide leakage occurs and to help retrieving stolen vehicle which the vehicle has this system implemented. The system aims to benefits people from its functions and avoid casualties from vehicle fire and carbon monoxide poisoning which is hard for drivers to be noticed when driving or not. It is also aiming to reduce the case of car theft or in the case when users have forgotten where their cars have parked at by having the function to monitor the whereabouts of their cars.

1.4 Contributions

The significance of vehicle monitoring/tracking system has been increasing in this modern era as stated by [7]. Therefore, vehicle monitoring system is needed to be improved and will be shown through this paper. This testing and developing will confirm the feasibility of the proposed cyber physical system for online vehicle monitoring features. Firstly, temperature readings will help users to identify any chances of ignition in the vehicle. This scenario will happen if there are any flammable item like alcohols or anything that can refract light such as a store-bought mineral water bottle to start a fire like a magnifying glass did and this feature will surely help to prevent such scenario. Moreover, the temperature reading can help users who hate hot weathers as their vehicle inner temperature is hot. Users can know the temperature of the vehicle and turn on the AC first until the temperature goes down before going into the vehicle. Secondly, humidity sensors' functionality shines utterly when it is rainy day. During rainy days or raining seasons, the humidity in the car can be above normal and the mirrors will be fog up that blocks the drivers view which will cause an accident. Hence, with this, users can keep track of the humidity in the vehicle cabin and can go for a check-up by a car mechanic to look for faulty in the AC system. Thirdly, a GPS tracker is to keep track of the exact location of users' vehicle. Users might have their vehicle stolen as some popular vehicle has a high demand and prices and this GPS tracker will help users and police to have a high possibility to track down the stolen vehicles. In another example of uses, the GPS tracker can be used by users to track where their car parked as there are users who are forgetful. Last but not least, air quality monitoring helps users to monitor the air quality of the vehicle cabin. Hazardous gases and alcohol will be detected by the sensor and will inform users about it to keep chances of accidental death in the cabin and drunk driving to as minimum as possible. The sensor also has a function of detecting early fire. Thus, the system aims to benefits the society through decreasing the chance of having a car incident like vehicle theft, vehicle fire, carbon monoxide poisoning and fogging of windshield. With the chance decreased, the probability of death in vehicle incident is also decreased.

1.5 Report Organization

Beginning with Introduction as Chapter 1, the project is divided by 7 chapters which is Literature Review, System Methodology or Approach, System Design, System Implementation, System Evaluation and Discussion and lastly Conclusion and Recommendation. Introduction, which is the opening section of this development, contains the problem statements and motivations, objectives, project scope and direction, contributions and also report organization. The literature review carried out on several existing smart vehicle monitoring systems by several researcher and developers which is the second chapter will be used to evaluate and referenced to make the system better.

For Chapter 3 and 4, it will be about the preparation of the project before proceeding forward. In Chapter 3, a method or approach is proposed so that the project has a fixed direction to work on. A fixed direction of working can save a lot of time when developing the system and has a clear view on how the system works at the end. For instances, it comprises of activity diagram, system architecture diagram and use case diagram which illustrates the way of how the system works. In Chapter 4, it is another preliminary work that prepares how the system should be looking like and what hardware are needed for the system. A block diagram is drawn and components specifications are mentioned. Circuits and components design will also be displayed to show how the system's components are connected and system components interaction operations are also mentioned to show how the does the components interact with each other.

For Chapter 5 and 6, it will be the showcase of the system and evaluation of the system. Chapter 5 will be showing how the system looks and indicates the problems and obstacles faced. While Chapter 6 will be the evaluation of the system. There will be some testing done and evaluate the whole projects. Lastly, Chapter 7 will be the final chapter of this project. This chapter will be about the wrap-up of the whole project and also recommendation given to improve the project in the future.

Chapter 2

Literature Review

2.1 Existing works on Vehicle Monitoring System

2.1.1 IOT Based Smart Vehicle Monitoring System

Figure 2.1 shows the overall architecture of SVMS framework done by [5].

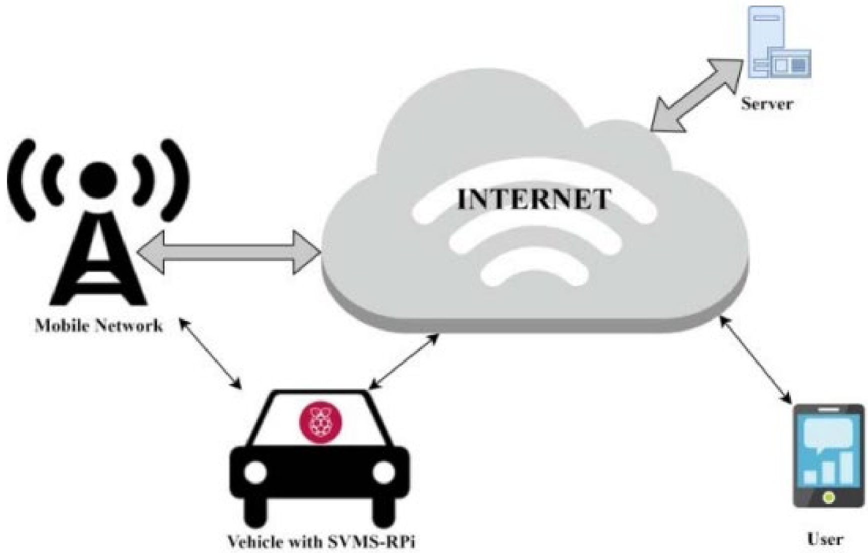

Figure 2.1 Overall Architecture of SVMS Framework

[8] proposed a development project SVMS which is IoT based. The SVMS is developed using Raspberry Pi with sensors for early accident detection. Machine learning based also be used for image classification to find the severity of the accident. Vehicle location is also been tracked through cellular network with the help of GPS and GSM. The system's framework is designed to immediately detect accidents with severity, help user to remotely shutdown the vehicle during theft and allows user to locate vehicle position globally. The SVMS is a success as the promised function proposed has promising outcomes when testing.

2.1.2 Smart Vehicle Monitoring and Assistance using Cloud Computing in Vehicular Ad Hoc Networks

Figure 2.2 shows the flowchart diagram of OBU of the Smart Vehicle Monitoring and Assistance using Cloud Computing in Vehicular Ad Hoc Networks

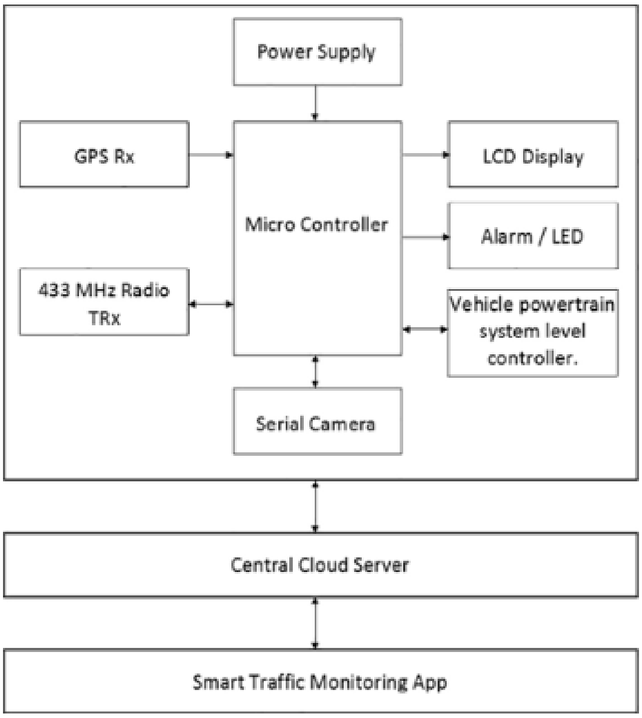

Figure 2.2 Flow chart diagram of the OBU

[9] proposed a vehicle monitoring system simulated in SUMO and NS2 with 6 functionality which is speed-based lane changing, collision avoidance, video or photo surveillance, vehicle or accident detection, time of arrival-based localization and broadcasting emergency messages. For the algorithm, it is designed to facilitate all those mentioned functions and are divided into 3 parts based on the platform and application used. The microcontroller used will be PIC6P877A with a 9600bps GPS receiver, 433MHz radio transceiver and serial JPEG camera interfaced to it. An interface for mobile app is also created which can interact with the hardware to be used for remote and mobile traffic monitoring. The system is then developed, tested and analyze and resulted to be a promising success for the project.

2.1.3 Internet of Things based Vehicle Monitoring System

Figure 2.3 shows the system design of the proposed system. It consists of a microcontroller and a GPS & GSM/GPRS module. The parameters are sent to the microcontroller and the IP is later sent to a server to record.

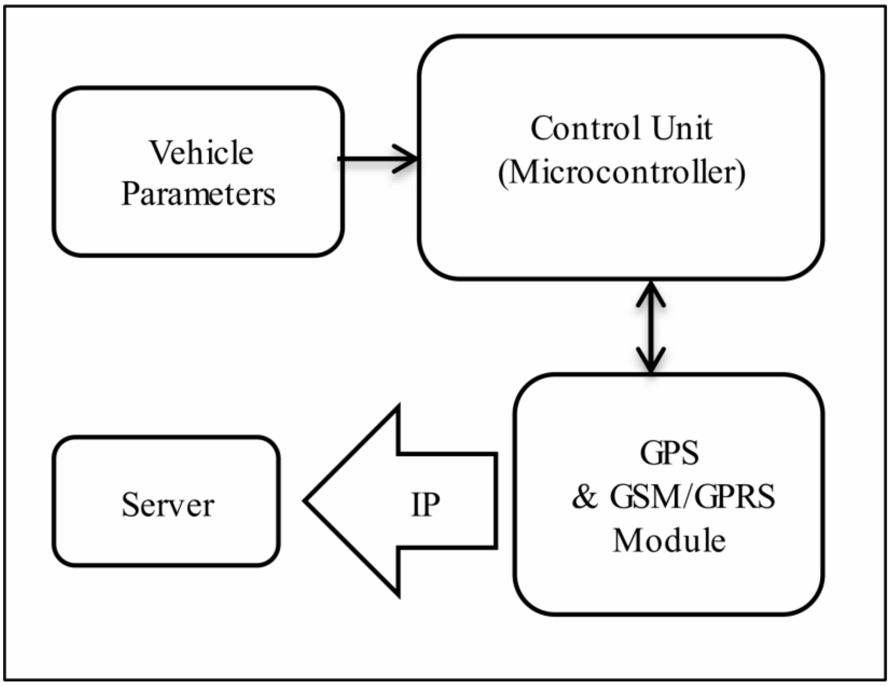

Figure 2.3 Proposed system for vehicle tracking/monitoring

[10] has proposed a vehicle monitoring system using IoT. The objective of this designed system is for testing of vehicles that help R&D team in automobile industries for design validation of the vehicles. Several outdoor tests were performed on vehicles and parameters are observed. The tests include speedometer and odometer calibration, average fuel consumption, temperature mapping for engine compartment and endurance running. The system involves a microcontroller which is Arduino and a GPS+GPRS/GSM module, SIM8o8. The outcome of the system consists of the vehicle location, vehicle speed, temperature of engine compartment and many more.

2.2 Strengths and Weaknesses

2.2.1 IOT Based Smart Vehicle Monitoring System

IoT is a current trend for devices as it connects to the internet for all the things. The strengths in this system are that it has features for vehicle condition detection and vehicle control. Features like web server is used to turn on or off the fuel relay switch in the vehicle and to show the current location of the vehicle in Google maps. The previous locations are also been stored in the web server. Severity detection, accident detection and the most important features is the vehicle control. User is able to shut down the vehicle fuel system and hence secure their vehicle. The result from this system is also promising with great results.

However, this development of the system has several weaknesses. One the most, environment monitoring inside the vehicle were not cover in the previous studies by [8]. It has done location tracking and speed monitoring as a common function but temperature, humidity and air quality monitoring are not included in the project development. These parameters monitoring is crucial for driver's safety and convenience as these parameters will cause deteriorate the driver driving condition. Furthermore, an application was not created for the system for user as it only creates a website. A mobile application for user to monitor what is the current reading of data and alert user when the reading changes or is above or below the acceptable range of values is needed as user does not open the website all the time. An application can send notifications even it is not used.

