
# OPTIMIZING THE AUTOMOBILE HEAT EXTRACTION CONTROL USING ARDUINO

MUHAMMAD ISMANAJMI BIN ROZI



**BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY (REFRIGERATION & AIR-CONDITIONING SYSTEMS) WITH HONOURS**

**2022**


**Faculty of Mechanical and Manufacturing Engineering Technology**

# OPTIMIZING THE AUTOMOBILE HEAT EXTRACTION CONTROL USING ARDUINO



**Muhammad Ismanajmi Bin Rozi**

**Bachelor of Mechanical Engineering Technology (Refrigeration and Air-Conditioning Systems) with Honours**

**2022**

# OPTIMIZING THE AUTOMOBILE HEAT EXTRACTION CONTROL USING ARDUINO

**MUHAMMAD ISMANAJMI BIN ROZI**

**A project report submitted**
**in fulfillment of the requirements for the degree of**
**Bachelor of Mechanical Engineering Technology (Refrigeration and Air-Conditioning Systems) with Honours**



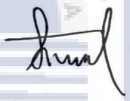
**Faculty of Mechanical and Manufacturing Engineering Technology**

**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**2022**

## DECLARATION

I Declare That This Project Entitled “Optimize of Heat Extraction of Automobile Interior Cabin by Arduino” is The Result of My Own ResearchEexcept As Cited in The References. The Project Report has not been Accepted for Any Degree and is not Concurrently Submitted in Candidature of Any Other Degree.

Signature : 

Name : Muhammad Ismanajmi Bin Rozi

Date : 28/01/2022

**APPROVAL**

I Hereby Declare That I Have Checked This Thesis and In My Opinion, This Thesis is Adequate in Terms of Scope and Quality for The Award of The Bachelor of Mechanical Engineering Technology (Refrigeration and Air-Conditioning Systems) with Honours.

Signature : 


Supervisor Name : *Ts. Mohd Faez Bin Zainol*

Date : 28/01/2022

**DEDICATION**

Alhamdullillah, my entire gratitude goes to Allah, The Glorious Lord, for providing me with the chance to live in His dominion. Initially, I would want to thank my family, particularly my parents, Mr. Rozi Bin Awang and Mrs. Shamsinar Bt Anuar, for their unwavering support and drive in completing this tremendous accomplishment. The prayers of my family had led me throughout the course of my bachelor's degree. Ts. Mohd Faez Bin Zainol is the second most significant individual for me to complete my report. Thanks again for your hard work and consistent direction during this whole process.

Thank you one again.

## ABSTRACT

According to the Department of Environment, the higher occurrence of wildfires relates to hot and dry weather, that also received 19,099 biomass burning reports over a three-year period from January 2019 to January 2022. Based to the ministry, Malaysia often suffers a hot and dry period from the month of January to the middle of March owing to the second stage of the northeast monsoon, when rainfall absorption percentages are minimal in most locations of the nation. A drastic climate change had caused in global warming which increase the chances of human in getting heat stroke. In addition, the heat stroke will not only happen at open space but can occur inside a vehicle. However, another advantage of the heat is the existence of solar power. The solar power will be used as a recyclable power in the system through a photovoltaic chip. In this project, the applied device called exhaust fan is invented by the usage of Blynk application to add in more features of maintaining the temperature in the cabin vehicle. This exhaust fan only requires an internet connection and can be controlled from further distance. The device is then tested in a used car with the interior dimension of 3263060 $cm^3$ starting from 1100 hours until 1600 hours. The device runs for 30 minutes after receiving a notification from the Blynk. The greatest temperature differential is seen on 1230, with a variation of 20 °C. Small differences on temperature due to cloudy weather of the day. The efficiency without exhaust fan is 12.73 % while the overall efficiency attained for all temperature, heat quantity, electric work, and power readings is just 12.93 % with differences of only 0.2%. This is a minimal percentage of efficiency, implying that the gadget can only be completely operational if the cabin dimension is anticipated to be 421913.66 $cm^3$. However, if the quantity of fans or the placement of the device in the cabin automobile increases, the exhaust fan can be fitted to the 3263060 $cm^3$ cabin.

## *ABSTRAK*

*Menurut Jabatan Alam Sekitar, pembakaran terbuka yang berlaku disebabkan oleh cuaca yang panas dan kering, yang menyebabkan 19,099 pembakaran bio jisim yang direkodkan dalam tempoh 3-tahun bermula daripada Januari 2019 sehingga Januari 2022. Berdasarkan fakta daripada Menteri, Malaysia kebiasaannya mengalami cuaca panas dan kering daripada bulan Januari sehingga pertengahan bulan Mac, berkait dengan peringkat kedua monsun timur laut, dan apabila hujan, peratus penyerapan adalah pada minima dalam kebanyakan lokasi di negara. Perubahan iklim yang drastik telah menyebabkan pemanasan global yang meningkatkan peluang untuk mendapat strok haba. Tambahan itu, strok haba bukan sahaja boleh berlaku di kawasan terdedah malah boleh berlaku di dalam kenderaan. Walau bagaimanapun, kelebihan haba adalah penghasilan kuasa solar. Kuasa solar boleh digunakan sebagai kuasa yang dipakai semula dalam sistem melalui cip fotovoltaik. Dalam projek ini, peranti yang di aplikasikan dipanggil ' kipas ekzos' dicipta dengan penggunaan aplikasi Blynk untuk mengekalkan suhu dalam kabin kenderaan. 'Kipas ekzos' ini hanya memerlukan sambungan internet dan boleh dikawal dari jarak yang lebih jauh. Peranti itu kemudiannya diuji dalam kereta terpakai dengan reka bentuk dalaman yang berdimensi 3263060 cm³ bermula dari jam 1100 hingga jam 1600. Peranti ini berjalan selama 30 minit selepas menerima isayarat daripada Blynk. Perbezaan suhu terbesar dilihat pada jam 1230, dengan variasi 20 °C. Perbezaan kecil pada suhu disebabkan oleh keadaan cuaca yang mendung pada hari itu. Kecekapan tanpa peranti ialah 12.73% manakala kecekapan keseluruhan yang dicapai untuk semua suhu, kuantiti haba, kerja elektrik dan bacaan kuasa hanyalah 12.93% dengan perbezaan 0.2% sahaja. Ini adalah peratusan kecekapan yang minimum, mendefinisikan bahawa alat ini hanya boleh beroperasi sepenuhnya jika dimensi kabin ialah 421913.66 cm³. Walau bagaimanapun, jika kuantiti kipas atau penempatan peranti dalam kereta kabin meningkat, 'kipas ekzos' boleh dipasang pada kabin bersaiz 3263060 cm³.*

## ACKNOWLEDGEMENTS

In the Name of Allah, the Most Gracious, the Most Merciful

Primarily, I want to appreciate and honour Allah the Almighty, my Creator and Preserver, for all I have earned from the commencement of my existence. I'd wish to thank Universiti Teknikal Malaysia Melaka (UTeM) for offering the project platform.

My heartfelt special gratitude to my primary supervisor, Ts. Mohd Faez Bin Zainol of Universiti Teknikal Malaysia Melaka (UTeM), for all his encouragement, advise, and inspiration. His unwavering patience in mentoring and imparting precious insights will be treasured for the rest of his life.

Ultimately, I would want to express the deepest appreciation to my dear parents, Mr. Rozi and Mrs Shamsinar, for their inspiration and for being a strong role model in all my attempts. Furthermore, I'd want to thank my siblings for respecting my situation and for their constant support throughout this academic adventure. Lastly, I'd want to convey my gratefulness to everyone who helped, supported, and inspired me to pursue my studies.

## TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

## LIST OF SYMBOLS AND ABBREVIATIONS

| | | |
|---|---|---|
| D,d | - | Diameter |
| W,w | - | Work Done |
| P,p | - | Power |
| V,v | - | Voltage |
| E, e | - | Electric Current |
| Q, q | - | Quantity of Heat |
| H,h | - | Height |
| V,v | - | Volume |

## LIST OF APPENDICES

# CHAPTER 1

# INTRODUCTION

## 1.1 Background

This study is concerned with the ventilation of air in a confined space, this lets hot air to be replaced with natural sunlight from the outside into the interior car. The study aims at optimizing a ventilation mechanism for cars that keeps the temperature in the car's interior from rising excessively during parking time. It applies specifically to a ventilation system in which a solar panel converts sunlight to electrical energy that powers a fan that removes heated air from inside the car.

Besides that, the phenomenon of global warming in the atmosphere is now the most critical issue for the global environment. Global warming is hazardous to human health, throws our national security in jeopardy, and endangers other basic human needs. Any impacts, such as heat waves, rising sea levels, drought resistance, and drought, are becoming more prevalent.



Issue heat in car, such heat stroke is diagnosed by observation of the symptoms and signs in a person exposed to extreme temperatures (Keller, 2003) . Heat stroke usually cost when a person is exposed to a high temperature of sunlight in a long period of time. The individual usually suffers.

This can trigger dehydration of the body because intense temperature can cause dehydration if one does not drink enough water, and dehydration happens as the body lacks water and mineral salts such sodium, potassium, calcium, phosphate, and so on. Yet there's heat rash, which concerns not only youngsters but also senior citizens. When the weather is

hot and people are not embracing appropriate clothing, such as sweat-absorbing fabric, bright color fabrics, and not drinking enough water, the condition occurs. The sweat factory appears clogged and jammed because heat is trapped in the body. The skin surface will become infected and unpleasant as a culmination of this.

Beside from that, the solar can be used as a production of fuel to generate energy to run the blower engine. The principle behind a solar exhaust fan heat architecture is to achieve a new design based on a car air conditioning system. The new design piping in this system would help heat inside the cars to escape.

This time around, unlike any other experiments, they tend to place the system at the interior of the cabin. Instead of that, this device is located inside the air-conditioning system of the vehicle itself. It helps not by only managing the limited space of the interior cabin but also act as double act of cooling. Cooling during the car's movement (engine on) and during the rest, where the speed of the car is zero in a certain period.

As a response, the hot air inside the automotive will be eliminated, encouraging the heat trapped inside the vehicle to be diminished. When the heat method senses a high temperature, the solar exhaust heat module inhales warm air into the cabin.



As the stress increases the reference position, the solar panel unlocks, and the blower activates to evacuate the warm air from the engine through a hose located under the car's hood. The solar exhaust heat develops from the original component in the car air-conditioning process to generate the nature of the blower flow to two directions. This program comprises a solar plate as well as a power supply to the system as a contributor. The solar is used to conveniently get solar energy to the solar panel and obtain power supply for the blower fan to perform.

Each sun power is easy to obtain, saves resource utilization, and ecological. The result of this device is that it will decrease the ventilation inside the car, making the

passenger more comfortable. Furthermore, this would eliminate the temperature issue that refers to a situation where the driver stops or leave their cars in sunshine.

## 1.2 Problem Statement

Most of the Malaysian nowadays refers secondhand car rather than the original with the main purpose of saving budget, adding in receiving the same car as the original one. However, the major disadvantage of buying second grade car is early-onset problem. Mechanical breakdown usually does not occur in new original car and owner will not be concern for the problem within 1 or 2 years of usage.

Nevertheless, the condition of the used cars is not the same even if one another. The sale price represents the condition of the car itself. Table 1.1 explains Perodua's Axia (used car) price and specifications. The main purpose Perodua Axia is chosen for this project testing due to the higher demand in automotive industry in Malaysia due to its affordable price range. The price different is based on several factors which in this situation can be seen in the interior design. The interior design helps in controlling the price market.

Despite of the price range, the foremost problem of each used car owner is to maintain the interior and exterior of the car especially with the extreme climate in Malaysia which are hot and dry seasons. These situations increase in the car paint's damage when exposed to direct sunlight in a long period of time.

Besides that, the amount of solar heat (> 30°) emitted to the vehicle over a long period of time in open areas, can cause vehicle users to feel less comfortable when wanting to drive it again. In addition, the number of close parking sites are still in minimum range in Malaysia. Parking lots are not only located at mall, parks or other social activities places yet; the front yard of houses areas is also considered to be a parking site. Normally, at condominium or flats area, closed parking are provided with some extra fees of entrance. Nonetheless, overheat interior cabin problem still occur due to the

limited closed parking lot as most ofthe other cars owners still need to park somewhere else which cause the vehicle to be exposed directly to the sunlight repeatedly.

Although, the specification of the car had indeed stated that the interior or car paint will not be affected. However, long period of sun exposure or interior's temperature overheat (maximum) can lead on the continuous cabin problems such as dashboard and car cushion.