2.2.2 Smart Vehicle Monitoring and Assistance using Cloud Computing in Vehicular Ad Hoc Networks

For this system, it has the strengths by writing their algorithm in the report and there are 3 algorithms. There are assumptions made before writing its 3 algorithms. Assumption like all vehicles have the system installed and have subscription to the service, can be accessed by registered authorized people, emergency vehicle has the highest priority and so on is made to configure the algorithm. The algorithm is then used as how the system generally works. Each algorithm is responsible for each function like mobile traffic monitoring. There are also applications being made for users to be used.

Nevertheless, this system has several weaknesses. One of the weaknesses is that environment monitoring inside the vehicle were not cover in the previous research by [9]. The study has done functions like speed detection, vehicle detection, location detection and so on but temperature, humidity and air quality monitoring are not included in the project development. These data monitoring is crucial for driver's safety and convenience as these parameters will affects the driver driving condition. Furthermore, cloud server is easy for hackers to be hack inside. In the studies, there are no counter techniques used to prevent attackers to modify the data. Hence, the system can be attacked by attacker easily

2.2.3 Internet of Things based Vehicle Monitoring System

In this study, the strength is that 1 minicomputer and 1 module is used for this system which is Arduino and SIM8o8 and is simple to have all the products needed. With this said the time used for hardware testing will be short as less hardware is used. Arduino MEGA 2560 controller board is used specifically in this project because it has an 8-bit controller chip. It is used as a microcontroller in the system which is the central brain of the structure. While SIM8o8 is used as a sub controller of the system. It is integrated with high performance GSM/GPRS engine, GPS engine and BT engine. The module is combined with GPS technology for satellite navigation. Hence, 1 module is only needed for the system to have the functions required for the system.

Though, this system has a weakness and it is due to the strength mentioned above. The weakness will be the lack of functions for the system. The system is only designed to record data engine compartment only. No monitoring of other elements like temperature, humidity, gas quality and so on to monitor the environment of vehicle. To protect users from accident and to help R&D team in automobile industries for design validation of the vehicles, inner vehicle condition should also be monitored to let users have a more pleasant drive.

Chapter 3
System Methodology/Approach

3.1 System Design Diagram

In this section, the preliminary idea of the methodology for the system is proposed. The idea is presented in diagrams for easy understanding which consists of use case diagram, system architecture diagram and activity diagram. Each diagram will have its own purposes and is explained in the description in each subchapter.

3.1.1 System Architecture Diagram

Figure 3.1 shows the diagram of the proposed structure's architecture. The system architecture diagram shows that the Raspberry Pi is interacting with Firebase and Firebase is interacting with mobile app.

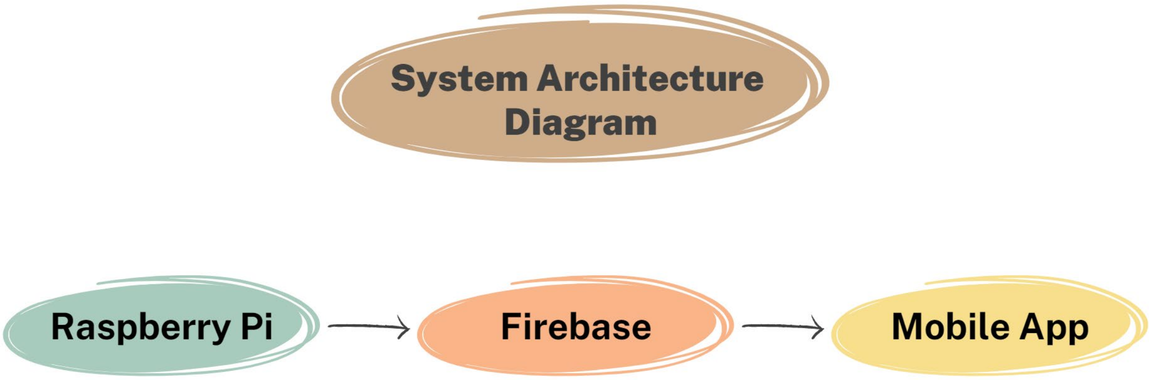

Figure 3.1 System Architecture Diagram

The visual representation of a system's structure or behaviour is called an architecture diagram. This will help the report to be more transparent and more understandable when reading through. In this project, the system architecture diagram is shown as figure 3.1 above. Raspberry Pi is first interacting with Firebase as it needs to upload the data collected from various sensors or hardware to Firebase through the internet. Then, Firebase will read the data and stored it inside a real time database. Lastly, Firebase will interact with mobile app to display the data to users. The mobile app will read the data from Firebase and display it in a simple way for users to view.

3.1.2 Use Case Diagram and Description

Figure 3.2 shows the diagram of the proposed structure's users' use cases. The use case diagram shows how the user will be using the system.

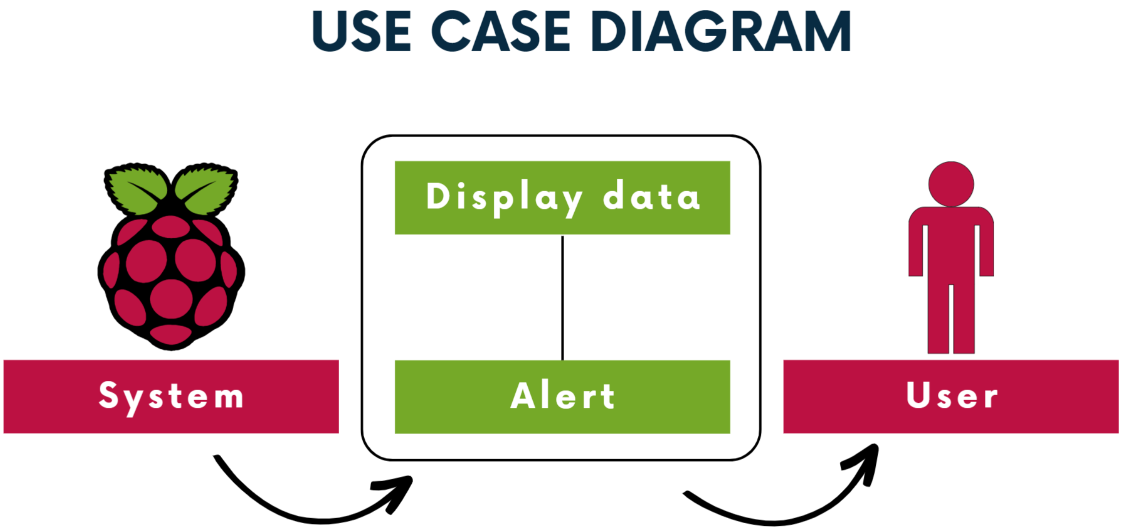

Figure 3.2 Use Case Diagram

A use case diagram will be showing the description of how a user interacts with a system. In this project, the use case diagram is shown in figure 3.2. From figure 3.2, user will not interact with the system or in another term will be not giving instructions to the system to operate certain functions. The system will only operate in a fixed way unless there are no power supply to the system. From the system side, the system will operate in a way of collecting data and display data to users. When the system has detected abnormalities, the system will be able to notify or alert user of the abnormalities happened. Looking at the user side, user will only need to view the data from the system. When abnormalities happened, user will be notified and is able to view such abnormalities in the mobile app. User will not be able to interact with the system to do any functions.

3.1.3 Activity Diagram

Figure 3.3 shows the activity diagram of the proposed system. The activity diagram will be a flowchart of how the system works from the start to the end user. The flowchart will begin from Raspberry Pi to Firebase then to mobile app for the end user to view.

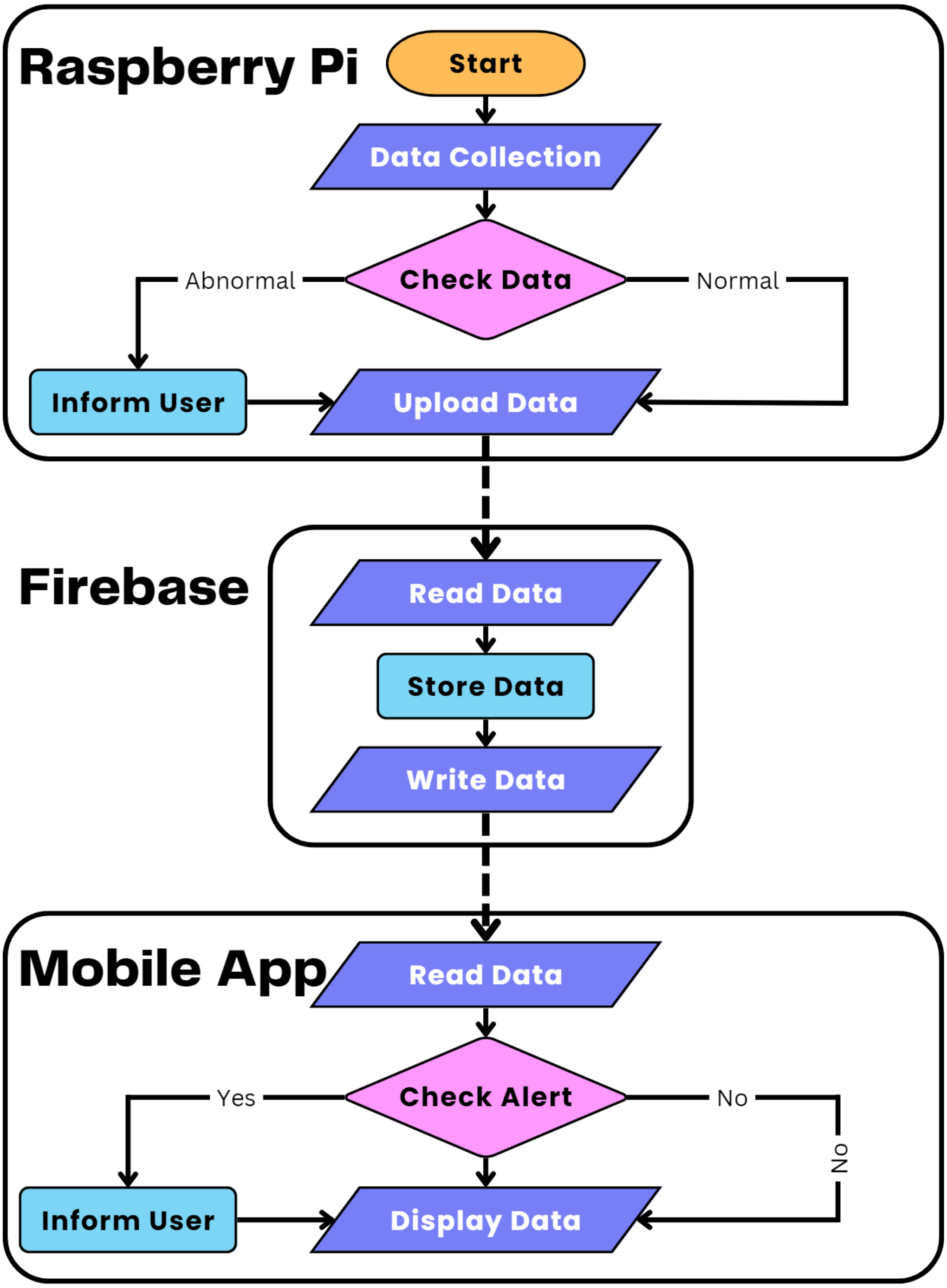

Figure 3.3 Activity Diagram

As for the activity diagram, it is drawn to show the inner activity of the system workflow. The design is presented with the use of flowcharts as shown in figure 3.3. The system will launch the data collection process when it boots up. The system collects the data from sensors and does checking with every data. When there are abnormalities, the system will alert users using sound alerts and upload the data to Firebase. If there are no abnormalities, the system will directly upload the data to Firebase without alerting users. Firebase will store the data in a real time database for further use. A real time database is used to have the speed of uploading data, storing data and reading data from Firebase to be quick. By comparing both the real time database and Firestore, real time data base will be much faster than Firestore which the system required as users will always view the data in real time. Then, the mobile app will request data from Firebase to display real time data. Thus, Firebase will send the data to the mobile app for display. At the mobile app part, the app will then check for any alerts needed to notify the user. If alerts are needed, the app will then send a notification to user for alerts. User is able to tell that they are abnormalities with their vehicle and check through the app.