Table 1.1 Perodua Axia (used car) with price and specifications.

| CAR BRAND AND TYPE | SPECIFICATION | CAR PRICE | EXAMPLES |
|---|---|---|---|
| Perodua Axia 1.0 Special Edition (SE) Advanced, AT ( (Arvind, July,2020). | • 1.0L Petrol Engine, 3 Cylinder 12 Valve DOHC.<br>• Power: 67 hp @ 1,200 rpm<br>• Torque: 91 Nm @ 2,400 rpm<br>• Transmission: 4-speed automatic, front-wheel drive<br>• Safety: Two airbags, ABS with EBD, ISOFIX<br>• Price: RM42,000 – March 2018 launch (OTR with insurance) | RM42,000.00 |  |

.

Malaysia's government had prepared public parking lots which are mostly exposed directly towards sunlight which releases a chemical known as UV ray. UV rays had been known to be at its highest during 10 a.m until 4 p.m Malaysia, country of Southeast Asia, lying just north of the Equator, that is composed of two noncontiguous regions:

Peninsular Malaysia (Semenanjung Malaysia), also called West Malaysia (Malaysia Barat), which is on the Malay Peninsula, and East Malaysia (Malaysia Timur), which is on the island of Borneo (Ahmad, 2021). This is the reason why Malaysia had been considered having only 2 seasons which are dry and wet seasons yearly. The dry seasons happens in May to September while wet season is predicted from November until March.

This issue had become worsen this year, 2021 and a newspaper report even stated it in Figure 1.1, Figure 1.2 , Figure 1.3, and Figure 1.4 below.


Figure 1.1 Addressing heat in cities (Ahmad, 2021).

**LETTER:** According to reports by non-governmental organisation Think City, which did a land temperature study for five cities in Malaysia, there have been increases in temperatures of between 1.640C and 6.750C over the last few decades due to development and changing urban trends.

The peak temperature increases of only 1.640C in the Kuala Lumpur city centre over a 30-year period between December 1989 and October 2019 was attributed to the efficiency of domestic gardens, parks and woodlands in the city.

Ipoh recorded a peak temperature increase of 6.750C within a 21-year period between November 1998 and March 2019, the highest temperature increases among the five cities studied.

This was due to an increase in areas with a maximum temperature range, by 245 per cent in 2019, or from 66km to 163sq km, which indicated extreme ecological change and urban trends in Ipoh.

MORE NEWS

- **Yellow level heat wave in seven areas in Peninsula**
- **Pahang firemen battle forest, peat fires in three districts [NSTTV]**
- **Time for Malaysia to think about setting carbon neutrality target**
- **Volvo to help make Gothenburg climate-neutral city by 2030**

It is obvious from the report that temperatures in Malaysian cities are increasing. Unless a drastic and holistic action is taken to address it, we will suffer from severe health problems related to heat, which will also lead to internal migration among the people to places that are lower in temperature.

Figure 1.2 The news on Malaysia's heat problem nowadays (Solhi, March 2021).

**Malaysian cities are getting hotter: Study**

By Farah Solhi - March 6, 2021 @ 3:43pm


Figure 1.3 Malaysia cities are getting hotter (Ahmad, 2021).



A woman uses an umbrella to protect her from the scorching heat in Kuala Lumpur. - NSTP/ASYRAF HAMZAH

KUALA LUMPUR: Malaysian cities are getting hotter, revealed a land surface temperature mapping study.

The study undertaken by Think City Sdn Bhd has showed marked increases in peak land surface temperatures in Kuala Lumpur city centre, Bayan Lepas and George Town in Penang, Johor Baru as well as in Ipoh, Perak.

The study found an increase of 1.64°C in Kuala Lumpur's surface temperature between 1989 and 2019.

There was an increase of 5.63°C in Bayan Lepas' surface temperature between 1988 and 2020 and nearby George Town surface temperature between 1988 and 2020 showed an increase of 6.37°C.

MORE NEWS

- **Malaysian gets Covid-19 vaccine in New York**
- **Bursa Malaysia opens higher**
- **Bursa snaps three-day winning streak at opening on profit-taking**
- **Dhaya Maju-LTAT gets green light for judicial review over termination of KVDT2 project contract**

The study also showed an increase of 6.75°C in Ipoh city between 1998 and 2019 and an increase of 6.7°C in Johor Baru's surface temperature between 2005 and 2018.

The study found that the rise of temperatures in these urban areas is primarily linked to the urban heat island effect, as well as a lack of greenery and is also attributed to global warming.

Figure 1.4 The news on Malaysia's heat problem nowadays (BENJAMIN, March 2021).

Students, lecturers, and University's staffs can park their vehicles at the parking provided such as in Universiti Teknikal Malaysia Melaka (UTeM). However, the situation gets critical as the location of the parking lots are exposed directly towards the sun which cause the escalation of interior heat inside the automobile vehicles, confine in how long the vehicles being exposed.

The radiation again from sun's rays that pass through the glass window is the origin of heat in cars. The high heat and limited thermal conductivity glass window of the cars is does not enable to any internal heat power to flow so easily as light, so that heat is retained within the enclosed space of the cabin producing an increase in interior temperature (william, 2016).

The heat is reflected within an automotive system and has absorbed certain parts of the seats, the dashboard, steering, transmission case, hand break case, (Devonshire, 2002). As a result, air is stalled in the enclosed area inside the vehicle because air circulation in the enclosed area of the car cabin is not present (Sayer, 2002). The vehicle parts such as instruments, leather seats and plastic accessories (Zhi Li, 2014)

High interior temperatures can be lowered by eliminating excess heat from a vehicle by unlocking a doors or vehicle glass panel, starting the engine, and switching on the air conditioners to maximum power upon boarding the vehicle.



Both methods, though, require more time to get the indoor temperature down to a normal degree. In addition, the additional loading that is produced will lead to the fast abrasion of the mechanical components in the engine and to an increase in age for fuel consumption quickly if exposed to extreme heat during a long period of time. when the engine is not functioning correctly when the air conditioners are activated (K. David Huang, Sheng-Chung Tzeng, Wei-Ping Ma and Ming-Fung Wu, 2005).

With the price of Perodua Axia (RM42,000.00) as the maximum value and as a protection for the car interior, this new cooling device, called 'Heat Extraction System' will prevent damage to the car's interior by reducing temperature at open parking especially for UTeM's parking lot area.

## 1.3 Research Objective

The main aim of this research is to recreate the exhaust fan device for vehicles that consistently remove heat when reaching predetermined temperature (45 °C) in effort to optimize the interior automobile heat to the ambient conditions. The sub-objectives are as follows:

a) To optimize an existing car exhaust fan product by merged with internet of things(IOT).

b) To analysis and study heat extraction efficiency.

## 1.4 Scope of Research:

The scope of research listed the device set up from the beginning until end of result:

- Conceptual an ideas of heat extraction in vechicel cabin.
- A Special Edition Perodua Axia 1.0 will be used for this project.
- The car will be parked at FTKMP's Melaka Malaysia on daylight from 10.00 am until 4.00pm. The period of 10.00 am until 4.00 pm are chosen due to the arrival and departure of the staffs or students to the University.
- It will be held in FTK's campus car park during daylight for 3 different periods which are morning (10.00am), afternoon (12.00pm) and evening (4.00pm).
- The variety of times recorded indicates the identification of the maximum heat exposure to the car interior by measuring its temperature.

- Furthermore, there are several selection parameters are chosen, which are interior cabin temperature front and back (deg), ambient exterior temperature (deg), exhaust fan power capacity (watt), electric work (kJ) and time taken (30 minutes).
- Nevertheless, due to some weather conditions, such as windy and cloudy might effect the temperature reading as the sunray does not directly emit towards the car. In addition, the experiment cannot be held if its raining as there will be no sunlight emitted. The ideal data recorded will be on fine days as there are no other obstacle for a full sun radiation.
- Once the interior cabin setting's temperature is obtained, the programmed Arduino will automatically initiates the exhaust fan's movement to run the heat extraction system.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

Excessive heat in parked automotive mobile had been a major problem towards everyone, especially children and senior citizen due to health issue. Existing air-conditioning system in every automobile only function when the mobile is on the run or can be said as functioning.

However, the system takes around 1-5 minutes to be fully operate and simmer down the excessive heat in the car cabin. This project helps to reduce the heat excessive of the automobile cabin during its rest which helps in prevention of dehydration problem and becoming more comfortable for passengers and drivers even though the mobile is located under the sunlight area.



## 2.2 Solar Energy as Main Source

Malaysia is a country that is gifted with the diversity of energy resources including fossil fuel as well as various renewable energy sources (P.D. Abd. Aziz, S.S.A. Wahid, Yanuar Z. Arief and N. Ab. Aziz, 2016). One of the renewable energy sources is the sunlight power. It can be converted into electrical power or to electrolyze a system to work.

Malaysia has the advantageous values in developing its solar energy due to its location in the equatorial zone (P.D. Abd. Aziz, S.S.A. Wahid, Yanuar Z. Arief and N. Ab. Aziz, 2016).

Besides, Malaysia is blessed with natural tropical climate with average daily solar radiation of 4500 kWh $m^{-2}$ and abundant sunshine (Solangi, K.H., T.N.W. Lwin, N.A. Rahim, M.S. Hossain, R. Saidur and H. Fayaz,, June 27-29, 2011) for about 12 h $day^{-1}$.

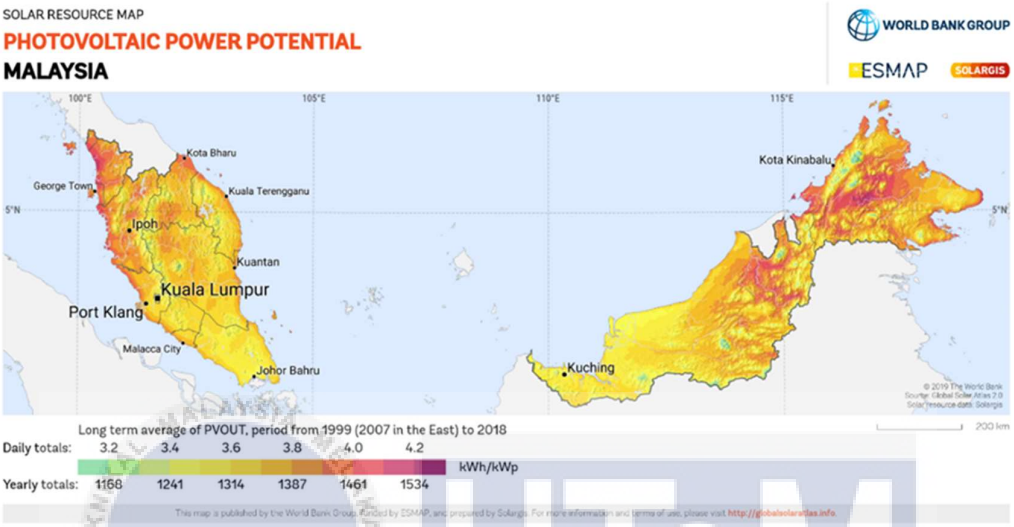



Figure 2.1 Photovoltaic Power Potential in Malaysia (Bank, 2019).

Figure 2.1 shows a map of Malaysia main cities referring on the Global Solar Atlas. The photovoltaic solar system is indicated based on the contour each city. The darker colour it gets, the higher the sunlight arrays directed (kWh/kWp). This is one of the pieces of evidence to strengthen the reason why solar power will be used as the main source power throughout this project.

Moreover, other benefit of solar power is the peak hours of arrays. An article talks on energy demand tends to be higher in the 11:00-16:00 time frame and then early in the evening (GreenMatch, 2021). A high demand in using the solar power using those range of times. Figure 2.2 strengthen the fact on a high temperature occurred in the car cabin even with window open.

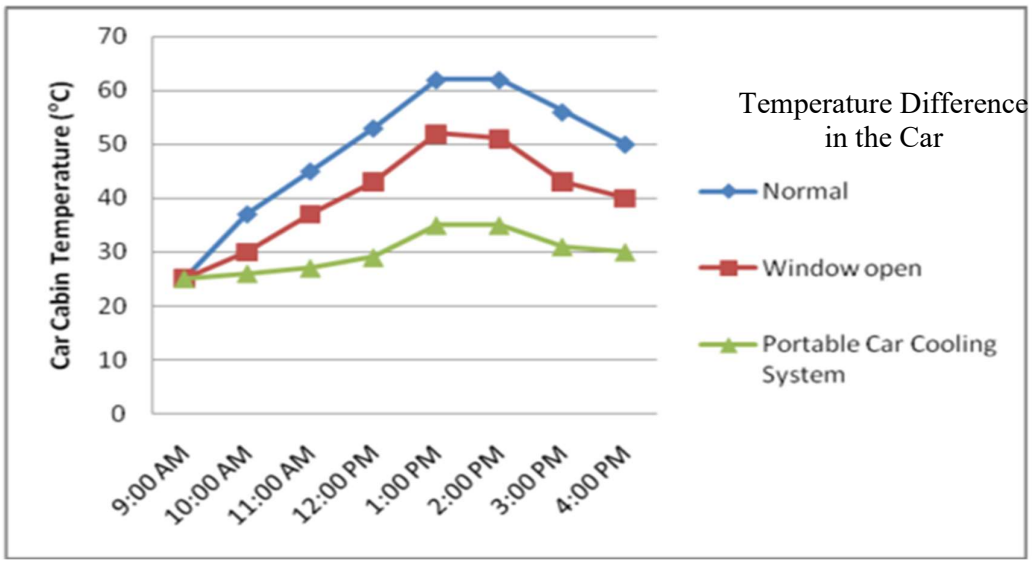



Figure 2.2 Temperature Difference in the Car Cabin (Basar, 2013).

In addition, sun power is a cost-effective method on saving budget especially by modifying a used car. Generating own electricity means it will be using less from the utility supplier, and this will immediately translate to savings on your energy bill (GreenMatch, 2021).

The owner budget can be focusing on a major breakdown or maintenance of the car instead of figuring out on managing the power supply of the cooling system. This also makes the new invented device to be affordable for all Malaysian regarding their wealth other than reducing the vehicle's interior temperature at an open parking area.

## 2.3 Solar Electricity (Photovoltaic)

A photovoltaic (PV) system is composed of one or more solar panels combined with an inverter and other electrical and mechanical hardware that use energy from the Sun to generate electricity (Bethel Afework, Microgeneration Alberta, Jordan Hanania, Braden Heffernan, James Jenden, Kailyn Stenhouse, Brodie Yyelland, Jason Donev, April 28, 2020)

The photovoltaic effect occurs as radiation from the Sun, composed of light photons, drop onto a photovoltaic array, and creates an output current. Each panel generates a fraction of the energy but can be connected to certain other platforms to generate larger quantity of power as a solar installation. The electricity generated by a solar panel is current source (DC). While certain electronic devices, such as phone and other gadgets, use direct current power, they are built to run on the power distribution network, which offers alternating current (AC).

Figure 2.3 shows the example of photovoltaic process in generating electrical power. This shows the overall process on how the solar radiation is to be converted into energy. In this matter, the project will eventually use a solar car ventilator type.

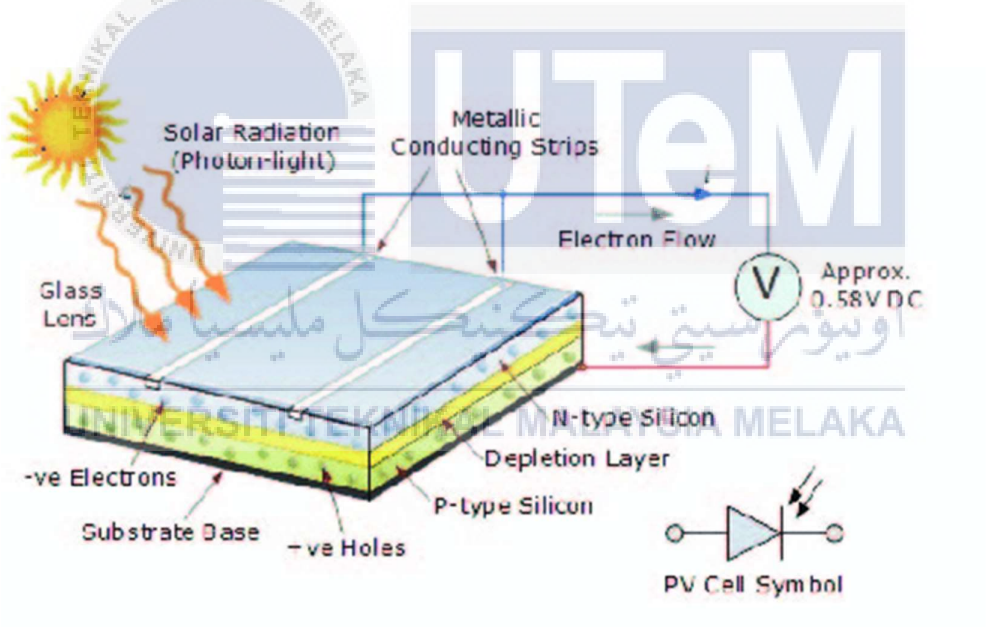



Figure 2.3 The Example of Photovoltaic Process in Generating Electrical Power (Ajid, 2008).

Photovoltaic mostly originated from silicon which comes in two different types. There are bulk and thin filmed as shown in Table 2.1 below. The materials form in PV cells have individual's spectral effects to incident light and exposed a different sensitivity

because of the absorption of photons at given wavelengths. Higher than threshold frequency, the kinetic energy from the photoelectron change based on the wavelength of the incident radiation but has no connection to the light magnitude.

Table 2.1 Bulk and Thin-Film Type of PV cell (Corporation, retrieved on 1" October 2008).

| | **BULK TYPE** | | |
|---|---|---|---|
| | **Mono-crystalline Si** | **Multi-crystalline Si** | **Multi-crystalline band** |
| **Pros** | High efficiency | High efficiency with respect to price | - |
| **Cons** | Increased manufacturing cost caused by the supply shortage silicon | | - |
| | **THIN-FILM TYPE** | | |
| | **Amorphous** | **CIGS or CdTe** | **Polymer Organic** |
| **Pros** | Low price | Low price<br>Able to automate all manufacturing process | Low manufacturing<br>Can be more efficient |
| **Cons** | Low efficiency | | |



## 2.4 Arduino.

Arduino is an open-source platform used for constructing and programing of electronics (M. Banzi, 2009).It can receive and send information to most devices, and even through the internet to command the specific electronic device.

In this modern day, Arduino are used a lot in microcontroller programing among other things due to its user friendly or easy to use setting, like any microcontroller an Arduino is a circuit board with chip that can be programmed to do numerous numbers of tasks (A. M. Gibb, 2010).

### 2.4.1 Software Arduino IDE

Software arduino IDE an accessible programmed created by Arduino.cc that is primarily used for creating, building, and transferring code to practically all Arduino Modules. It is an authorized Arduino programmed that makes code compilation so simple that even a layperson with no previous technical expertise may get started.

The main code as shown in Figure 2.4, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded in the controller on the board (TEP, 2021).

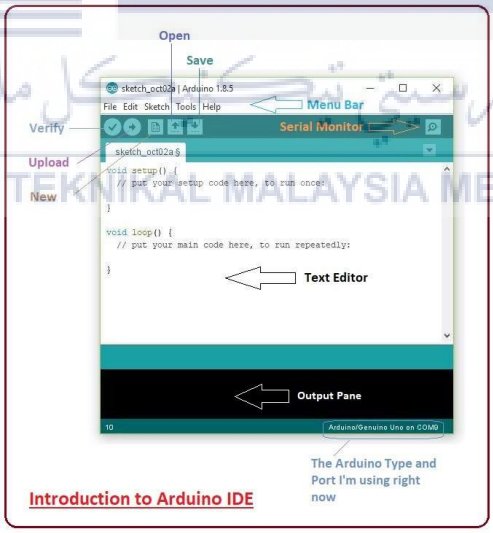



Figure 2.4 Main Code Software Arduino IDE (TEP, 2021).

### 2.4.2 Apps Blynk

The Apps Blynk is a physical layer consists of the devices that are to be controlled. The sensors to sense the surrounding environmental conditions are also connected to this layer. The data link layer consists of IoT gateway router ,the device manager and various communication protocols.

This layer links the home appliances to the webserver or cloud via Wi-Fi communication. In this system, under database/server layer. The application and presentation layer consist of web protocol. This layer con- stitute either designing of a webpage for accessing the devices connected to the perception layer via PC or laptop computer, or building an android or iOS mobile application if the devices are to be controlled and monitored via smartphones.

Temperature Sensor with Thermostat Heat Sensor .The layers of IoT for the proposed system are shown below, (Bharat Bohara, Sunil Maharjan, and Bibek Raj Shrestha, 2017).



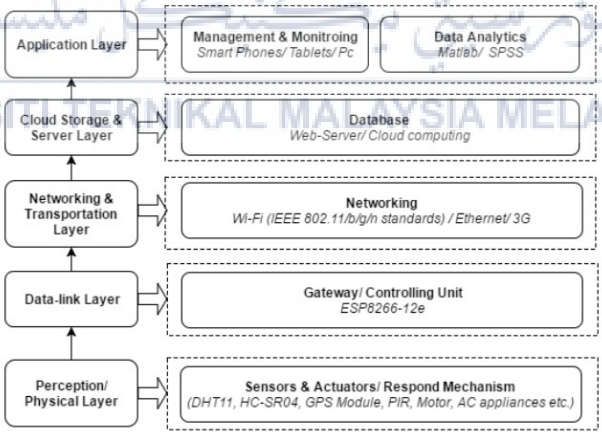



Figure 2.5 The layers of IoT for the proposed system (Bharat Bohara, Sunil Maharjan, and Bibek Raj Shrestha, 2017).

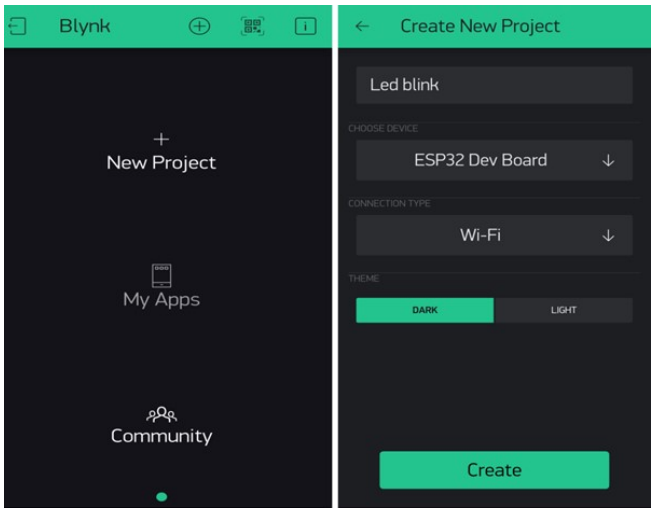



Figure 2.6 Main create New Project Apps Blynk (Pro, 2019)

## 2.5 Battery Storage 5V

In this project, a usage of 5V of battery storage is required by the help of rechargeable batteries within the voltage range of 3.3V until 5V as shown in Figure 2.5 below. This is because an addition of ESP32 device which can only operates optimally within the range given.




Figure 2.7 Rechargeable Batteries 1.5V Type AA.

## 2.6 Microcontroller

A microcontroller is an integrated circuit (IC) device used for controlling other portions of an electronic system, usually via a microprocessor unit (MPU), memory, and

some peripherals (Keim, 2019). These gadgets are connected to the motherboard that demand both processing capabilities and rapid, immediate interactions with digitized, analogue, or electronic components.

### 2.6.1 ESP 32 Thing-Microcontroller (RTU)

The ESP 32 microcontroller is designed as a comprehensive developed platform. It is a Wi-Fi compatible micro-controller, it supports Bluetooth Low-Energy for example, BLE, BT4.0, Bluetooth Smart, and it has nearly 30 Input/Output (I/O) pins (Jimblom., 2019).

Table 2.2 ESP32 Technical Specialists

| **Microprocessor** | **Tensilica Xtensa LX6** |
|---|---|
| **Maximum Operating Frequency** | 240MHz |
| **Operating Voltage** | 3.3V |
| **Analog Input Pins** | 12-bit, 18 Channel |
| **DAC Pins** | 8-bit, 2 Channel |
| **Digital I/O Pins** | 39 (of which 34 is normal GPIO pin) |
| **DC Current on I/O Pins** | 40 mA |
| **DC Current on 3.3V Pin** | 50 mA |
| **SRAM** | 520 KB |
| **Communication** | SPI(4), I2C(2), I2S(2), CAN, UART(3) |
| **Wi-Fi** | 802.11 b/g/n |
| **Bluetooth** | V4.2 – Supports BLE and Classic Bluetooth |

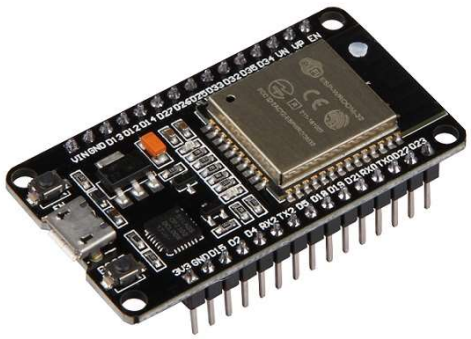


Figure 2.8 ESP 32 module (Xukyo, 2020).

### 2.6.2 DHT 22

The tools for detection of air temperature and humidity by Using DHT22 based Arduino microcontroller have been successfully conducted. The entire system on the device is supplied by a power supply. DHT22 sensor functions as a gauge of temperature and humidity of the air.

The Arduino microcontroller functions as a controller, receiver and processor of data from the DHT22 sensor , the results of the DHT22 sensor measurement will be displayed on the smartphone ios or android (Yuan Alfinsyah Sihombing & Sustia Listiari, 2015).