Chapter 4
System Design

4.1 System Block Diagram

The block diagram of the system will be an illustration of the connection of sensors with Raspberry Pi, Raspberry Pi with Firebase and Firebase with the mobile app. On the hardware side, Raspberry Pi will be connected with all the hardware like sensors, power supply and buzzer then connect to the Firebase through the internet. Firebase is then connected to the mobile app via internet also to send data for display.

Figure 4.1.1 shows the block diagram of the system. Raspberry Pi as the core of the system powered by a power supply connected with several hardware components to supply them power and controls them. Raspberry Pi also connects to Firebase through internet to transmit data. Firebase then sent data to the mobile app to display.

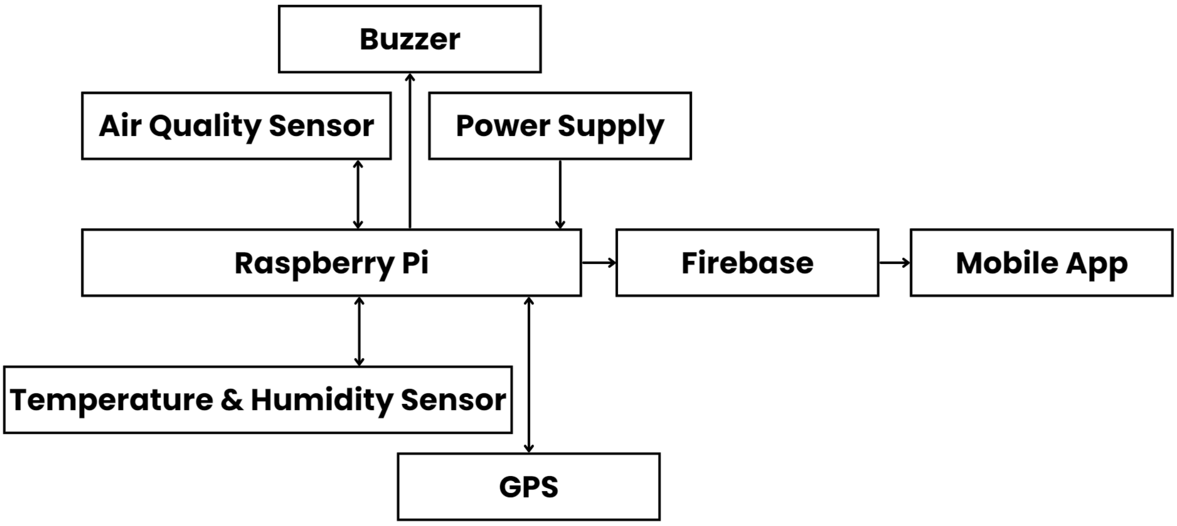

Figure 4.1 System Block Diagram

4.2 System Components Specifications

The components utilized in this development project is an embedded computer named Raspberry Pi, a GPS receiver, buzzer and sensors such as temperature and humidity sensor and air quality sensor. Raspberry Pi acts as the brain of the cyber physical system to controls and monitors the entire system with various sensors attached to it. A GPS receiver, which is a Neo 6M, is used to receive GPS location data for location tracking. Sensors is to sense and transmit data for respective measurement which is temperature, humidity and air quality and each sensors used will be DHT22 and MQ135 respectively. Lastly, buzzer is used to alert users through buzzing. Additionally, a 2x20 pin header will be needed to be soldered on a PCB board as Raspberry Pi will need to supply power to the components as well as reading the data from the components. The specifications for Raspberry Pi and buzzer are shown below while others will be in the Appendix.

Table 4.1 Specifications of buzzer

Description	Specification
Model	Piezo buzzer
Operating voltage	5V DC

Table 4.2 Specifications of Raspberry Pi

Description	Specifications
Model	Raspberry Pi 3 Model B+
SoC type (Processor)	Broadcom BCM2837B0
Core type	Cortex-A53 64-bit (ARMv8)
No. of Cores	Quad-Core
GPU	VideoCore-IV
GPU Clock	1.4 GHz
Multimedia	H.264, MPEG-4 decode (1080p30) H.264 encode (1080p30) OpenGL ES 1.1, 2.0 graphics
Memory/OS storage	MicroSD

RAM	1GB LPDDR2 SDRAM
Ethernet	Gigabit Ethernet
USB port	4 x USB 2.0
Display port	MIPI DSI
Camera port	MIPI CSI
HDMI	1 x full size HDMI
WIFI	2.4 GHz and 5.0 GHz IEEE 802.11b/gn/ac wireless LAN
Bluetooth	4.2 + Bluetooth Low Energy (BLE)
Antenna	PCB Antenna
GPIO	40 pins (fully backwards compatible with previous boards)
OS	Raspbian
Dimension	85mm x 56mm x 17mm
Power input	5V DC via micro-USB connector 5V DC via GPIO header Power over Ethernet (PoE) enabled (requires separate PoE HAT)

4.3 Circuits and Components Design

In this cyber physical system for vehicle monitoring, it has several devices like sensors and GPS to be control by Raspberry Pi and simultaneously ingest data from them. In this development, DHT22 sensor is used for monitoring temperature and humidity, MQ135 for monitoring air quality and Neo-6Mv2 is used as the GPS to monitor the location of the vehicle.

Figure 4.2 The schematic diagram of the hardware system. DHT22 is powered by 3.3V from Raspberry Pi and is connected to GPIO4. For Neo-6M and MQ135 is powered by 5V from Raspberry Pi. Neo-6M's RX is connected to GPIO14 and TX is connected to GPIO15 and MQ135 is connected to GPIO21. Buzzer is not powered by 5V and is powered and controlled by GPIO24. All devices eventually connected to the GND of Raspberry Pi.

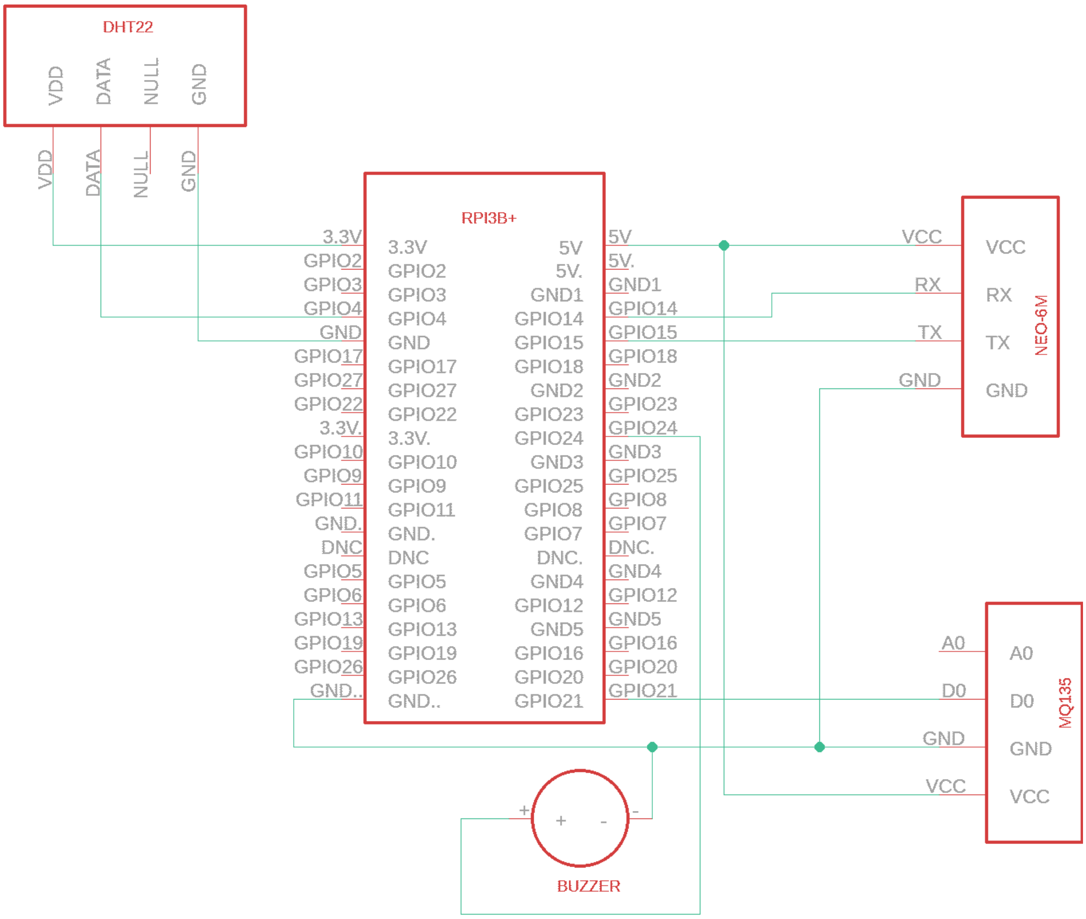

Figure 4.2 Hardware system in schematic form

Figure 4.3 The board diagram is the PCB diagram of the system that stack on top of the Raspberry Pi. Copper wires or air wires is displayed as the blue and red lines that connect to the pins. Blue indicates it is at the bottom layer and red indicates it is at the top layer. There are some via holes in between two different layers lines to help the line transverse the board between two layers.

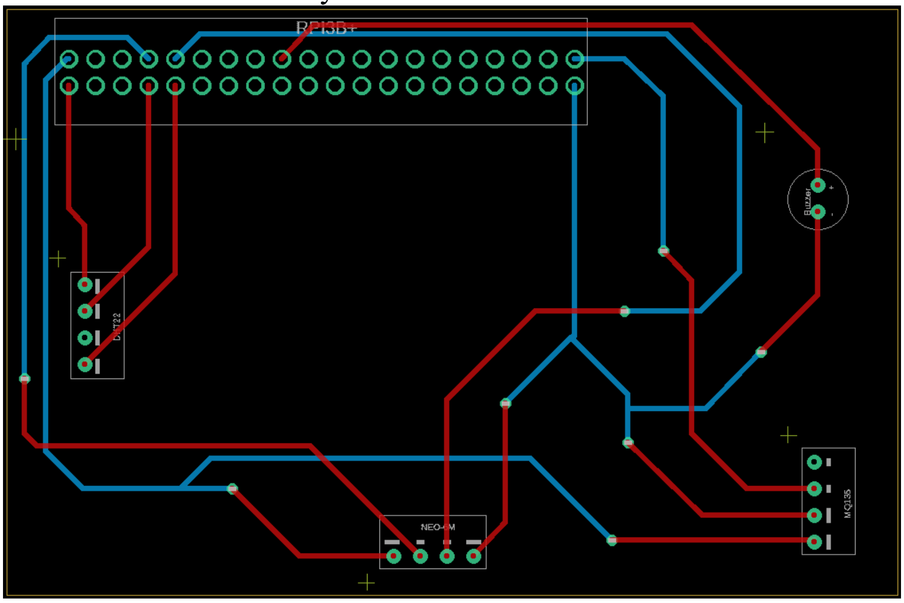

Figure 4.3 Hardware system in board form

By using an EDA tool which is EAGLE in this case, a schematic diagram and a board diagram is designed for a PCB to fabricate and stack on top of the Raspberry Pi. The schematic diagram shown in Figure 4.2 act as a foundation before designing the board. The schematic diagram is designed to show the actual connections for each device and to ease the job later when designing the board. With EAGLE's features, it is easy to switch between schematic and board diagram. Eagle ease the job of designing the route of air wires by having preconnected yellow lines which cannot be deleted and the route of air wires will follow the connection of yellow lines. The yellow lines are connected by referring the schematic diagram and only can be changed through the change of schematic. Hence, the board design is finalized as shown in Figure 3.4. There are lines using the via holes to change layers to avoid clashing with each other on the same layer. All air wires are designed to be on the top layers upon reaching a device as this will help in checking the condition of wires after stacking on top of the Raspberry Pi.