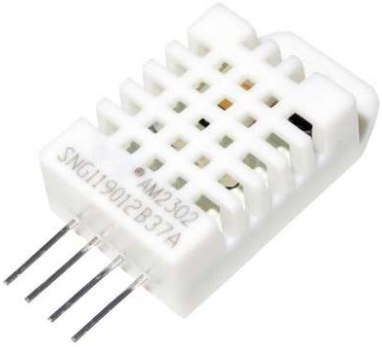



Figure 2.9 DHT22 / AM2302 temperature and humidity sensor (Postolache, 2020).

## 2.7 Portable Wi-Fi (Sim card Yes 4G)

Sim card from Yes Line is used for this project due to the presence of ESP32. It is much simpler and easier to receive data with accuracy. The device had been tested and cooperated the best with Celcom Network which is Yes.

The sim card is used to reach signal of the device from any length of distance which makes this is the major benefit of it rather than using GSM settings. Figure 2.10 below shows the example of sim card yes 4g is used.


Figure 2.10 Sim card Yes 4g (EINZ, 2016).



## 2.8 Lithium-Ion Battery Charger TP 4056

The TP4056 chip is a single-cell lithium-Ion battery charger that protects the cell against over and under charging. It features two status outputs, one for charging in progress and one for charging completed. It also has a charge current of up to 1A that may be programmed because the functional input voltage range is 4V 8V, you can charge batteries directly from a USB port. For this chip, there are two types of typical breakout boards, one that just contains the charger chip, and one has three on-board chips. Lithium batteries can be dangerous if not charged properly, which is why the TP4056 is useful because it detects voltage conditions and prevents overvoltage and current charging (Main, 2017).


Figure 2.11 Lithium-ion Battery Charger Using TP-4056 (AlanJacob688, 2018).

The TP4056 is a lithium-ion battery charger. It has 8 pins and is a Dual Inline Package IC. It comes in SOP packaging and has a low. External components make up the TP4056. It's ideally suited to mobile applications. The TP4056 can also be utilized with a USB and a wall adaptor.

To eliminate negative charge current circuits, no blocking diodes are required due to the intrinsic PMOSFET architecture. The programming resistor can be used to control the maximum current to the cells. It can produce a maximum current of 1000mA.



The greatest voltage that the Junction will supply to the cells is 4.2V with a 1.5 percent accuracy. The IC may achieve temperatures of 145°C. The TP4056 IC can operate in temperatures ranging from -40°C to 85°C (K.Uday Kumar1 T.Chiranjeevi2, Tauqeer Fathima3, K.Sudha Rani4, P.Maruthi5, 2017).

## 2.9 Ventilation System with Exhaust Fan

A ventilation system's overall goal is to remove undesired air or odors from any site while simultaneously maintaining temperature and odor levels that are appropriate for human habitation and industrial activities. The experimental approach used in this study is divided into two components. The first part of the research required developing and

installing temperature monitoring equipment within the cabin of the chosen vehicle, as well as documenting the rise in cabin temperatures without the usage of a ventilation system.

The second step of the project entailed developing, constructing, and installing a basic standalone solar PV ventilation system, as well as performing experimental studies to analyze cabin air temperature rise utilizing the manufactured solar PV ventilator (Sudhir C. V. and Jalal Marhoon Al Dhali, 2015).

Research was conducted on the performance of improved solar automotive ventilators. The current ventilation system has been modified to enhance air flow rate while decreasing steady-state temperature. When compared to a car with an existing ventilator, the improved ventilators can reduce temperature by 10.9 percent more effectively.

Aside from that, it offers the highest level of comfort and has a flow rate that is 5.5 times more than the current ventilator. At the soak temperature, the higher the flow rate, the better the result. Furthermore, the passengers will be more comfortable after entering the vehicle since it keeps the inside colder (Mohiuddin A.K.M, Amirah Osman, Mohammad Faisal Uddin, 2019).



A study was carried out to evaluate the performance of enhanced solar automotive ventilators. The existing ventilation system has been updated to increase air flow rate while lowering steady-state temperature. When compared to a vehicle that already has a ventilator, the enhanced ventilators can reduce temperature by 10.9 percent more effectively. Aside from that, it provides the most comfort and has a flow rate that is 5.5 times more than the existing ventilator.

The higher the flow rate at the soak temperature, the better the effect. Furthermore, because it keeps the inside cooler, the passengers will be more comfortable after entering the car (R. Saidur, H. H. Masjuki and M. Hasanuzzaman, 2014).

Figure 2.12 Solar Powered Car Vehicle Ventilation Exhaust Air (Khairuddin, Khairunnisaa, 2015).

# CHAPTER 3

# METHODOLOGY

## 3.1 Introduction

This chapter represents the technique and method used throughout this project. It also gives more detail information towards the overall progression until the coding of Arduino. It is a compulsory section as it helps to indicate whether the objectives are achieved towards the end.

## 3.2 Flowchart

These show the flowchart of the total project, experimental setup, and Arduino setting. It explains the procedure done step by step as shown in Figure 3.1, Figure 3.2, and Figure 3.6.



### 3.2.1 Flowchart of Project.

Figure 3.1 below shows the overall project methodology. After the objectives of the project are discussed and verified, the Arduino coding begins followed by the setup of the device inside Perodua Axia car during daylight. Next, the data are collected through notification from mobile phone and interpreted.

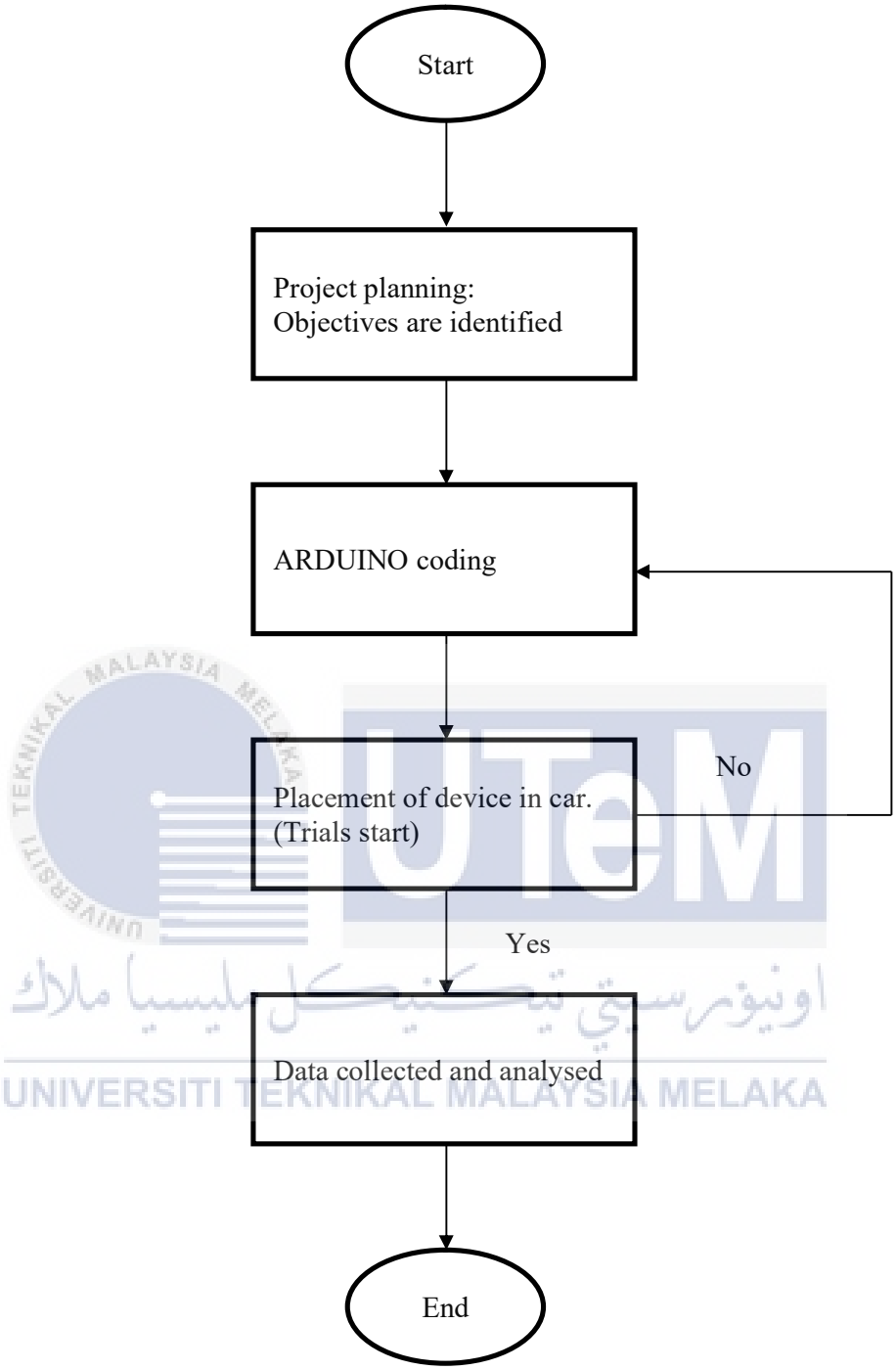



Figure 3.1 Overall Project Flowchart

### 3.2.2 Arduino Setting Flowchart.

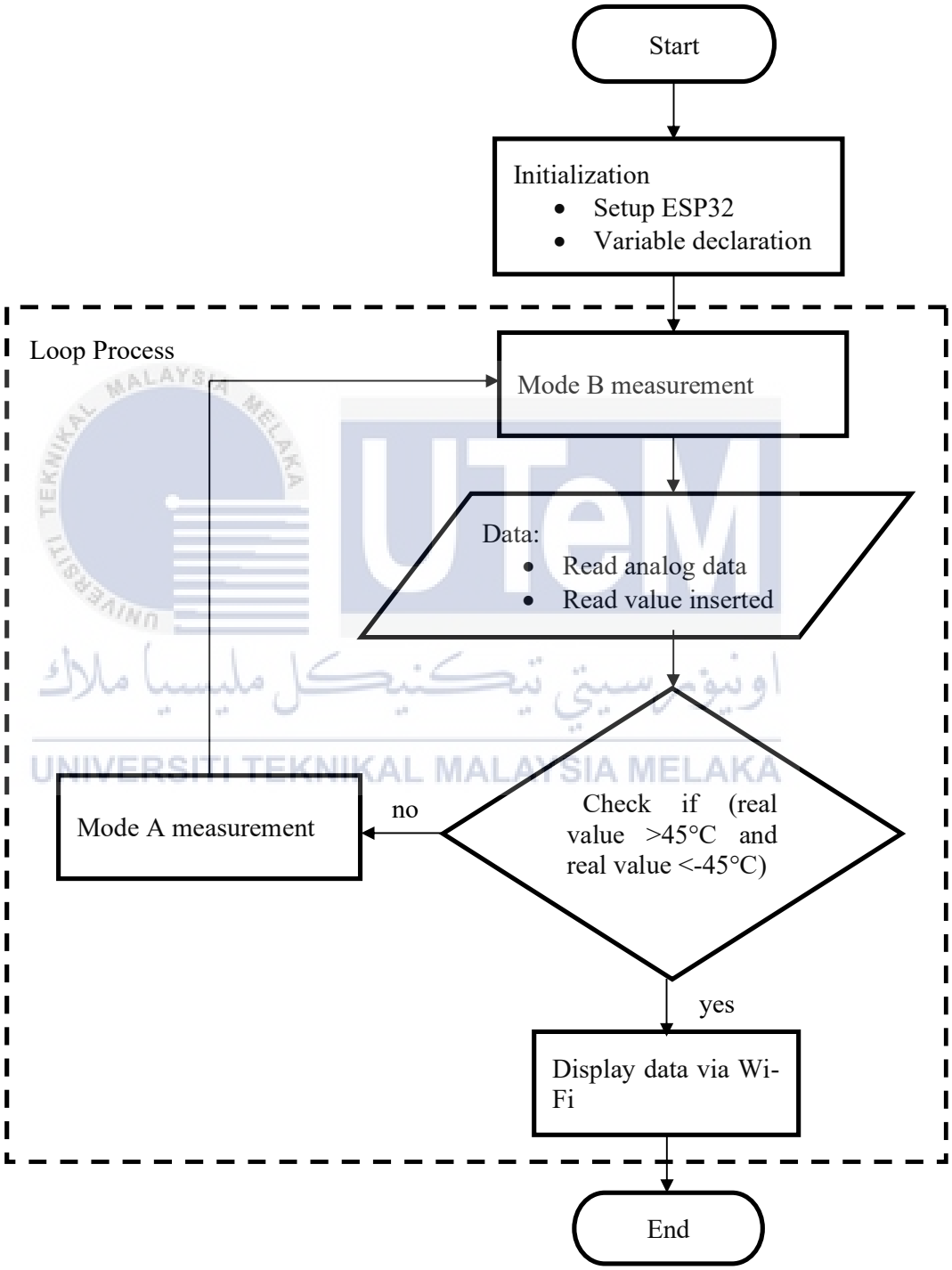



Figure 3.2 Arduino Setting Flowchart

### 3.2.2.1 Arduino Set Up

A software called ‘Arduino’ is installed. The coding used for this installation as shown in Figure 3.3, Figure 3.4 and Figure 3.5 below.