4.4 System Components Interactions Operations

To explain how the system components interact with each other, a clear understanding of roles for each component should be done. The main components of the project will be Raspberry Pi and it acts as the main brain of the system or can be called as the central control of the system. Raspberry Pi will be tasked to control the all the hardware components while accepting inputs from the components. All components will not directly interact with each other and instead they interact only with Raspberry Pi due to the output of the components are digital outputs which can directly become the input for Raspberry Pi as it does not accept analog inputs.

For temperature and humidity data to be taken, Raspberry Pi will be taking them from DHT22 which is a temperature and humidity sensor. The temperature data is taken in degree Celsius while humidity data is taken in percentage with the range from 0 to 100. For gas quality, MQ135 will output a 1 or True when there is not harmful gas or alcohol detected while a 0 or false output represents the existence of harmful gas or alcohol is detected. To get the data for location or latitude and longitude, Neo 6M which is a GPS module that retrieve data from the satellite and output the longitude and latitude to Raspberry Pi. It is a serial data for Raspberry Pi and Raspberry Pi will have the ability to receive it while analyse it with just some configuration on the Raspberry Pi. Lastly, the buzzer is controlled by a GPIO pin from Raspberry Pi. Raspberry Pi will output voltage from GPIO to let the buzzer buzz when abnormalities found.

Chapter 5
System Implementation

5.1 Hardware Setup

Figure 5.1 shows the sensors are connected to the Raspberry Pi through jumper wires and PCB board.

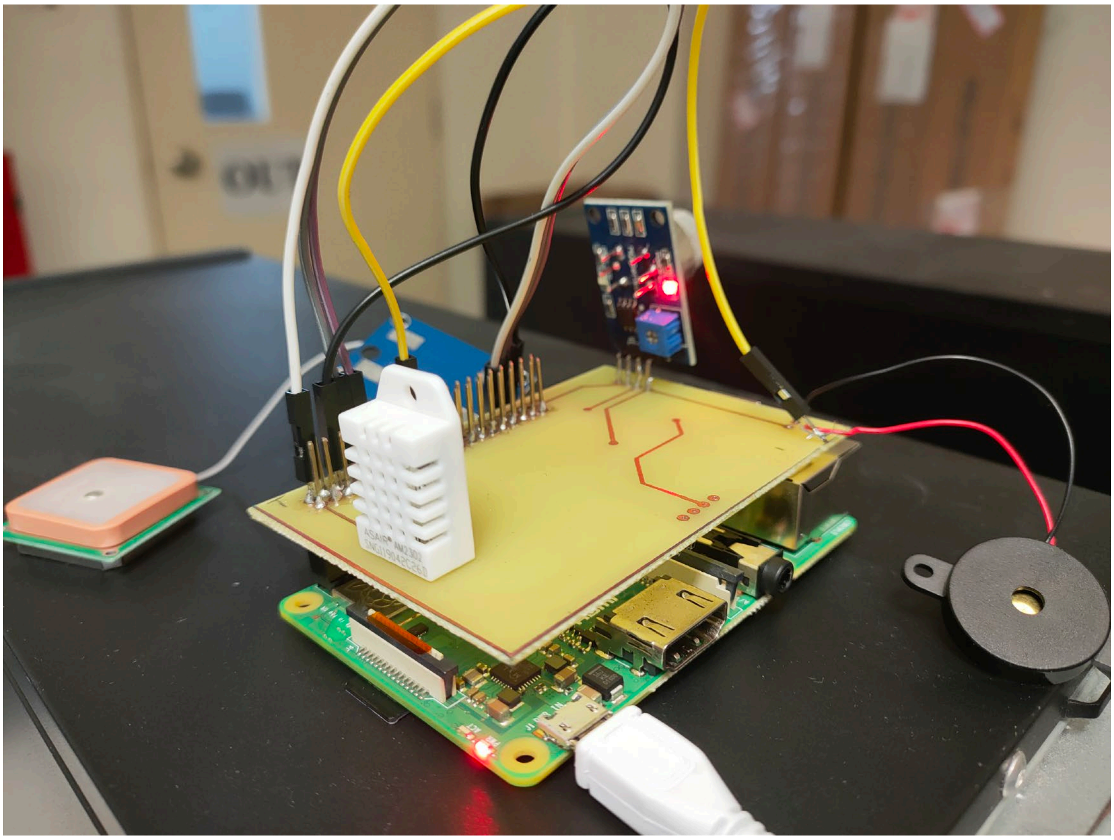

Figure 5.1 Hardware setup

Before proceeding to develop the software for the systems, hardware must be bought from trusted seller. The modules consumed in this project are Raspberry Pi 3B+, DHT22, MQ135, buzzer and Neo-6M. All hardware is connected to Raspberry Pi through a PCB board or a jumper wire. The hardware is all tested using breadboard and jumper wire before mounting on the PCB board. This will ensure the components are all working fine before mounting due to the difficulty of changing components after soldering. The testing phase before mounting will reduce the time after mounting as it just needed to test the connectivity of all components with the Raspberry Pi after soldering.

Figure 5.2 The figure shows the top layer of the exact PCB board fabricated by the lab.

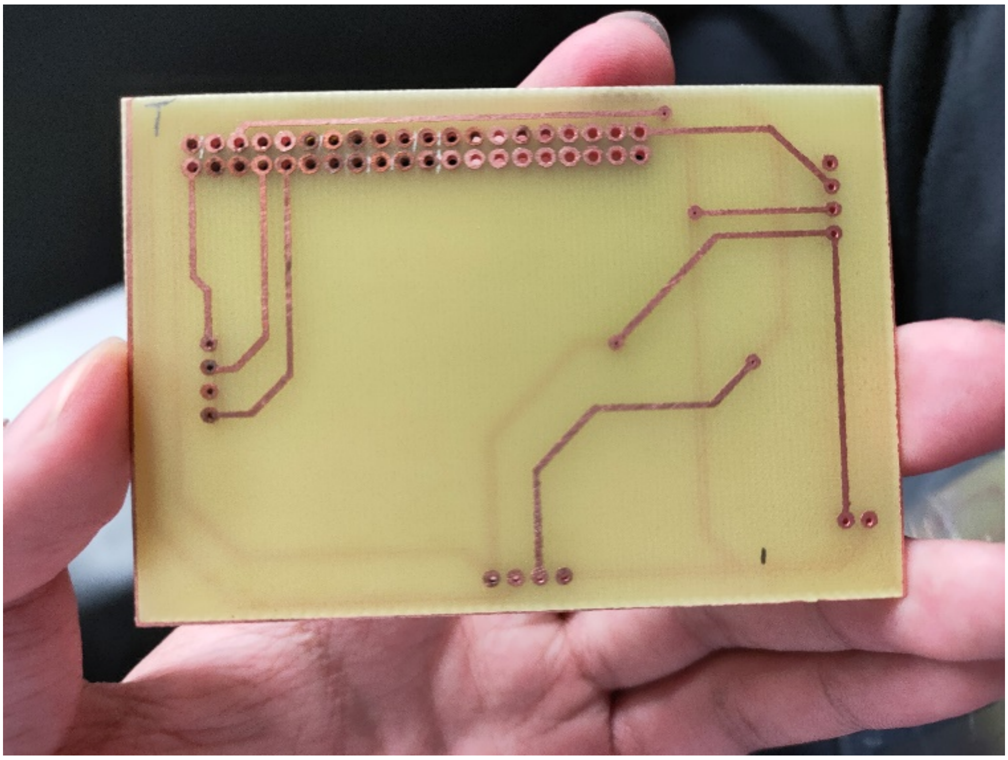

Figure 5.2 PCB board top layer

Figure 5.3 The figure shows the bottom layer of the exact PCB board fabricated by the lab.

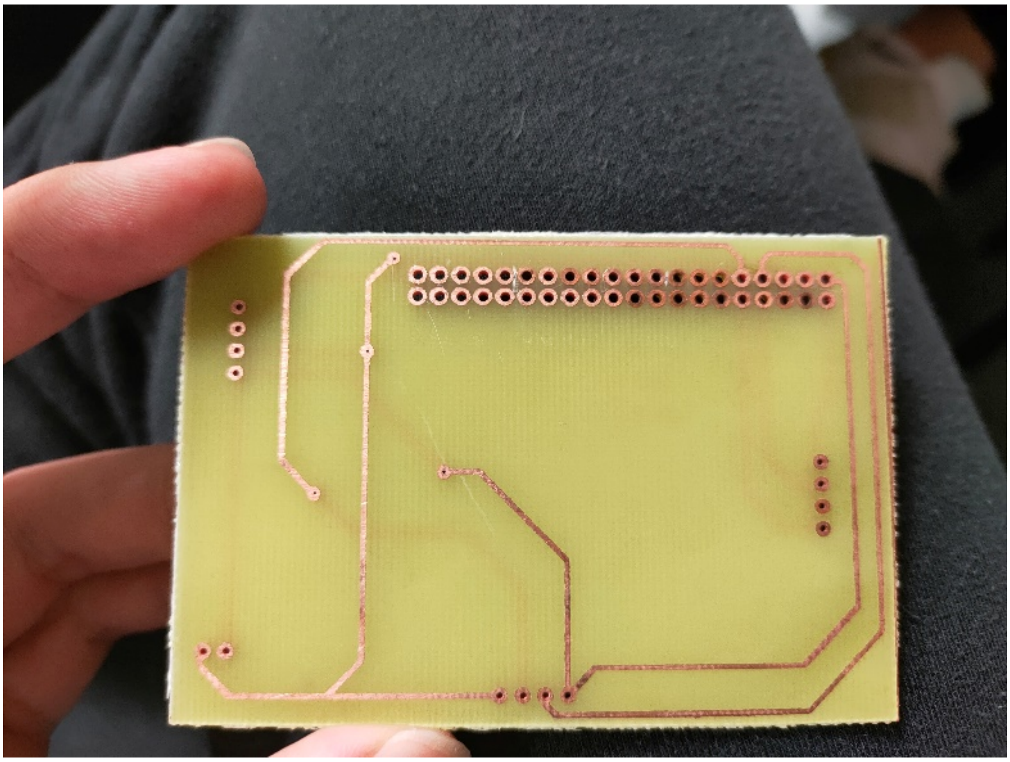

Figure 5.3 PCB board bottom layer

The physical product of the PCB board can be shown in figure 5.2 and figure 5.3. The fabricated PCB board is done by the lab officer using the design shown by figure 4.3. The board is designed using an EDA tool which is EAGLE. The board has taken 2 weeks to fabricate as there are 2 layers of wiring to be done. After retrieving the board from the lab officer, the PCB board is then tested using multimeter for any connection issues. Since there are no big issues with the board, the board is then mounted onto the Raspberry Pi after soldering the components to the PCB.

5.2 Software Setup

The software used in this project will be mainly used for developing the code files for Raspberry Pi to run and developing a mobile application. On the minor side, it will be used to develop a custom PCB board to sit on top of the Raspberry Pi and create a slick look of the whole hardware. The first software used will be Geany. Geany is an open-source text editor came with the Raspian OS that enable users to write, compile and debug code files. Geany is used in the project when developing Python code files in the Raspian Os. The next software used will be Visual Studio Code. It will be used for developing a mobile app for the system to display data and alert users. Visual Studio Code is a editor for source codes and is able to generate and write code files in any programming language. The last software used in the project will be EAGLE. EAGLE is a software capable to generate electronic designs and respective files used. Thus, this software is used to develop a custom PCB board to solder electronics, sensors, pin headers and more on the board. After done setting up the software for designing the system, a mobile app is then designed for data display using Visual Studio Code.

Figure 5.4 shows the home page of the app with data like abnormalities, gas, humidity and Temperature.