ESP32_WiFi_PSM2

```
#define BLYNK_PRINT Serial

#include <WiFi.h>
#include <WiFiClient.h>
#include <BlynkSimpleEsp32.h>
#include <DHT.h>;

#define DHTPIN 4          // What pin we're connected to
#define DHTTYPE DHT22     // DHT 22  (AM2302)
DHT dht(DHTPIN, DHTTYPE); // Initialize DHT sensor for normal 16mhz Arduino

char auth[] = "BYRt5iSGFNE9KJfZREruLDYhvIR4_m_N"; //Authorize key can be found in the Blynk App

// Your WiFi credentials.
// Set password to "" for open networks.
char ssid[] = "Yes4G Huddle LTE - 20C4"; //WiFi ID
char pass[] = "Fatin177684"; //WiFi password

float temp = 0, hum = 0, maxTemp = 40; //Inital max temp is 30(Can be changed)
int enableNotify = 1, fan = 0, fan_cnt = 0, notify_cnt = 61;

BlynkTimer timer; // Announcing the timer
WidgetLED led(V5);

BLYNK_WRITE(V3) {
   enableNotify = param.asInt(); //Detect the button's value (ON = 1, OFF = 0)
}
BLYNK_WRITE(V4) {
   maxTemp = param.asFloat();    //Detect the slider's value (From 1 until 100)
```

Code formatted for HTML has been copied to the clipboard.

ESP32_WiFi_PSM2

```
BLYNK_WRITE(V4) {
   maxTemp = param.asFloat();    //Detect the slider's value (From 1 until 100)
}
BLYNK_WRITE(V2) {
   fan = param.asInt();          //Detect the button's value (ON = 1, OFF = 0)
}

void setup()
{
  // Debug console
  Serial.begin(9600);

  pinMode (21, OUTPUT); //Set pin as digital OUTPUT
  pinMode (22, OUTPUT); //Set pin as digital OUTPUT
  pinMode (23, OUTPUT); //Set pin as digital OUTPUT
  pinMode (33, OUTPUT); //Set pin as digital OUTPUT
  pinMode (19, OUTPUT); //Set pin as digital OUTPUT
  pinMode (27, OUTPUT); //Set pin as digital OUTPUT
  pinMode (14, OUTPUT); //Set pin as digital OUTPUT
  pinMode (25, OUTPUT); //Set pin as digital OUTPUT
  pinMode (26, OUTPUT); //Set pin as digital OUTPUT
  dht.begin();
  Blynk.begin(auth, ssid, pass);
  timer.setInterval(1000L, sensorDataSend); //Timer will run every sec
}

void sensorDataSend() {
  delay(1000); //Delay 1s (1000 = 1 second)
```

Figure 3.3 Arduino Coding 1.

ESP32_WiFi_PSM2

```
  delay(1000); //Delay 1s (1000 = 1 second)

  if (fan) {        //When fan timer is larger than 0, it will turn on the fan
    ++fan_cnt;              //Fan timer increased

    digitalWrite(21, HIGH); //Turn on the fan
    digitalWrite(22, HIGH); //Turn on the fan
    digitalWrite(23, HIGH); //Turn on the fan
    digitalWrite(33, HIGH); //Turn on the fan
    digitalWrite(19, HIGH); //Turn on the fan
    digitalWrite(27, HIGH); //Turn on the fan
    digitalWrite(14, HIGH); //Turn on the fan
    digitalWrite(25, HIGH); //Turn on the fan
    digitalWrite(26, HIGH); //Turn on the fan
    led.on();

    if (fan_cnt > 1800) {   //When fan timer reached 1800 (or 30 minutes), it will turn off the fan
      fan_cnt = 0;          //Fan timer is set to 0
      fan = 0;
      Blynk.virtualWrite(V2, LOW);  //Sending humidity data to Blynk
    }
  }
  else
  {
  digitalWrite(21, LOW); //Turn off the fan
  digitalWrite(22, LOW); //Turn off the fan
  digitalWrite(23, LOW); //Turn off the fan
  digitalWrite(33, LOW); //Turn off the fan
  digitalWrite(19, LOW); //Turn off the fan
```

Code formatted for HTML has been copied to the clipboard.

ESP32_WiFi_PSM2

```
  digitalWrite(33, LOW); //Turn off the fan
  digitalWrite(19, LOW); //Turn off the fan
  digitalWrite(27, LOW); //Turn off the fan
  digitalWrite(14, LOW); //Turn off the fan
  digitalWrite(25, LOW); //Turn off the fan
  digitalWrite(26, LOW); //Turn off the fan
  led.off();
  }

  hum = dht.readHumidity();     //Accepting the humidity data from DHT
  temp= dht.readTemperature();  //Accepting the temperature data from DHT
  Blynk.virtualWrite(V0, temp); //Sending temperature data to Blynk
  Blynk.virtualWrite(V1, hum);  //Sending humidity data to Blynk

  if(temp < maxTemp){  //Notification is enabled every 5 seconds
  notify_cnt = 61;                                  //Notify timer is set to 0
  }
  if(notify_cnt > 60 && temp >= maxTemp && enableNotify == 1){ //Notification is enabled every 5 seconds
  Blynk.notify("HIGH TEMPERATURE DETECTED!");       //Send notification to Blynk
  notify_cnt = 0;                                   //Notify timer is set to 0
  }
  notify_cnt++;                                     //Notify counter increased every second
}

void loop()
{
  Serial.print("Humidity: ");
  Serial.print(hum);
  Serial.print(" %, Temp: ");
```

Code formatted for HTML has been copied to the clipboard.

Figure 3.4 Arduino Coding 2.

```
ESP32_WiFi_PSM2
  digitalWrite(26, LOW); //Turn off the fan
  led.off();
  }

  hum = dht.readHumidity();     //Accepting the humidity data from DHT
  temp= dht.readTemperature();  //Accepting the temperature data from DHT
  Blynk.virtualWrite(V0, temp); //Sending temperature data to Blynk
  Blynk.virtualWrite(V1, hum);  //Sending humidity data to Blynk

  if(temp < maxTemp){  //Notification is enabled every 5 seconds
  notify_cnt = 61;                                          //Notify timer is set to 0
  }
  if(notify_cnt > 60 && temp >= maxTemp && enableNotify == 1){ //Notification is enabled every 5 seconds
  Blynk.notify("HIGH TEMPERATURE DETECTED!");               //Send notification to Blynk
  notify_cnt = 0;                                           //Notify timer is set to 0
  }
  notify_cnt++;                                             //Notify counter increased every second
}

void loop()
{
  Serial.print("Humidity: ");
  Serial.print(hum);
  Serial.print(" %, Temp: ");
  Serial.print(temp);
  Serial.println(" Celsius"); //Print temp and humidity values to serial monitor
  Blynk.run();
  timer.run();               //Run timer every second
}
Code formatted for HTML has been copied to the clipboard.
```

Figure 3.5 Arduino Coding 3.

### 3.2.3 Experimental Setup Flowchart

Experimental setup is done outdoor where the heat extraction device is being tested in the car during daylight within 10.00 am until 4.00pm. The device will be located at the passenger's mirror. The experimental setup flowchart is shown in Figure 3.6 below.

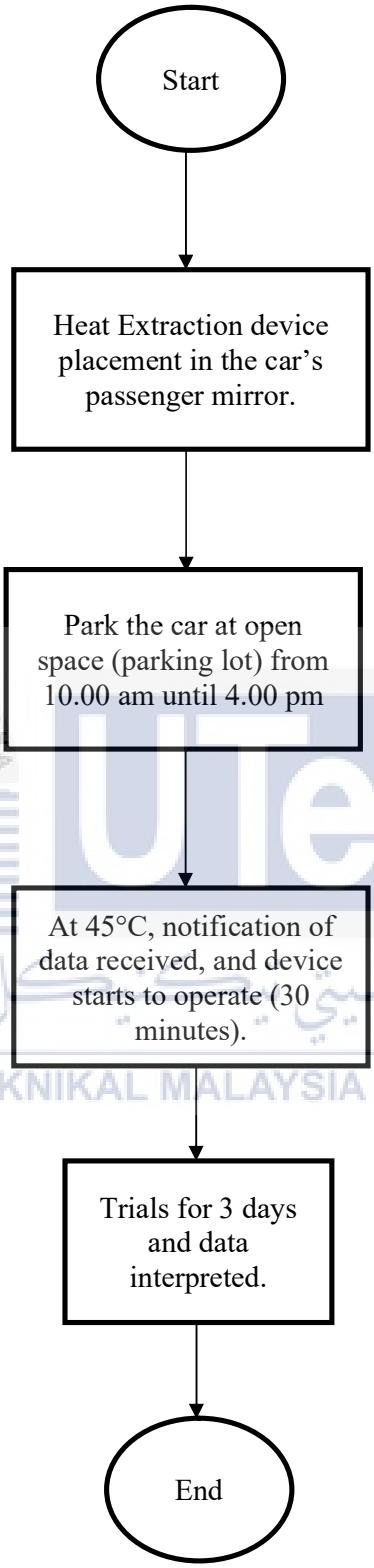





Figure 3.6 Experimental Setup Flowchart.

### 3.2.3.1 Experiment Setup

The exhaust fan setup is on the passenger window car. These figures show the following setup of the project. Initially, put the glove compartment on the window as shown in Figure 3.7 below. Next, place the exhaust fan device on the window as shown Figure 3.8. Lift the window up as shown in Figure 3.9.

Furthermore, place the digital thermometer on the cushion for double measure the temperature as shown Figure 3.10. Lastly, after the product is ready to be measured, make sure the temperature readings on the digital thermometer and in the apps are the same. take readings at ambient temperature (outside) as shown Figure 3.11.


Figure 3.7 Glove compartment on the window.


Figure 3.8 Exhaust fan device on the window

Figure 3.9 Lift the window up.



Figure 3.10 Digital thermometer on the cushion.

Figure 3.11 Product is ready to be measured.

Figure 3.12 Sketch of exhaust fan in car.

### 3.2.4 Formula of Heat Quantity, Electric Work and Power.

There are several steps before able to calculate heat quantity, electric work and power which are by determining the hot air volume in the cabin in Equation (1).

Hot air volume in car cabin:

$$V = Length\ x\ Width\ x\ Height\ (cm^3) \quad (1)$$

Following determining the interior volume, the quantity of heat within the car's compartment may be estimated. The method used to compute the heat amount within the automobile cabin is shown in Equation (2).

$$Q_h = \rho_a \times V \times C_a(T_2 - T_1) \quad (2)$$

$Q_h$ = Heat quantity in car cabin (J)

$\rho_a$ = Density of air (0.0012g /cm³)

V = Volume of car (cm³)

$C_a$ = Specific heat of air (1.0048 J/g °C)

$(T_2 - T_1)$ = Changes in temperature (°C)



According to equation (2), the heat amount, $Q_h$, is exactly equal to the volume of the automobile. As a result, a larger automobile with a greater V factor will produce more heat than a smaller car at the similar temperature.

The measure of heat derived through equation (2) is supposed to be the similar as the proportion of energy effort needed by the device to take out a specified amount of hot air in each time frame.

The formula for Electric Work Required is as follows:

$$W_e = VI\Delta t \quad (3)$$

$W_e$ = Electric work (kJ)

V = Hot air volume ($cm^3$)

I = Current (A)

Δt = Time taken (1800s)

Market survey, the power supply for the entire device in the project is anticipated to be 4.2V. The time necessary to lower the inside temperature is instead set. Lastly, the current value, I, may be determined. The amount will then be entered into equation (4) to compute the level of power necessary by the fan to expel the heated air leaving the automobile interior.

$$P = IV \quad (4)$$

P = Power (W)

I = Current (A)

V = Voltage used by the rechargeable battery (4.2V)

The power, P, amount derived from formula (4) will be employed to determine the fan, solar panel, and rechargeable battery to be applied in the devices. Efficiency of the device is then calculated as in Equation (5)

$$\eta = Output \div Input \times 100\% \quad (5)$$

### 3.3 The Parameters Measure

There are 3 parameters measure for this project which are ambient temperature, interior temperature and difference of temperature taken for the car cabin to cool down as shown in Table 3.1 below.