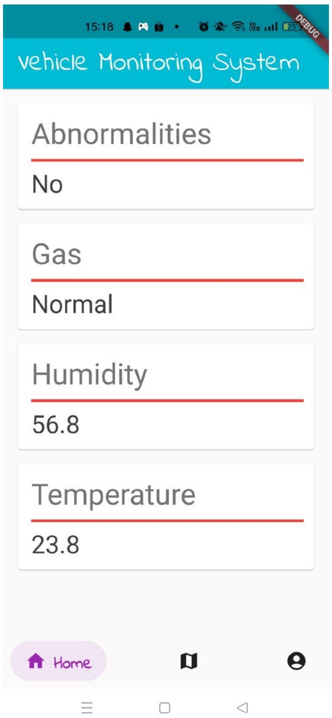

Figure 5.4 Mobile app home page

Figure 5.5 shows the map page that shows the coordination of the system at on a map.

Figure 5.5 Mobile app map page

Figure 5.6 shows the profile page that shows the profile of the user.

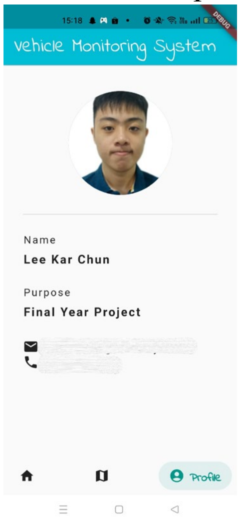

Figure 5.6 Mobile app profile page

From figure 5.4, figure 5.5 and figure 5.6, the mobile app is developed to have functions like data display, map and profile display. On the first page, it will be called as "Home" and it will be displaying the data for Abnormalities, Gas, Humidity and Temperature. Abnormalities and Gas's data will be displaying with words while Humidity and Temperature will be displaying data in numbers and the parameters used will be in percentage and Degree Celsius respectively. For the data of longitude and latitude, the mobile app will be displaying them through a map with a red pointer. The pointer will be pointed at the exact location of the system with the help of latitude and longitude as a reference point. Moving on to the last page which is the profile page, the profile page is a page to display user's information. In this report, the profile page is designed to display the researcher's data and also the purpose of the app while also displaying the email address and phone number at the bottom. This mobile app will be the foundation in the future if there are updates and redesign of the mobile app's GUI.

5.3 Setting and Configuration

To start and progress in this project, there are several settings and configuration that should be done so that everything works smoothly. The first part will be doing configuration on the Raspberry Pi. A SD card that has Raspian OS booted up should be inserted into the card slot of Raspberry Pi before powering up. After that will be a series of configuration of user's preference like device name, password and more. The next thing to do will be importing all the Python libraries used in the project. The Python libraries that should be installed in the device will be time, adafruit_dht, psutil, schedule, serial, pynmea2 and lastly pyrebase. As Raspberry Pi is using UART for serial console, there will be additional steps to shut down this functionality to have the Raspberry Pi to interact with the GPS module. With this done, the Raspberry Pi's configuration is done. To do this configuration, there will be several commands to do it which will be display down below.

Step 1: Access the /boot/config.txt file

sudo nano /boot/config.txt

Step 2: Copy the below code and paste at the bottom of the file

dtparam=spi=on

dtoverlay=pi3-disable-bt

core_freq=250

enable_uart=1

force_turbo=1

Step 3: For safety, make a copy of the /boot/cmdline.txt file

sudo cp /boot/cmdline.txt /boot/cmdline_backup.txt

Step 4: Access and edit the file

sudo nano /boot/cmdline.txt

Step 5: Replace the text in the file with the text below

dwc_otg.lpm_enable=0 console=tty1 root=/dev/mmcblk0p2 rootfstype=ext4 elevator=deadline fsck.repair=yes rootwait quiet splash plymouth.ignore-serial-consoles

Step 6: Reboot the Raspberry Pi

sudo reboot

Moving on to the mobile app, Visual Studio Code have to install Dart extension and Flutter extension to design an app with Flutter. After installation, a mobile phone is used for debugging instead of Android Studio as it needs more configuration for determining which model of phone we are using. So, to debug the designed app with our phone, the phone should open developer mode by tapping 3 times on the build number which can be found at the "About Phone" settings. Then, Firebase should be linked to the mobile app. To do this, an app should be created by typing the command "*flutter create app_name*" in the Visual Studio Code's terminal. After doing so, we can move on to the Firebase website. After logging in, we have to create an android project and find the respective information from the flutter app that was created to be copied and pasted inside Firebase project creation steps. After done so, a guideline will be shown and followed the steps will have the Firebase to linked to the mobile app.

5.4 System Operation

Figure 5.7 shows the Firebase real time database as an example of the type of JSON tree used in the project.

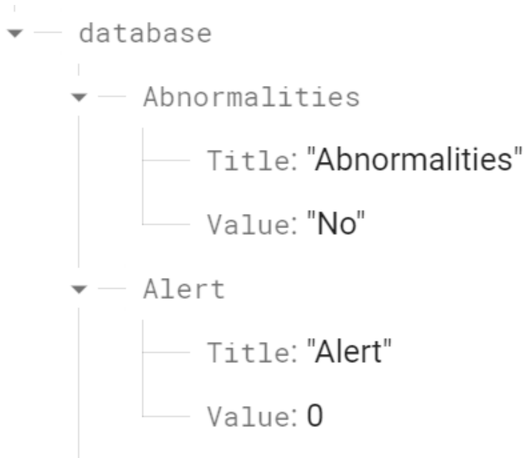

Figure 5.7 Firebase real time database

When Raspberry Pi done its parts of data collection and analysis, it will then prepare the data for upload after checking abnormalities. Data prepared and abnormalities alert will then upload to Firebase's real time database for data storage. The data is stored as a JSON tree with every data type will be stored separately as a JSON tree's child. Figure 5.7 will be an example of the how the JSON tree looks like in the project with every type of data is a child of "database" and there will be 2 child which is "Title" and "Value" for every data type in the JSON tree.

Figure 5.8 shows the example of an error appeared in the mobile app for “Humidity”. This will be an example of how the abnormalities showed for “Humidity”, “Temperature” and “Gas”.

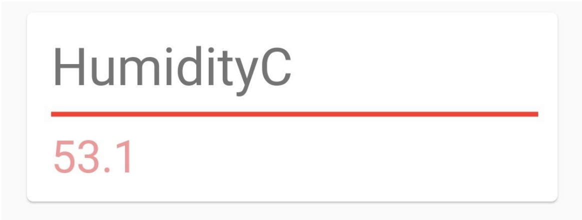

Figure 5.8 Mobile app abnormal data

Figure 5.9 shows the notification of the mobile app when there are abnormalities found by the system.

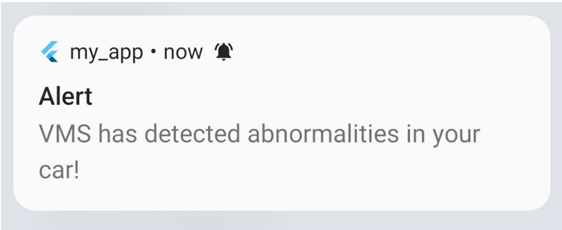

Figure 5.9 Mobile app notification

With the data stored, the mobile app will be reading the data changed in real time and changed the displayed data to users. The mobile app will request data in every second and also receive any requests for notification of abnormalities from Raspberry Pi through Firebase. After that, the mobile app will display the data at the home page and at the map page. If there are abnormalities for “Gas”, “Humidity” and “Temperature”, the value showed by the mobile app will be in red indicating which the abnormalities found in the system are. The red wordings in the mobile app is shown in Figure 5.8. For the changed “Latitude” and “Longitude”, the pin on the map page will change respectively to indicate the exact latitude and longitude receive by the system. As such, there will also be a notification from the mobile app to alert user about the abnormalities found which is showed by figure 5.9.

5.5 Implementation Issues and Challenges

With this method is proposed, there are still issues and challenges when implementing this approach. The issue faced will be the finding of a suitable hardware for the project. This project requires hardware like temperature and humidity sensor, gas quality sensor, buzzer and GPS receiver. Another problem is that the PCB fabrication duration has been extended. The machine needs maintenance and has a lot of PCB fabrication needed to be done by the lab officer has eventually delayed the project for some time. Due to the above reasons, the machine has to have maintenance after a few rounds of fabrication. Since there are a lot of requests for fabrication, the amount of maintenance is increased and duration for the PCB fabrication is delayed. Another issue faced in the process will be finding the way to have the data to be retrieved from Firebase correctly every seconds. But along the way, the issue is solved while developing more understanding in Flutter. Lastly, the issue faced in the project will be having the GPS module to function properly. As the GPS is not very sensitive, the GPS needs to be brought to an open field to be usable and is difficult to have it to function in the lab as there are ceilings and roof that blocks out the signals from the satellite.

For challenges, figuring out the pin to be connected is the challenge for this project. It is challenging because connecting the hardware with jumper wires to Raspberry Pi as there is a need to figure out where the pin from hardware is going to which pin from Raspberry pi is hard. If there is any pin is connected wrongly, either Raspberry Pi or hardware will be ruined and needed to be replaced. If worst case happened, both Raspberry Pi and hardware has to be swapped out with a new one. This will slow down the progress and should be avoided under any circumstances. Another challenge in this project will be soldering the pins on to the PCB board especially for the pin header as there are 40 pins to be soldered on. Soldering requires techniques and focus to make sure the soldering is connected to the air wires on the PCB board and also needs to make sure each pin of the soldered components should not be connected with each other. This can be checked simply using a multimeter.

5.6 Concluding Remark

As a short concluding remark on the system implementation, the implementation of the system is a success. The hardware setup is done with no big issues as well as setting up the software. The hardware setup is done with all the components soldered onto the PCB board while the PCB board is mounted on top of the Raspberry Pi. The software setup is just installation of Raspian OS, Visual Studio Code and EAGLE with the design of the mobile app in the project introduced. The mobile app is designed to have 3 pages which are the Home page, Map page and lastly the Profile page with Home page displaying the data for temperature, humidity, gas and abnormalities, Map page displaying a map with a pin to indicate the latitude and longitude while Profile page display the profile of user. For this system to functions as intended, there will be settings and configuration done in the Raspberry Pi, mobile app and also Firebase. All settings and configuration should be done before the designing of the system operation. In system operation, Raspberry Pi will do the data collections and analysis before upload the information to store at Firebase real time database. The mobile app will then retrieve the information from Raspberry Pi to display to users and also pop up a notification if it is needed. While implementing the project, there are also issues and challenges faced. There are no big issues faced as they just need more time to debug and find the optimum solutions for the issues while the challenges are just a representation of lack of experience in working with hardware. To complete this project, there are also further actions to be done which is a testing phase for the whole system to test the performance of the system.

Chapter 6

System Evaluation and Discussion

6.1 System Testing and Performance Metrics

To have a system ready for testing, the methods for testing should be set to have the system perform with how a user normally used it. So, the method for testing should be logical and making sure the system is working like it should. In this case, the testing is done inside the lab. The condition of the lab will be in an enclosed rooms with air conditioners and the entire system including the Raspberry Pi will not be moved. This results in a stable temperature, humidity, gas quality and location which is not suitable for testing to be done. The location is fixed inside the lab as there are constraints by the faculty to not bring the components outside of the lab. Therefore, the system will be tested in the lab by simulating the data in 2 ways. The system will first be tested to be functional by printing out the data in the terminal then the system is tested by altering the data in Firebase to simulate the changes in the mobile app and the appearance of notification. After this has been done, the system will be concluded as functional by having the data uploaded to Firebase for storing and having the mobile app to alert the user and displaying data from the Firebase.

6.2 Testing Setup and Result

Figure 6.1 shows the testing result of the first method which is to test the system is functional by collecting the data from various components.