The mathematical model developed aided in the construction computation of the Solar Powered Exhaust Fan for Cars, as well as the conceptual examination of its efficiency. An example automobile has been considered as the core for this project. The car's interior dimensions are Perodua Axia:

Length = 190 cm  Width = 138.5cm Height = 124.0 cm

These measurements are substituted into equation (1) to calculate the volume of hot air in the car's interior.

$V = 3263060\ cm^3$

## 3.4 Location for Experiment.

The appropriate place to do the experiment is in the FTK campus parking lot. The chosen parking spot is the student parking lot.

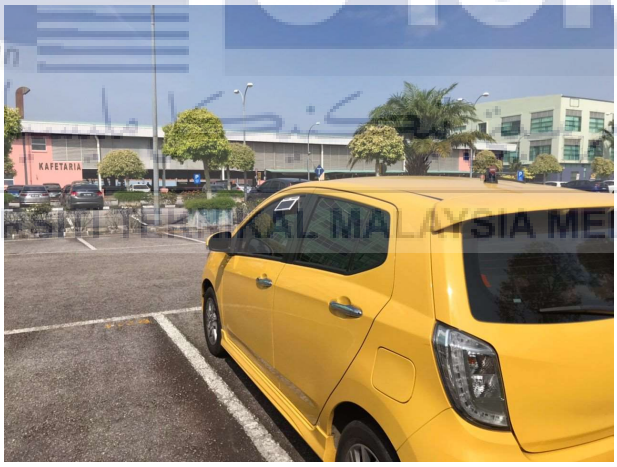



Figure 3.13 Back view during experiment.

Figure 3.14 Side view during experiment.

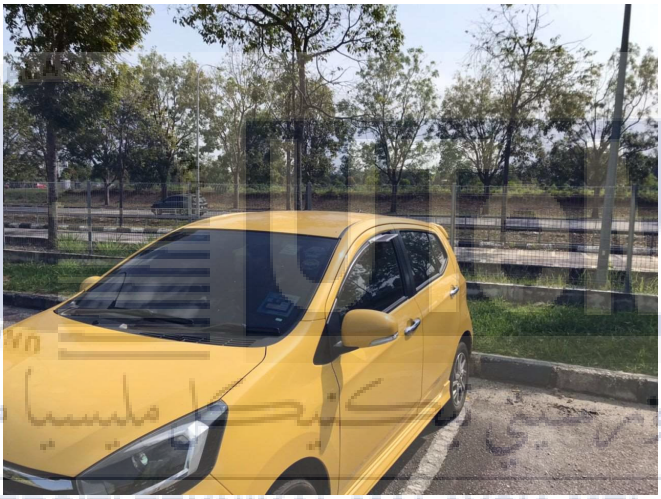




Figure 3.15 Front view during experiment

Figure 3.16 Interior view during experiment

Table 3.1 Parameters Measure

| Time (24H) | Ambient Temperature, $T_\infty$ (°C) | Interior Temperature, $T_1$ (°C) | $\Delta T$ (°C) |
|---|---|---|---|
| 1100 | | | |
| 1145 | | | |
| 1230 | | | |
| 1315 | | | |
| 1400 | | | |
| 1445 | | | |
| 1530 | | | |



## 3.5 Limitation of Proposed Methodology

There are few limitations encounter during the set up. Firstly, the failure of connecting device by other apps. Most of the apps used more complicated features of establishment to connect the device which consider to be a failure as no usage of Internet of Things (IOT).

Secondly, is the place of device setup. The device is initially planning to be located at the driver seat or back seat. However, due to the uncomfortable and blind zone of driver, the location had been replaced to the left passenger seat. The back seat is too far away from the driver and being reconsider of the heat efficiency will drop.

## 3.6 Summary

This chapter explains on how the device is created and setup in Perodua Axia cabin car. The flowcharts are compulsory as guidance throughout the process. After the objectives of the project are discussed and verified, the Arduino coding begins followed by the setup of the device inside a Axia car during daylight.

Next, the data are collected through notification from mobile phone and interpreted. A software called ‘arduino’ is installed. The coding used in this installation. The exhaust fan configuration is on the automobile with the passenger window. To begin, place the glove compartment on the windows. Install the exhaust fan device on the window.

Moreover, slide the glass all the right up to ensure the gadget stays in place. In addition, set the temperature probe on the seat to double-check the temperature. Finally, once the product is fit to be tested, double-check that the temperature data on the digital thermometer and in the applications are identical.

# CHAPTER 4

# RESULTS AND DISCUSSION

## 4.1 Introduction

This chapter will talk about the result and analysis on the parameters measured as table in Chapter 3. The analysis is then done by Minitab Software for more details. Not only that, the limitation throughout the process will also be classified.

## 4.2 Result of Parameters Measure

Initially, the exhaust fan device is set up about 10 minutes before measurement is taken. It is placed on the passenger seat on the left. Six days of observations which are Mondays, Tuesdays, and Wednesdays. Each day had been taken out the measurements before and after. The before indicating the measurement of the car without the presence of exhaust fan as in Table 4.1, Table 4.3, and Table 4.5. Meanwhile the after measurement shows the measurement with the exhaust fan as in Table 4.2, Table 4.4, and Table 4.6.

The ambient temperature and interior temperature are taken before the process start by using the thermometer device without the function of the exhaust fan to differentiate the temperature between the existence of exhaust fan and not if the device managed to show cooling effect in the cabin car. The highest interior temperature normally car reached is at 1230 with 65 °C and difference with the ambient temperature is 26 °C.

Table 4.1 Interior and Ambient Temperature, $T_1$ (Without Exhaust Fan) (°C) Monday 29/11/2021

| Time (24H) | Ambient Temperature, T∞ (°C) | Interior Temperature (°C) |
|---|---|---|
| 1100 | 35 | 50 |
| 1145 | 34 | 58 |
| 1230 | 38 | 60 |
| 1315 | 36 | 52 |
| 1400 | 34 | 54 |
| 1445 | 31 | 58 |
| 1530 | 32 | 54 |

Table 4.2 Interior and Ambient Temperature, $T_1$ (With Exhaust Fan) (°C) Monday 6/12/2021

| Time (24H) | Ambient Temperature, T∞ (°C) | Interior Temperature (°C) |
|---|---|---|
| 1100 | 33 | 48 |
| 1145 | 36 | 60 |
| 1230 | 35 | 62 |
| 1315 | 34 | 60 |
| 1400 | 36 | 56 |
| 1445 | 35 | 54 |
| 1530 | 31 | 52 |

Table 4.3 Interior and Ambient Temperature, $T_1$ (Without Exhaust Fan) (°C) Tuesday 30/11/2021

| Time (24H) | Ambient Temperature, T∞ (°C) | Interior Temperature (°C) |
|---|---|---|
| 1100 | 37 | 55 |
| 1145 | 39 | 63 |
| 1230 | 45 | 63 |
| 1315 | 40 | 64 |
| 1400 | 40 | 59 |
| 1445 | 41 | 60 |
| 1530 | 42 | 63 |

Table 4.4 Interior and Ambient Temperature, $T_1$ (With Exhaust Fan) (°C) Tuesday 7/12/2021

| Time (24H) | Ambient Temperature, T∞ (°C) | Interior Temperature (°C) |
|---|---|---|
| 1100 | 34 | 47 |
| 1145 | 41 | 62 |
| 1230 | 37 | 64 |
| 1315 | 39 | 61 |
| 1400 | 37 | 59 |
| 1445 | 38 | 57 |
| 1530 | 34 | 50 |

Table 4.5 Interior and Ambient Temperature, $T_1$ (Without Exhaust Fan) (°C) Wednesday 1/12/2021

| Time (24H) | Ambient Temperature, T∞ (°C) | Interior Temperature (°C) |
|---|---|---|
| 1100 | 33 | 63 |
| 1145 | 35 | 74 |
| 1230 | 44 | 78 |
| 1315 | 32 | 79 |
| 1400 | 40 | 76 |
| 1445 | 45 | 62 |
| 1530 | 34 | 63 |

Table 4.6 Interior and Ambient Temperature, $T_1$ (With Exhaust Fan) (°C) Wednesday 8/12/2021

| Time (24H) | Ambient Temperature, T∞ (°C) | Interior Temperature (°C) |
|---|---|---|
| 1100 | 35 | 55 |
| 1145 | 43 | 70 |
| 1230 | 42 | 69 |
| 1315 | 41 | 68 |
| 1400 | 44 | 65 |
| 1445 | 41 | 66 |
| 1530 | 40 | 60 |

In addition, the data in Table 4.7 shows that it started at 1100 a.m. This is because the cabin temperature initial reached 45 °C at 1100 after being exposed starting from 10.00 a.m. The initial temperature started out at 30 °C before starting the process. The car had been parked inside house parking for the whole night and that is why it takes almost 1 hour for it to reach from 30 to 45 °C, adding in the weather changes to cloudy that day.

The time taken for the process is in the range of 10 am until 4 pm. However, some of the data recorded is not as expected as stated by (Khairuddin, Khairunnisaa, 2015). This is due to the changes of weather into cloudy which can affect the concentration of sun reflect onto the car.

Not only that, other changes of the small change of temperature are due to the presence of tinted mirror and windows which can be seen in Figure 4.1. The highest value of differences is only at 10 °C.

Table 4.7 Recorded Measurements by Blynk Apps (Before)

| Time (24H) | Ambient Temperature, T∞ (°C) | Interior Temperature, $T_1$ (Without Exhaust Fan) (°C) | $\Delta T_1$ (°C) (interior – ambient) | $\Delta T_2$ (°C), Differences of temperature.(45 – ambient) | Temperature Reduction Efficiency (%) T2/T1 x 100% |
|---|---|---|---|---|---|
| 1100 | 35 | 56 | 21 | 10 | 17.86 |
| 1145 | 36 | 65 | 29 | 9 | 13.84 |
| 1230 | 40 | 67 | 27 | 5 | 7.46 |
| 1315 | 36 | 65 | 29 | 9 | 13.85 |
| 1400 | 38 | 63 | 25 | 7 | 11.11 |
| 1445 | 39 | 60 | 21 | 6 | 10.00 |
| 1530 | 36 | 60 | 24 | 9 | 15.00 |
| | | | Total | 55 | 89.12 |



The total efficiency of the device is calculated by the temperature reduction (before) is 12.73 % as shown below.

$\eta$ = (0.8912/ 7 data) X 100 %

$\eta$ = 12.73%.

Table 4.8 Recorded Measurements by Blynk Apps (After)

| Time (24H) | Ambient Temperature, T∞ (°C) | Interior Temperature, $T_1$ (With Exhaust Fan) (°C) | $\Delta T_1$ (°C) | $\Delta T_2$ (°C), Differences of temperature. (ambient) (45 – T . | Temperature Reduction Efficiency (%) |
|---|---|---|---|---|---|
| 1100 | 34 | 50 | 16 | 11 | 22.00 |
| 1145 | 40 | 64 | 24 | 5 | 7.81 |
| 1230 | 38 | 65 | 26 | 6 | 9.23 |
| 1315 | 38 | 63 | 25 | 7 | 11.11 |
| 1400 | 39 | 60 | 21 | 6 | 10.00 |
| 1445 | 38 | 59 | 21 | 7 | 11.86 |
| 1530 | 35 | 54 | 19 | 10 | 18.52 |
| | | | Total | 52 | 90.53 |

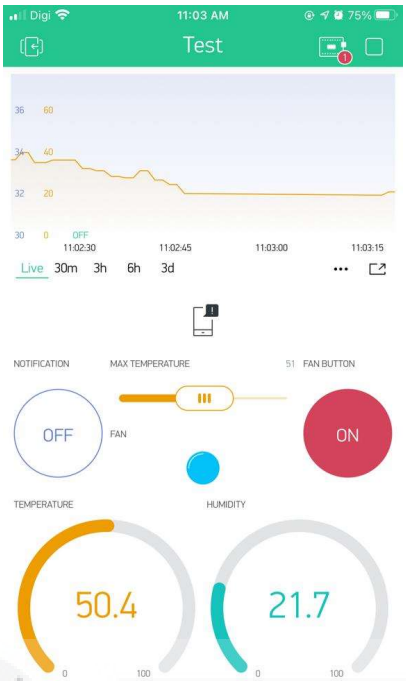



Figure 4.1 Result Data from Apps Blynk on 11.00 am.

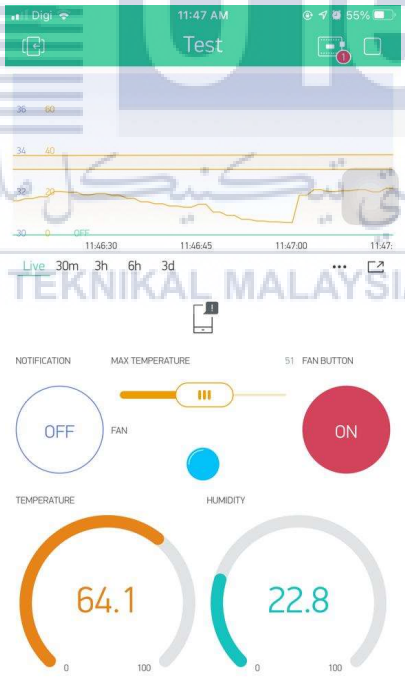



Figure 4.2 Result Data from Apps Blynk on 11.45 pm.

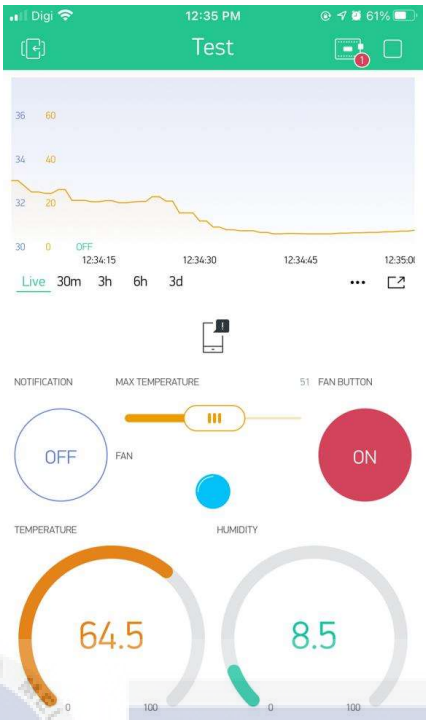



Figure 4.3 Result Data from Apps Blynk on 12.35 pm.

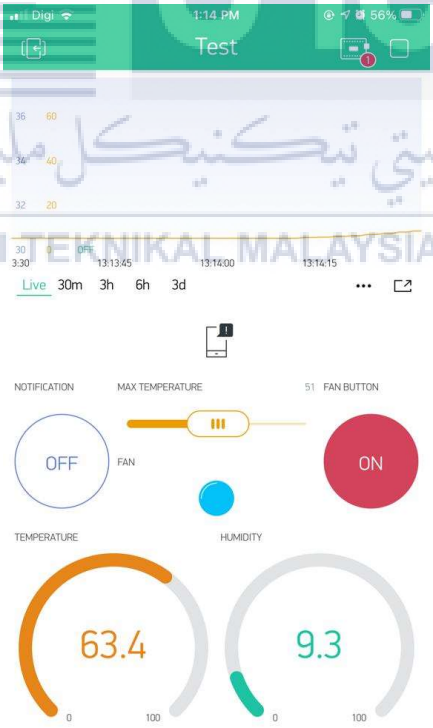



Figure 4.4 Result Data from Apps Blynk on 1.15 pm


Figure 4.5 Result Data from Apps Blynk on 2.00 pm

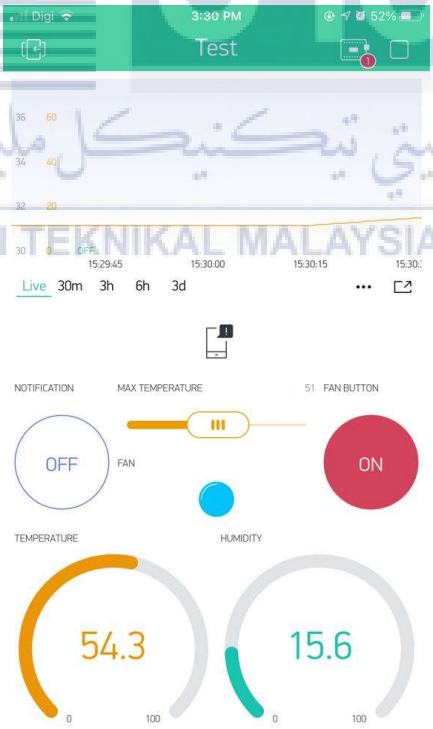



Figure 4.6 Result Data from Apps Blynk on 3.30 pm

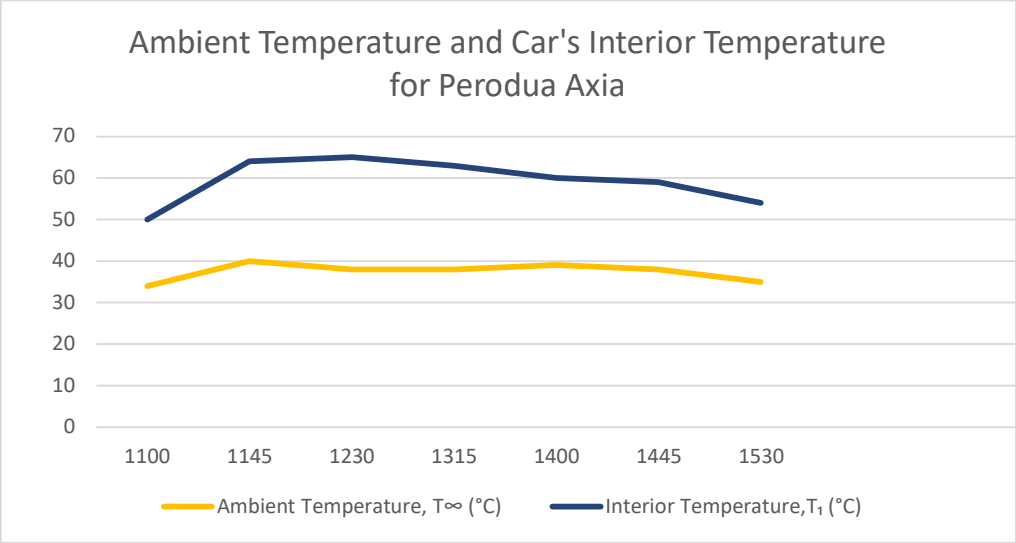



Figure 4.7 Graph of Ambient Temperature and Car's Interior Temperature for Axia.

Next is the calculation of other measurements. These are calculated each for all measurements given as shown in Table 4.7 and Table 4.8. The heat quantity is calculated by the substitute value of cabin dimension which represent the volume of hot air, 3263060 $cm^3$ in Equation 2.

In addition, is the electric work. The electric work equation 3 is used to determine the minimum current value to function the fans and so does for the power. The rechargeable battery used for this device is 4.2 V. By this, all the other items also need to be qualified by 4.2 V as well (Ajid, 2008).

The Blynk app is set to give notification after the cabin temperature reach 45 °C. Within that moment, the fan will be on for 30 minutes and then off. The data after 30 minutes are recorded. The Blynk app's settings can be change by its coding and the apps itself (Pro, 2019) which benefit for other users if the car is parked in a large distant. Based on Table 4.7 and Table 4.9, the exhaust managed to decrease the difference of temperature at the maximum which is during 1230 from 26 °C to 20 °C, symbolizing the device managed to cool down the car cabin to a more comfortable zone.

However, the importance in achieving the objectives is by showing the differences of the temperature after 45 °C is reached and the minimum power required for a 4.2V device to start. This had been indicated at 1100 with the smallest value power of 0.011 W.

Table 4.9 Heat Quantity, Electric Work and Power needed for each 45 minutes.

| Time (24H) | T∞ (°C) | T interior (°C) | ΔT (Tin - 45°C) (°C) | $Q_h$ (kJ) | $W_e$ (kJ) | I (A) | P (W) |
|---|---|---|---|---|---|---|---|
| 1100 | 34 | 50 | 5 | 19.7 | 19.7 | 2.61E-3 | 0.011 |
| 1145 | 40 | 64 | 19 | 74.8 | 74.8 | 9.89E-3 | 0.042 |
| 1230 | 38 | 65 | 20 | 78.7 | 78.7 | 0.01 | 0.042 |
| 1315 | 38 | 63 | 18 | 70.8 | 70.8 | 9.37E-3 | 0.039 |
| 1400 | 39 | 60 | 15 | 59.0 | 59.0 | 7.81E-3 | 0.033 |
| 1445 | 38 | 59 | 14 | 55.1 | 55.1 | 7.29E-3 | 0.031 |
| 1530 | 35 | 54 | 9 | 35.4 | 35.4 | 4.68E-3 | 0.020 |



Lastly is about the efficiency. The total efficiency of the device is calculated by the temperature reduction is 12.93 % as shown below.

Ƞ = (0.9053/ 7 data) X 100 %

Ƞ = 12.93 %.

The efficiency is only slightly differences between before and after which is (12.93% -12.73%), 0.2%. This means that the difference by the presence of the exhaust fan or not is only significant showing the capacity of the car cabin is larger for the existing exhaust fan to cool it down.

The reduction is received by the subtraction of the interior temperature with the exhaust fan and without the exhaust fan. The highest temperature reduction is on 1100 hours which is 22.0 %. The percentage increase is in smaller range, indicates that the device is relatively small for a cabin dimension 3263060 $cm^3$.

Nevertheless, the efficiency can achieve 100% or 1 if the cabin dimension tested is smaller or by increasing the number of fans or the varies the location of the device per cabin car. Another one is that the exhaust fan can be added into the car HVAC system for a much faster cooling rate.

### 4.3 Weather Effects on Temperature.

The climate in Malaysia is hot and humid throughout the year. The rainy days are usually occurred in between October, November and December. The exhaust fan is charge up by using the rechargeable battery which is connected to the photovoltaic chips This will affects the efficiency of the exhaust fan device if the weather changes into raining or cloudy.

During raining days, the sun ray's exposure will become lessen, resulting in low temperature of car cabin even though it has been parked for the whole days. This is due to the heating of rainwaters, it begins to evaporate, increasing the humidity of the air, which loses its capacity to insulate as a result, the air itself begins to feel colder. The presence of the exhaust fan in the cabin car will not function if the temperature does not reach up to 45 °C due to the cold and rainy weather.

Nevertheless, during cloudy days, the UV lights exposure is a bit higher than in rainy days as the clouds do not completely block off the sun. This means that the set-up temperature of 45 °C can be achieved and the differences of temperature reducing can be seen as in Table 4.1. Although the exhaust fan cannot function fully throughout the day yet, it will still be able to reduce the temperature to the comfort of 45 °C inside the cabin car.

## 4.4 Summary

This chapter discussing on the results received by the differences of temperature after 30 minutes, minimum power supply to work on the fan of 4.2V battery and the total of efficiency of the device throughout the process.

The highest ambient temperature is 40 °C at 1145 showing that the sunlight rays' maximum on 11.45 am. Despite that, the largest difference of temperature is located on 1230 with 20 °C. A 1 °C differenced by the measurement on 1145. The cloudy weather during that day is one of the causes that effect the temperature from afternoon until early evening at 1600.



Besides that, the addition of window tinted throughout the car body also effected the efficiency of the device. This is because the tinted had unintentionally helped in cooling the cabin by reflecting away the UV light.

The total efficiency achieved for the total measurements of temperature, heat quantity, electric work and power is 12.93 % only. The differences between before and after is only 0.2%. This is a small percentage of efficiency which resemble that the device can only fully operated if the cabin dimension estimated to be 421913.66 $cm^3$.

Yet, the exhaust fan can be applied on the cabin of 3263060 $cm^3$ if the number of fans or varies in location of device in cabin car increase.

# CHAPTER 5

# CONCLUSION AND RECOMMENDATIONS

## 5.1 Conclusion

In conclusion, Malaysia is one of the countries located in the Equator line and experience climate of hot and humid throughout the year, ending in larger exposure towards the sun. Most of the citizens had to park their cars in an open parking especially in town during hectic hours. Due to the weather in Malaysia of hot and humid, the car interior gets heated easily and reach to an uncomfortable temperature even though it had been left for only 30 minutes. Regardless the car had been invented with cooling system of air conditioner, it takes time to cool down the cabin and mostly more than 30 minutes at a maximum speed level.

Exhaust fan device is introduced to help in reducing the heated temperature to an optimal temperature at the parking lot. This is to ensure that even for a long time, the car's interior is still cozy for driving afterwards. The device is controlled by an app called the Blynk which can be controlled in a far distance by internet connection only. The app does not need a high coverage but only small enough to be able to send a notification to the user, indicating of a high temperature had been reached in the car and switch on the exhaust fan device.



Before marketing the device, it had been tested by applying it in a car with a 3263060 $cm^3$ parked at students' parking lot in Universiti Teknikal Malaysia Melaka (UTeM). The device is powered up the rechargeable battery of 4.2 V from 10.00 a.m. until 4.00 p.m. Instead of just neglecting the sun power, a solar panel also being applied in the

device to power up the rechargeable battery which also save cost method. The device will activate after car's cabin temperature increased to 45 °C with a notification from the app, for 30 minutes. Every time the temperature reached 45 °C, the device will run according to the coding in the time range.

After receiving the data, the heat quantity, electric work, power, and efficiency being calculated and analyzed. The greatest ambient temperature is 40 °C at 1100, indicating that the sun's rays are at their strongest around 11.45 a.m. Notwithstanding this, the greatest temperature differential is seen on 1230, with a variation of 20 °C. The observation on 1145 resulted in a 1 °C discrepancy.