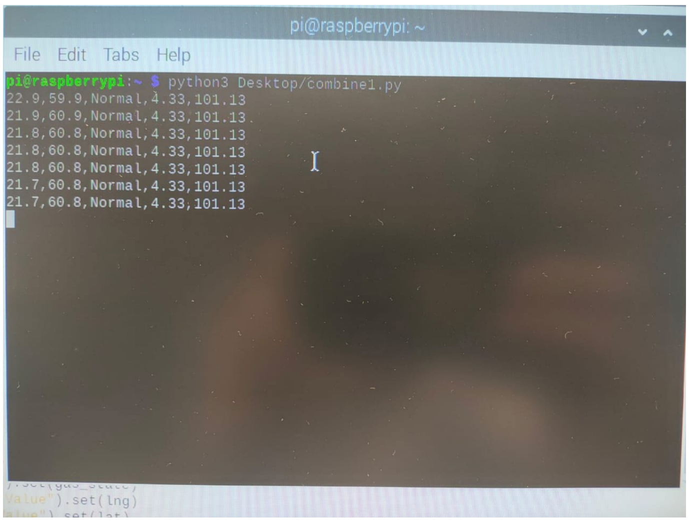

Figure 6.1 Result of first testing method

Figure 6.2 The figure shows the exact MQ135 used. The red LED indicates it is on

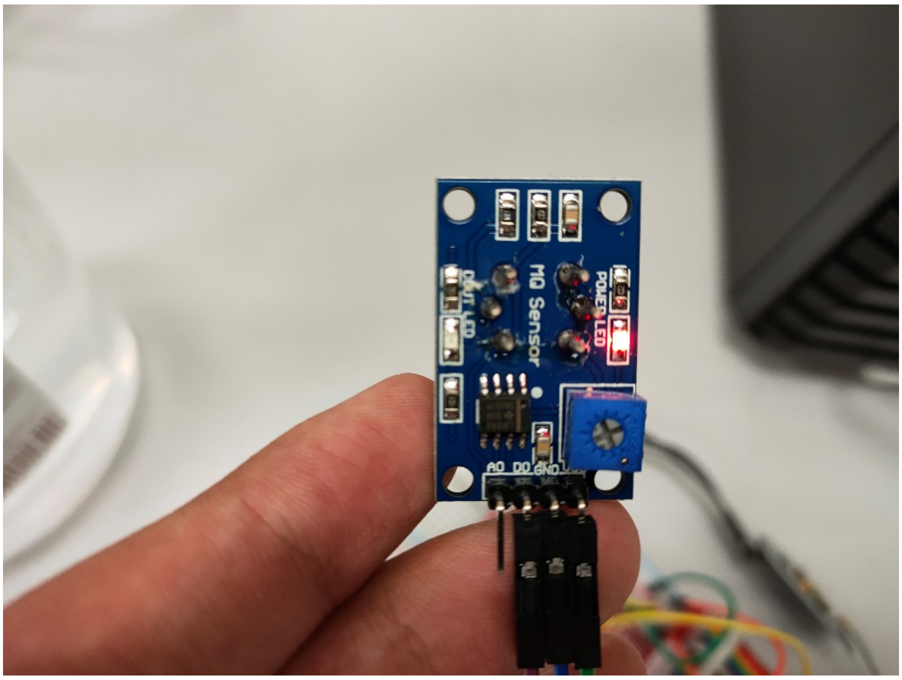

Figure 6.2 MQ135

Figure 6.3 The figure shows the exact MQ135 used. The red LED indicates it is on and the green light indicates it detected dangerous gas or flammable gas.

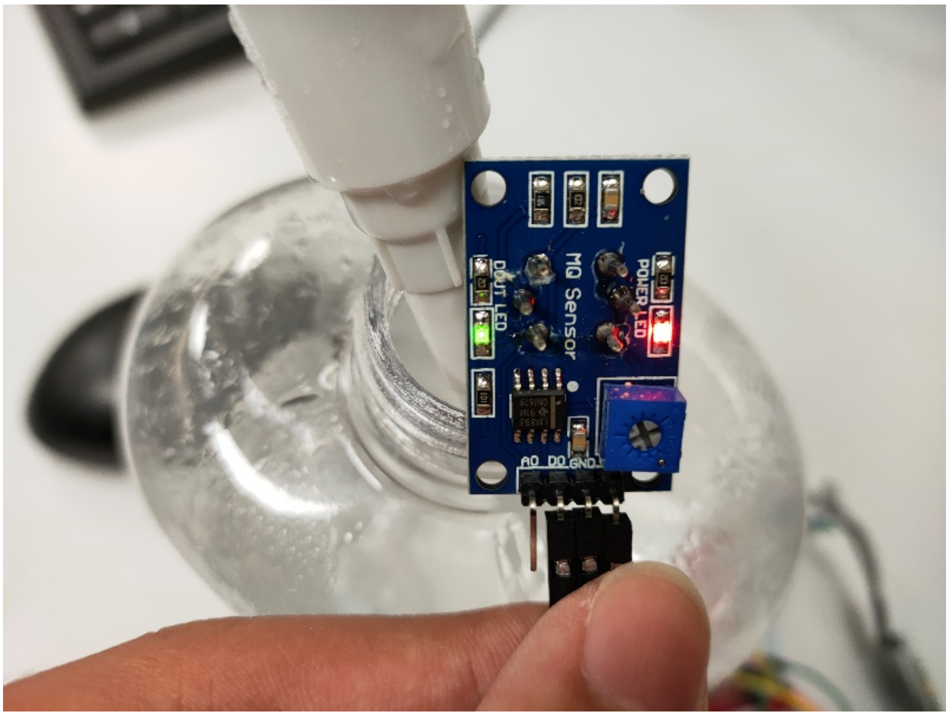

Figure 6.3 MQ135 detected dangerous gas or flammable gas

Figure 6.4 The figure showed is the Google map result of the results received from GPS module. The data received is type in Google map for result. The figure clearly showed that the current position is in the block where the hardware is tested.

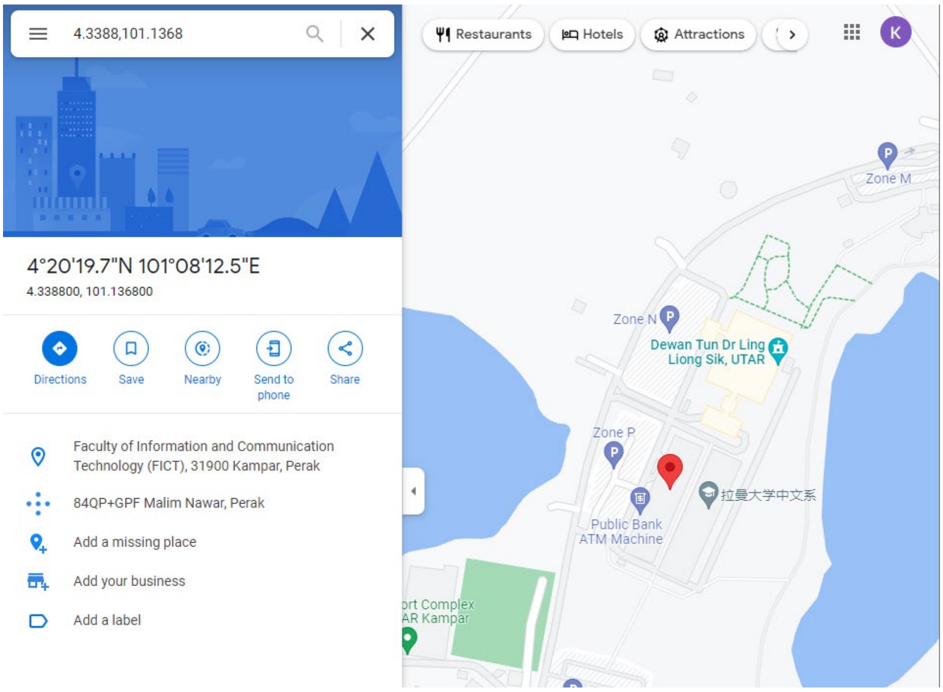

Figure 6.4 Google map result for Neo-6M hardware testing

After determining the methods used for testing, the testing setup will be prepared in a short period of time. First, to tested the system to be functional and the components is sending data to the Raspberry Pi without fail, a “print” is used in the Python code file to print out all the data received by Raspberry Pi as shown in figure 6.1. In figure 6.1, the data is printed out at the terminal by the form of temperature, humidity, gas, latitude and longitude. Then, the testing is then focus to the hardware’s results correctness. From figure 6.2 and figure 6.3, the MQ135 is tested to be working just fine like its intended function. In Figure 6.4, the result from the GPS is then tested to be correct as the testing is done in the lab of FICT and the Google Maps’ pin is also showing the location at FICT. As for buzzer, there are sound coming out from the buzzer to prove it is working just fine. Hence, the overall system is tested to be functional by looking at the result from figures above.

Figure 6.5 shows the current JSON tree in Firebase real time database that the mobile app is displaying.


```
{
  "database": {
    "Abnormalities": {
      "Title": "Abnormalities",
      "Value": "No"
    },
    "Alert": {
      "Title": "Alert",
      "Value": 0
    },
    "Gas": {
      "Title": "Gas",
      "Value": "Normal"
    },
    "Humidity": {
      "Title": "Humidity",
      "Value": 35
    },
    "Latitude": {
      "Title": "Latitude",
      "Value": 4.3383
    },
    "Longitude": {
      "Title": "Longitude",
      "Value": 101.1366
    },
    "Temperature": {
      "Title": "Temperature",
      "Value": 27.7
    }
  }
}
```


Figure 6.5 Current JSON tree in Firebase

Figure 6.6 shows the current shown data or view in the mobile app before the data in Firebase is changed

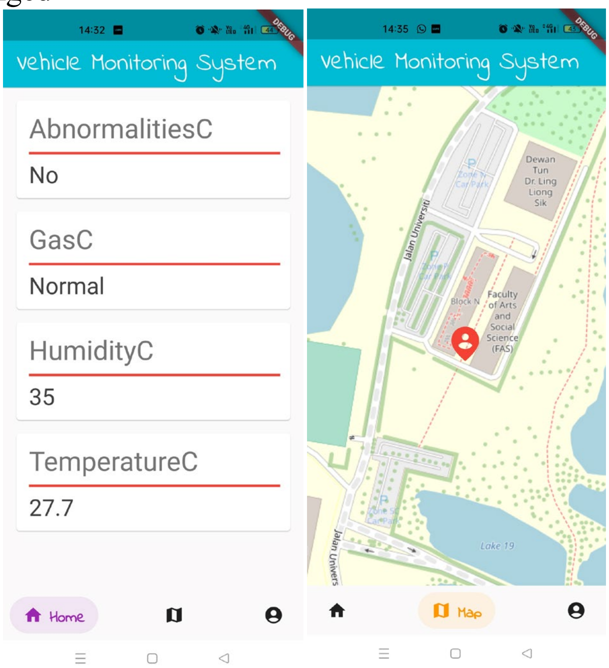

Figure 6.6 Current view in mobile app

Figure 6.7 shows the changes in Firebase real time database to simulate the data changed in the system.


```
{
  "database": {
    "Abnormalities": {
      "Title": "Abnormalities",
      "Value": "Yes"
    },
    "Alert": {
      "Title": "Alert",
      "Value": 1
    },
    "Gas": {
      "Title": "Gas",
      "Value": "Abormal"
    },
    "Humidity": {
      "Title": "Humidity",
      "Value": 30
    },
    "Latitude": {
      "Title": "Latitude",
      "Value": 4.336
    },
    "Longitude": {
      "Title": "Longitude",
      "Value": 101.1356
    },
    "Temperature": {
      "Title": "Temperature",
      "Value": 5
    }
  }
}
```


Figure 6.7 Changed JSON tree in Firebase

Figure 6.8 shows the changed view and notification in the developed mobile app after the changes in Firebase.

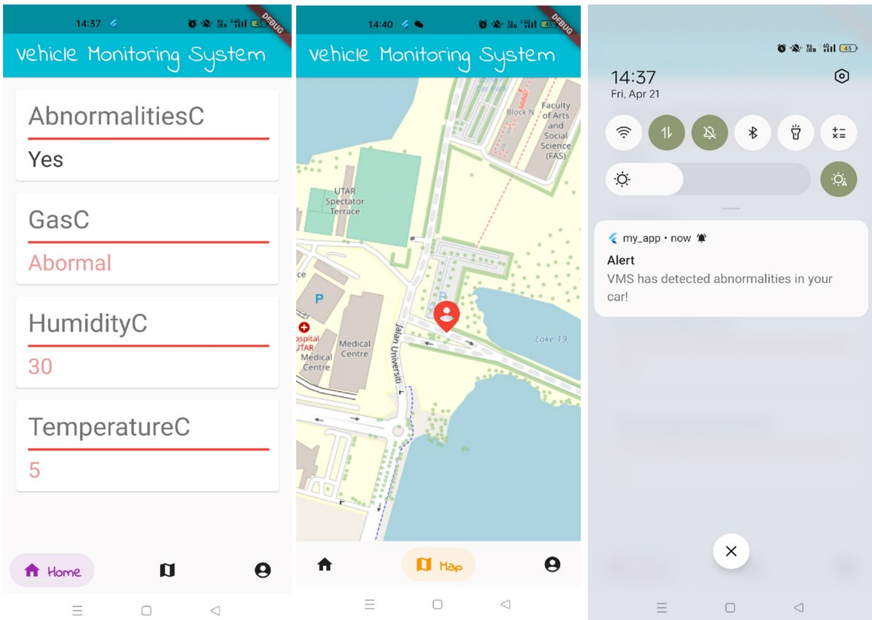

Figure 6.8 Changed view and notification in mobile app

After testing using the first method, the second method is used to test the mobile app's functions. The current view of the mobile app is first screenshotted to use as a reference after there are changes done to the data in Firebase as shown in figure 6.6. The data displayed by the app from Firebase is shown in figure 6.5. Then, the data is manually changed to showed abnormalities in the system so that the mobile app's notification, changes of data and map's pin will be tested as shown in figure 6.7. After changing the data in Firebase, the changed data is then displayed in the mobile app as shown in figure 6.8. From the results of first method and second method, the testing of system is concluded as a pass with every functionality required implemented to the system entirely.

6.3 Project Challenges

Projects often face obstacles, and this one is no exception as projects normally does. The challenges in the entire of this project is to find the optimum hardware and software to do the project in a short period of time. The hardware is limited to the hardware used in the project because there are budget constraints in this project which is set by the faculty. So, the hardware used has to be in good quality despite the cheap price and finding this kind of hardware is a challenge in this project as there are only a few choices in the Malaysia's market. As finding the suitable components is already being this difficult, having the components to function as required will be having more challenges than that. As the GPS module used in this project is not very sensitive, there are times that the GPS module cannot be determined to be functioning as it cannot receive the signals from the satellite due to the ceilings and roof of the lab used during the project implementation process. The other challenge in the project will be implementing database into the system. As database is required by the system for a medium to store data for further use, Firebase real time database is used in the project. Firebase is used due to it does not requires any subscription to start the usage of database and is the easiest database to be used among the other companies' database system in my opinion. But connecting the mobile app to Firebase is a headache which is caused by the inconvenience of how a Flutter app connects to Firebase at the start. There are quite a lot of settings and configuration to be done before using Firebase with the mobile app and every setting and configuration must be followed exactly as Firebase's guideline written so that the mobile app is connected successfully with Firebase.

6.4 Objectives Evaluation

After looking at the results from the system testing, the objectives are concluded as achieved. The primary purpose of this project is to create a Raspberry Pi based cyber physical system for vehicle monitoring over internet. The minicomputer used in this project is Raspberry Pi with temperature and humidity sensor, gas quality sensor, GPS module and a buzzer connected to become a cyber physical system for vehicle monitoring. Then, Raspberry Pi is connected to the internet and Firebase for data upload and storing. The mobile app will then connect to the internet to retrieve data from Firebase to display data to users and sent notifications to alert users about the abnormalities. Hence, the first objective is achieved with all required functionalities working. The next objective will be to have the alert function implemented in the system to notify the users. This objective is also achieved with the Raspberry Pi will have the buzzer to buzz when abnormalities found and the mobile app will also send out notification for user to check in the app about the abnormalities found. With these said, the objectives are achieved in a marvellous way with how well the system achieved the expectations although there are small issues faced for the project to be completed.

6.5 Concluding Remark

As a concluding remark for this chapter, the whole project is done successfully with all objectives achieved. System testing is done in order to evaluate the performance of the system and the methods used is also introduced in this chapter as well. After performing the testing methods and setups, the result from them are obviously the expected results from the system when it is working just fine. As the project is done, challenges of the project are also be written in this chapter to help others who are eager to try this project before working on this type of project on what will be the challenges they may face. Furthermore, the objectives of this project are then evaluated based on the testing done. The system is capable of achieving all the goals put forth in this project, including creating an online vehicle monitoring system based on a Raspberry Pi and creating warnings for the system.

Chapter 7
Conclusion and Recommendation

7.1 Conclusion

In summary, the project in this whole development phase is considered as a success as there are not much issues faced and no hinderance in the progress. The enthusiasm and problem statements of this project is the growth of incidents like vehicle theft, vehicle fires, carbon monoxide poisoning and fogging of windshield. To solve these problems, a cyber physical system for vehicle monitoring over internet is developed. The objective of this study is to develop a vehicle monitoring system which has functions like location tracking, temperature monitoring, humidity monitoring and gas quality monitoring by using Raspberry Pi. Besides that, the system aims to notify users when there are abnormalities while monitoring the vehicle's parameters. This system will contribute the society by decreasing the probability of vehicle incident when driving or not and death due to vehicle incident. Literature also has been reviewed to have a further grasp on the system and recognize the strength and weakness on then previous developed system. From the literature reviewed, the system can be improvised to suit the objective of the research. Then, a methodology or an approach is also proposed to develop the system. For improved comprehension and system transparency, diagrams like the use case diagram, system architecture diagram and activity diagram are developed. Next, a system design is projected as the overall hardware design of the system. A system block diagram is design and all the hardware components specifications are written in the project. Circuit and components design is also illustrated in the project to project how the components connected and how will the circuit will look like. The interaction operation of each component is also written in the project. Furthermore, implementation of the system is discussed in details with hardware setup, software setup, configurations and more. Then, the system is evaluated through testing to evaluate how well the system perform and resulted in positive feedback with how well the system performs. The objectives of this project are also evaluated and is given rise that the objectives are achieved successfully. Overall, the system works just fine with all the components, Firebase and mobile app while targeting the objectives.

7.2 Recommendation

As the project is done under budget constraint, there are obviously recommendations to improve the system far much better than the current prototype. The first recommendation will be changing all the components to a better component. The current sensors and modules used in this project are all small components with a small range and low sensitivity. Therefore, changing the current components of the system will surely improve its performance by increasing the sensing range and also the sensitivity of the system to detect changes such as locations, humidity, temperature and so on. Adding in more sensors like gyro sensor is also a way to improve the system and making the system to have more functions and features to reach the users' heart to become a solid selling product in the market. Moving onto the next suggestions, the mobile app should be modified to have more functions like user authentication and also a better GUI. Currently, the mobile app is just simply displaying the raw data and a map directly to users without any images or graphics like thermometer used. To ease the user and making the mobile app to be slicker and tidier, the mobile app should have a more proper GUI and features if the mobile app needs to published in the market with the system together.

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APPENDIX

Datasheet for Temperature and Humidity Sensor – DHT22

Aosong Electronics Co.,Ltd

Your specialist in innovating humidity & temperature sensors

1. Feature & Application:

* Full range temperature compensated * Relative humidity and temperature measurement
* Calibrated digital signal *Outstanding long-term stability *Extra components not needed
* Long transmission distance * Low power consumption *4 pins packaged and fully interchangeable

2. Description:

DHT22 output calibrated digital signal. It utilizes exclusive digital-signal-collecting-technique and humidity sensing technology, assuring its reliability and stability.Its sensing elements is connected with 8-bit single-chip computer.

Every sensor of this model is temperature compensated and calibrated in accurate calibration chamber and the calibration-coefficient is saved in type of programme in OTP memory, when the sensor is detecting, it will cite coefficient from memory.

Small size & low consumption & long transmission distance(20m) enable DHT22 to be suited in all kinds of harsh application occasions.

Single-row packaged with four pins, making the connection very convenient.

3. Technical Specification:

Model	DHT22
Power supply	3.3-6V DC
Output signal	digital signal via single-bus
Sensing element	Polymer capacitor
Operating range	humidity 0-100%RH; temperature -40~80Celsius
Accuracy	humidity +-2%RH(Max +-5%RH); temperature <+-0.5Celsius
Resolution or sensitivity	humidity 0.1%RH; temperature 0.1Celsius
Repeatability	humidity +-1%RH; temperature +-0.2Celsius
Humidity hysteresis	+-0.3%RH
Long-term Stability	+-0.5%RH/year
Sensing period	Average: 2s
Interchangeability	fully interchangeable
Dimensions	small size 14*18*5.5mm; big size 22*28*5mm

Datasheet for Gas Quality Sensor – MQ135

SPECIFICATIONS

A. Standard work condition

Symbol	Parameter name	Technical condition	Remarks
Vc	Circuit voltage	5V±0.1	AC OR DC
V_H	Heating voltage	5V±0.1	ACOR DC
R_L	Load resistance	can adjust	
R_H	Heater resistance	33Ω ±5%	Room Tem
P_H	Heating consumption	less than 800mw	

B. Environment condition

Symbol	Parameter name	Technical condition	Remarks
Tao	Using Tem	-10℃...+45℃	
Tas	Storage Tem	-20℃...+70℃	
R_H	Related humidity	less than 95%Rh	
O_2	Oxygen concentration	21%(standard condition)Oxygen concentration can affect sensitivity	minimum value is over 2%

C. Sensitivity characteristic

Symbol	Parameter name	Technical parameter	Remark 2
Rs	Sensing Resistance	30KΩ -200KΩ (100ppm NH_3)	Detecting concentration scope : 10ppm-300ppm NH_3 10ppm-1000ppm Benzene 10ppm-300ppm Alcohol
α (200/50) NH_3	Concentration Slope rate	≤ 0.65	
Standard Detecting Condition	Temp: 20℃±2℃ Vc:5V±0.1 Humidity: 65%±5% Vh: 5V±0.1		
Preheat time	Over 24 hour		

Datasheet for GPS – Neo-6M

1.3 GPS performance

Parameter	Specification		
Receiver type	50 Channels GPS L1 frequency, C/A Code SBAS: WAAS, EGNOS, MSAS, GAGAN		
Time-To-First-Fix[1]		NEO-6G/Q	NEO-6M
	Cold Start (Autonomous)	29 s	32s
	Warm Start (Autonomous)	29 s	32s
	Hot Start (Autonomous)	<1 s	<1 s
	Aided Starts[2]	<1 s	<3 s
Sensitivity[3]		NEO-6G/Q	NEO-6M
	Tracking & Navigation	-160 dBm	-160 dBm
	Reacquisition	-160 dBm	-160 dBm
	Cold Start (Autonomous)	-147 dBm	-146 dBm
Maximum Navigation update rate		5Hz	
Horizontal position accuracy[4]	Autonomous	2.5 m	
	SBAS	2.0 m	
Configurable Timepulse frequency range		0.1 Hz to 1 kHz	
Velocity accuracy		0.1m/s	
Heading accuracy		0.5 degrees	
Operational Limits	Dynamics	≤ 4 g	
	Altitude[5]	50,000 m	
	Velocity[5]	500 m/s	

Table 2: NEO-6 GPS performance

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3, Y3	**Study week no.: 1**
Student Name & ID: Lee Kar Chun 19ACB01106	
Supervisor: Mr. Teoh Shen Khang	
Project Title: Raspberry Pi Based Cyber Physical System For Vehicle Monitoring Over Internet	

1. WORK DONE Combination of all separated python files are done
2. WORK TO BE DONE Adding in conditions or functions and tidying up the code.
3. PROBLEMS ENCOUNTERED No problems encountered
4. SELF EVALUATION OF THE PROGRESS Did a great starting point for FYP2.

TEOH
Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3, Y3	**Study week no.: 2**
Student Name & ID: Lee Kar Chun 19ACB01106	
Supervisor: Mr. Teoh Shen Khang	
Project Title: Raspberry Pi Based Cyber Physical System For Vehicle Monitoring Over Internet	

1. WORK DONE
The code has added conditions and functions to perform as the system intended.
2. WORK TO BE DONE
Tidying up the code
3. PROBLEMS ENCOUNTERED
No problems encountered
4. SELF EVALUATION OF THE PROGRESS
Needed to do well in time management as assignments are coming.

TEOH

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3, Y3	**Study week no.: 3**
Student Name & ID: Lee Kar Chun 19ACB01106	
Supervisor: Mr. Teoh Shen Khang	
Project Title: Raspberry Pi Based Cyber Physical System For Vehicle Monitoring Over Internet	

1. WORK DONE

The code has been tidied up and waiting for further functions to be added.

2. WORK TO BE DONE

Installation of Flutter in laptop.

3. PROBLEMS ENCOUNTERED

No problems encountered

4. SELF EVALUATION OF THE PROGRESS

Keep up the pace and scheduled the time more efficiently so the project is done on time.

TEOH

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3, Y3	**Study week no.: 4**
Student Name & ID: Lee Kar Chun 19ACB01106	
Supervisor: Mr. Teoh Shen Khang	
Project Title: Raspberry Pi Based Cyber Physical System For Vehicle Monitoring Over Internet	

1. WORK DONE Flutter is installed and a template of an app is created when creating a new app.
2. WORK TO BE DONE Designing the mobile app's framework
3. PROBLEMS ENCOUNTERED As Flutter commands needed to be added to PowerShell, it causes a lot of errors as the file path needed to be added into the environment variable's default path.
4. SELF EVALUATION OF THE PROGRESS Keep up the pace and scheduled the time more efficiently so the project is done on time.

TEOH

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3, Y3	**Study week no.: 5**
Student Name & ID: Lee Kar Chun 19ACB01106	
Supervisor: Mr. Teoh Shen Khang	
Project Title: Raspberry Pi Based Cyber Physical System For Vehicle Monitoring Over Internet	

1. WORK DONE

Profile page which is one of the 3 pages designed to be in the mobile app is done

2. WORK TO BE DONE

Home page for data display and map page should be done.

3. PROBLEMS ENCOUNTERED

No problems encountered

4. SELF EVALUATION OF THE PROGRESS

Keep up the pace and scheduled the time more efficiently so the project is done on time.

TEOH

Supervisor's signature

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FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3, Y3	Study week no.: 6
Student Name & ID: Lee Kar Chun 19ACB01106	
Supervisor: Mr. Teoh Shen Khang	
Project Title: Raspberry Pi Based Cyber Physical System For Vehicle Monitoring Over Internet	

1. WORK DONE Home page is done
2. WORK TO BE DONE Map page to be done
3. PROBLEMS ENCOUNTERED No problems encountered
4. SELF EVALUATION OF THE PROGRESS Keep up the pace and scheduled the time more efficiently so the project is done on time.

TEOH

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3, Y3	Study week no.: 7
Student Name & ID: Lee Kar Chun 19ACB01106	
Supervisor: Mr. Teoh Shen Khang	
Project Title: Raspberry Pi Based Cyber Physical System For Vehicle Monitoring Over Internet	

1. WORK DONE
Map page is done
2. WORK TO BE DONE
Combination of all pages to be the framework of the app
3. PROBLEMS ENCOUNTERED
As Google Maps needed subscription fee for API key, an alternate map is needed to be used.
4. SELF EVALUATION OF THE PROGRESS
Keep up the pace and scheduled the time more efficiently so the project is done on time.

TEOH
Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3, Y3	**Study week no.: 8**
Student Name & ID: Lee Kar Chun 19ACB01106	
Supervisor: Mr. Teoh Shen Khang	
Project Title: Raspberry Pi Based Cyber Physical System For Vehicle Monitoring Over Internet	

1. WORK DONE

Mobile app framework is done.

2. WORK TO BE DONE

Linked the mobile app to Firebase and solder the components to the PCB board.

3. PROBLEMS ENCOUNTERED

GPS module broken after internship.

4. SELF EVALUATION OF THE PROGRESS

Continue the momentum to work on the project.

TEOH

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3, Y3	Study week no.: 9
Student Name & ID: Lee Kar Chun 19ACB01106	
Supervisor: Mr. Teoh Shen Khang	
Project Title: Raspberry Pi Based Cyber Physical System For Vehicle Monitoring Over Internet	

1. WORK DONE
Firebase is linked to the mobile app
2. WORK TO BE DONE
Buy a new GPS module and test it
3. PROBLEMS ENCOUNTERED
Firebase has a lot of configurations for Flutter
4. SELF EVALUATION OF THE PROGRESS
Able to handle complicated configurations

TEOH

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3, Y3	Study week no.: 10
Student Name & ID: Lee Kar Chun 19ACB01106	
Supervisor: Mr. Teoh Shen Khang	
Project Title: Raspberry Pi Based Cyber Physical System For Vehicle Monitoring Over Internet	

1. WORK DONE
New GPS module is bought and tested to be working.
2. WORK TO BE DONE
Solder the components to the PCB board and the mobile app should be done.
3. PROBLEMS ENCOUNTERED
GPS module is hard to be tested as the GPS module is not very sensitive and the testing is done in the lab.
4. SELF EVALUATION OF THE PROGRESS
Keep up the pace and scheduled the time more efficiently so the project is done on time.

TEOH

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3, Y3	**Study week no.: 11**
Student Name & ID: Lee Kar Chun 19ACB01106	
Supervisor: Mr. Teoh Shen Khang	
Project Title: Raspberry Pi Based Cyber Physical System For Vehicle Monitoring Over Internet	

1. WORK DONE

Soldering of all the components onto the PCB.

2. WORK TO BE DONE

Minor adjustments to the mobile app

3. PROBLEMS ENCOUNTERED

GPS module is hard to be tested as the GPS module is not very sensitive and the testing is done in the lab after soldering is done.

4. SELF EVALUATION OF THE PROGRESS

Learnt and practiced how to solder and the soldering is done perfectly

TEOH

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3, Y3	**Study week no.: 12**
Student Name & ID: Lee Kar Chun 19ACB01106	
Supervisor: Mr. Teoh Shen Khang	
Project Title: Raspberry Pi Based Cyber Physical System For Vehicle Monitoring Over Internet	

1. WORK DONE
The mobile app is eventually done with all the features needed.
2. WORK TO BE DONE
Presentation and report writing.
3. PROBLEMS ENCOUNTERED
Notifications wont pop up on screen
4. SELF EVALUATION OF THE PROGRESS
Did a great job on the development of the mobile

TEOH

Supervisor's signature

Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: T3, Y3	**Study week no.: 13**
Student Name & ID: Lee Kar Chun 19ACB01106	
Supervisor: Mr. Teoh Shen Khang	
Project Title: Raspberry Pi Based Cyber Physical System For Vehicle Monitoring Over Internet	

1. WORK DONE
The report's contents are all written and has pass Turnitin's plagiarism checks.
2. WORK TO BE DONE
Supervisors' checking of the report, alteration of the report according to supervisor's demand and also presentation of the whole FYP.
3. PROBLEMS ENCOUNTERED
Turnitin has slow checking on the plagiarism
4. SELF EVALUATION OF THE PROGRESS
Did a great job in completing the development and report of the FYP

TEOH

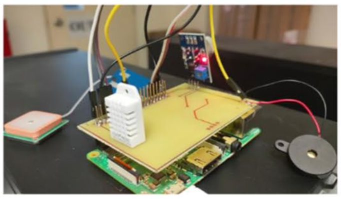
Supervisor's signature

Student's signature

RASPBERY PI BASED CYBER PHYSICAL SYSTEM FOR VEHICLE MONITORING OVER INTERNET

INTORDUCTION

Vehicle monitoring system powered by Raspberry Pi which monitors the temperature, humidity and gas quality inside the vehicle and location of the vehicle



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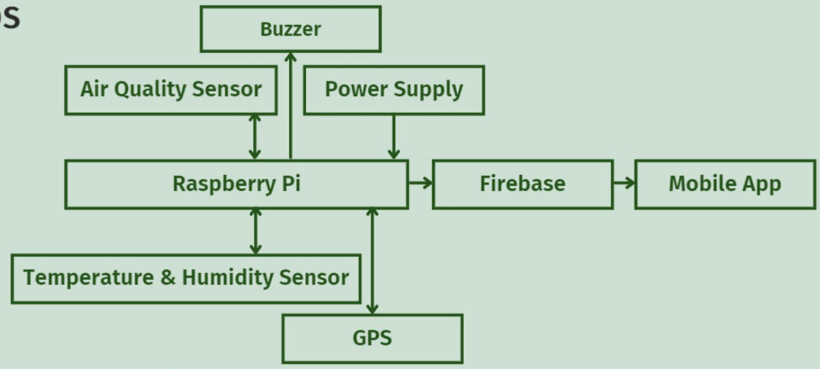

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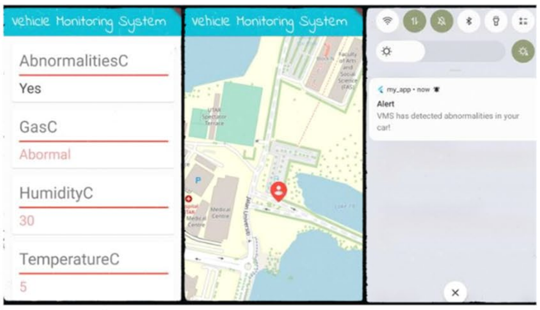

DISCUSSIONS

- User friendly
- Monitors the physical condition of the vehicle and alerts users
- Data display over internet
- Long distance monitoring

CONCLUSION

- The system is functional
- All hardware is workable & connected to Raspberry Pi
- Data display through mobile app

Project Developer: Lee Kar Chun
Project Supervisor: Mr. Teoh Shen Khang

PLAGIARISM CHECK RESULT

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FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

Full Name(s) of Candidate(s)	Lee Kar Chun
ID Number(s)	19ACB01106
Programme / Course	Bachelor of Information Technology (Honours) Computer Engineering
Title of Final Year Project	Raspberry Pi Based Cyber Physical System For Vehicle Monitoring Over Internet

Similarity	**Supervisor's Comments (Compulsory if parameters of originality exceeds the limits approved by UTAR)**
Overall similarity index: 8 **%** **Similarity by source** Internet Sources: 6 % Publications: 4 % Student Papers: 4 %	
Number of individual sources listed of more than 3% similarity: 0	
Parameters of originality required and limits approved by UTAR are as Follows: **(i) Overall similarity index is 20% and below, and** **(ii) Matching of individual sources listed must be less than 3% each, and** **(iii) Matching texts in continuous block must not exceed 8 words** ***Note: Parameters (i) – (ii) shall exclude quotes, bibliography and text matches which are less than 8 words.***	

Note Supervisor/Candidate(s) is/are required to provide softcopy of full set of the originality report to Faculty/Institute

Based on the above results, I hereby declare that I am satisfied with the originality of the Final Year Project Report submitted by my student(s) as named above.

TEOH
Signature of Supervisor

Name: Teoh Shen Khang

Date: 27 April 2023

Signature of Co-Supervisor

Name: ____________

Date: ____________

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(KAMPAR CAMPUS)

CHECKLIST FOR FYP2 THESIS SUBMISSION

Student Id	19ACB01106
Student Name	Lee Kar Chun
Supervisor Name	Mr. Teoh Shen Khang

TICK (√)	DOCUMENT ITEMS Your report must include all the items below. Put a tick on the left column after you have checked your report with respect to the corresponding item.
√	Front Plastic Cover (for hardcopy)
√	Title Page
√	Signed Report Status Declaration Form
√	Signed FYP Thesis Submission Form
√	Signed form of the Declaration of Originality
√	Acknowledgement
√	Abstract
√	Table of Contents
√	List of Figures (if applicable)
√	List of Tables (if applicable)
√	List of Symbols (if applicable)
√	List of Abbreviations (if applicable)
√	Chapters / Content
√	Bibliography (or References)
√	All references in bibliography are cited in the thesis, especially in the chapter of literature review
√	Appendices (if applicable)
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√	Signed Turnitin Report (Plagiarism Check Result - Form Number: FM-IAD-005)
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I, the author, have checked and confirmed all the items listed in the table are included in my report.

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(Signature of Student)
Date: 24/4/2023