The gloomy weather that day is one of the factors influencing the temperature from midday till early evening at 1600. Aside from that, the installation of window tinting across the automobile structure had an influence on the device's performance. This is due the window film had unintentionally aided in cooling the interior by bouncing UV radiation.

The overall efficiency attained for all temperature, heat quantity, electric work, and power readings is just 12.93 %. This is a minimal percentage of efficiency, implying that the gadget can only be completely operational if the cabin dimension is anticipated to be 4211913.66 $cm^3$. However, if the quantity of fans or the placement of the device in the cabin automobile increases, the exhaust fan can be fitted to the 3263060 $cm^3$ cabin.



By this, it can be said that the objectives of the project, for adapt an exhaust fan device into an existing car by merged with Internet of Things (IOT) and managed to analyze the data to receive the heat extraction efficiency have been achieved.

## 5.2 Recommendations

For further studies on this relating exhaust fan project, some recommendations are suggested for more accurate results are:

i) Wider the usage of Internet of Things (IoT) apps. Some mobile phone does not support Blynk app due to its regulation. Not only that, a second app can be used of emergency if Blynk suddenly crashed.

ii) Include study for a better coding experience and reading. The coding's creation can be hard for a person who does not understand the concept and cannot be able to identify the mistakes if the device is not running.

iii) Increase the number of fans or amount of exhaust fan device in the cabin car which has an estimate cabin dimension as Perodua Axia, 3263060 $cm^3$.

## 5.3 Project Potential

The exhaust fan device can be applied and market into the industry especially for local automotive department such as Perodua and Proton. This will increase the car's marketing value and approved by most citizens exclusively for a family car. In addition, it will widen the usage of the Internet of Things (IOT) by Malaysian which eventually will upgrade Malaysia product in other country. This new application will not only help in reducing the cabin car temperature or increase health of users but benefit for Malaysia economy index.

# REFERENCES


D. Mellis, M. Banzi, D. Cuartielles, and T. Igoe,. (2007). Arduino. An open electronic prototyping platform.

A. M. Gibb. (2010). New media art, design, and the Arduino microcontroller:. PhD thesis.

Ahmad. (2021). Malaysia Barat, Semenanjung Malaysia, West Malaysia. Peninsular Malaysia.

Ajid, A. B. (2008). Solar Powered Exhaust Fan for Automobiles. University Teknologi Petronas, 31.

Andrew A. Kenny, C. F. (2007, February 29 March 4). The Engineering Resources For Advancing Mobility. Electronic Thermostat System for, 12.

Arvind. (2020). iCarData: The Best Time To Buy/Sell A 2015 Perodua Axia "Lagi Best" 1.0L SE. carlist.my, https://www.carlist.my/news/icardata-the-best-time-to-buy-sell-a-2015-Perodua-Axia-1.0L-79744/79744/.

Bank, T. W. (2019). Solar resource maps of Malaysia. Global Solar Atlas 2.0, https://solargis.com/maps-and-gis-data/download/malaysia.

Basar, M. e. (2013). Alternative Way in Reducing Car Cabin Temperature Using Portable Car Cooling System (Car-Cool). International Journal of Innovative Technology and Exploring Engineering, 140-143.

Benjamin, R. (March 2021). Addressing heat in cities. The News Strait Times, https://www.nst.com.my/opinion/letters/2021/03/678308/addressing-heat-cities.

Bethel Afework, Microgeneration Alberta, Jordan Hanania, Braden Heffernan, James Jenden, Kailyn Stenhouse, Brodie Yyelland, Jason Donev. (2020). Photovoltaic System. Eenergy Education, University of Calgary, 1.

Bharat Bohara, Sunil Maharjan, and Bibek Raj Shrestha. (2017). IoT Based Smart Home Using Blynk Framework. Blynk, IoT, NodeMcu, Raspberry Pi, Smart Home,, 2.

Corporation, N. I. (retrieved on 1" October 2008). Bulk and Thin Film Type. <http:/lzone.ni.com/devzone/cda/tut/p/id/7229>.

Devonshire, J. M. (2002). Thermal Comfort and Visual Performance. The Effects of Infraredreflective and Antireflective.

EINZ. (2016). Cara Dapatkan Simkad Yes 4G LTE Bagi Pelanggan Yes 4G Broadband. EINZ, https://einz.my/yes-4g-lte-sim-card/.

GreenMatch. (2021). 7 Benefits of Using Solar Energy. GreenMatch Blog, https://www.greenmatch.co.uk/blog/2014/09/7-benefits-of-using-solar-energy.

Jimblom. (2019). ESP32 Thing Hookup Guide. SparkFun, https://learn.sparkfun.com/tutorials/esp32-thinghookup-guide.

Junko Yoshida, L. M. (2017). Electronic Tutorials. Temperature Sensors, 8.

Keim, R. (2019). What Is a Microcontroller? The Defining Characteristics and Architecture of a Common Component. FORTE The Intelligent Bom Tool, https://www.allaboutcircuits.com/technical-articles/what-is-a-microcontroller-introduction-component-characteristics-component/.

Keller. (2003). Heat stroke is diagnosed by observation. heat stroke, 35-55.

Khairuddin, K. B. (2015). Development of Heat Extraction System for Automobile Application using Peltier Device. University Technology Petronas, 36-38.

M. Banzi. (2009). Getting Started with arduino. O'Reilly Media, Inc.

P.D. Abd. Aziz, S.S.A. Wahid, Yanuar Z. Arief and N. Ab. Aziz. (2016). Evaluation of Solar Energy Potential in Malaysia. Science Alert, https://scialert.net/fulltext/?doi=tb.2016.35.43#76636_con.

Postolache, A. (2020). DHT22 / AM2302 temperature and humidity sensor. DHT22 temperature and humidity sensor for Arduino, https://www.industrialshields.com/blog/arduino-industrial-1/post/dht22-am2302-temperature-and-humidity-sensor-224.

Pro, I. d. (2019). IoT Controlled LED using ESP32 with Blynk App. Configuring Blynk App for ESP32, https://iotdesignpro.com/projects/iot-controlled-led-using-esp32-with-blynk-app.

Sayer, J. (2002). The Effects of Infrared-Reflective and Antireflective Glazing. Thermal Comfort and Visual Performance.

Solangi, K.H., T.N.W. Lwin, N.A. Rahim, M.S. Hossain, R. Saidur and H. Fayaz,. (June 27-29, 2011). Development of solar energy and present policies in Malaysia. Proceedings of the 1st Conference on Clean Energy and Technology, (pp. 115-120). Kuala Lumpur.

Solhi, F. (March 2021). Malaysian cities are getting hotter: Study. The News Straits Times, https://www.nst.com.my/news/nation/2021/03/671506/malaysian-cities-are-getting-hotter-study.

Stroustrup, B. (1995). The C++ programming language. Pearson Education India.

TEP. (2021). Introduction to Arduino IDE. The engineering projects, https://www.theengineeringprojects.com/2018/10/introduction-to-arduino-ide.html.

William. (2016). Engineering Continuing Education PDH Courses. In Heat Transfer through Windows.

Xukyo. (2020). Create a web interface to control your NodeMCU ESP32. The NodeMCU ESP32 is a microcontroller with integrated Wifi and Bluetooth modules, https://www.aranacorp.com/en/create-a-web-interface-to-control-your-nodemcu-esp32/.

Yuan Alfinsyah Sihombing & Sustia Listiari. (2015). Detection of Air Temperature, Humidity and Soil pH by Using DHT22 and pH Sensor Based Arduino Nano . The Measurement of Air Temperature, Humidity and Soil pH of Strawberry Plants, 3-5.

Zhi Li, H. X. (2014). A newly exhaust fan is installed at the rear of the car. Pushing-Pulling Based Vehicle Parking Ventilation Cooling Characteristics Analysis.

## APPENDICES

APPENDIX A Gantt Chart PSM 1

| TASK | WEEKS | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| **PSM 1 Briefing and Meeting with supervisor** | | | | | | | | | | | | | | |
| **Identify research questions and research objectives** | | | | | | | | | | | | | | |
| **FYP title confirmation** | | | | | | | | | | | | | | |
| **Reading journal and article** | | | | | | | | | | | | | | |
| **Chapter 1c**<br>**1. Finding the information.**<br>**2. Create introduction, problem statement, objective and scope** | | | | | | | | | | | | | | |
| **Submit proposal to supervisor** | | | | | | | | | | | | | | |
| **Chapter 2**<br>**1. Sorting**<br>**2. Writing the literature review** | | | | | | | | | | | | | | |
| **Chapter 3**<br>**1. Create methodology flowchart.**<br>**2. Explain the data by using statistical method.** | | | | | | | | | | | | | | |
| **Turn it in with supervisor** | | | | | | | | | | | | | | |
| **Preparation of chapter 4**<br>**1. The half od result product.** | | | | | | | | | | | | | | |
| **Submit first draft to supervisor** | | | | | | | | | | | | | | |
| **Correction draft with supervisor** | | | | | | | | | | | | | | |
| **Submit final draft to panel and supervisor** | | | | | | | | | | | | | | |
| **PSM 1 presentation** | | | | | | | | | | | | | | |

APPENDIX B Gantt Chart PSM 2

| TASK | WEEKS | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| PSM 2 Briefing | | | | | | | | | | | | | | |
| Material's preparation | | | | | | | | | | | | | | |
| Blynk's app coding | | | | | | | | | | | | | | |
| Report correction | | | | | | | | | | | | | | |
| Model calculation of device | | | | | | | | | | | | | | |
| Set up testing | | | | | | | | | | | | | | |
| Measurement of data | | | | | | | | | | | | | | |
| Analysis of heat quantity, electric work and power. | | | | | | | | | | | | | | |
| Present to supervisor | | | | | | | | | | | | | | |
| Report updates of Chapter 4 and Chapter 5<br><br>Presentation slides | | | | | | | | | | | | | | |
| Submit first draft to supervisor | | | | | | | | | | | | | | |
| Correction draft with supervisor | | | | | | | | | | | | | | |
| Submit final draft to panel and supervisor | | | | | | | | | | | | | | |
| PSM 2 presentation | | | | | | | | | | | | | | |

APPENDIX C Turnitin Thesis Report

PSM

ORIGINALITY REPORT

| 19% | 16% | 6% | 13% |
|---|---|---|---|
| SIMILARITY INDEX | INTERNET SOURCES | PUBLICATIONS | STUDENT PAPERS |

PRIMARY SOURCES

| | | |
|---|---|---|
| 1 | Submitted to Universiti Teknikal Malaysia Melaka<br>Student Paper | 4% |
| 2 | utpedia.utp.edu.my<br>Internet Source | 3% |
| 3 | arxiv.org<br>Internet Source | 1% |
| 4 | components101.com<br>Internet Source | 1% |
| 5 | mail.scialert.net<br>Internet Source | 1% |
| 6 | eprints.utem.edu.my<br>Internet Source | 1% |
| 7 | aip.scitation.org<br>Internet Source | 1% |
| 8 | www.carlist.my<br>Internet Source | 1% |
| 9 | Submitted to Middlesex University<br>Student Paper | <1% |

| | | |
|---|---|---|
| 10 | Submitted to University of Reading<br>Student Paper | <1 % |
| 11 | www.coursehero.com<br>Internet Source | <1 % |
| 12 | Submitted to Universiti Malaysia Perlis<br>Student Paper | <1 % |
| 13 | research.library.mun.ca<br>Internet Source | <1 % |
| 14 | Submitted to Institute of Research & Postgraduate Studies, Universiti Kuala Lumpur<br>Student Paper | <1 % |
| 15 | Submitted to University of Central Lancashire<br>Student Paper | <1 % |
| 16 | Submitted to Bahrain Training Institute<br>Student Paper | <1 % |
| 17 | Submitted to University Tun Hussein Onn Malaysia<br>Student Paper | <1 % |
| 18 | www.allaboutcircuits.com<br>Internet Source | <1 % |
| 19 | Submitted to Laureate Education Inc.<br>Student Paper | <1 % |
| 20 | Submitted to Fiji National University<br>Student Paper | <1 % |

| | | |
|---|---|---|
| 21 | Submitted to Shen Wai International School<br>Student Paper | <1 % |
| 22 | www.greenmatch.co.uk<br>Internet Source | <1 % |
| 23 | Submitted to University of Bristol<br>Student Paper | <1 % |
| 24 | umpir.ump.edu.my<br>Internet Source | <1 % |
| 25 | Submitted to Middle East College of Information Technology<br>Student Paper | <1 % |
| 26 | Submitted to Universiti Tenaga Nasional<br>Student Paper | <1 % |
| 27 | idr-lib.iitbhu.ac.in:8080<br>Internet Source | <1 % |
| 28 | Submitted to Kyungpook National University<br>Student Paper | <1 % |
| 29 | hdl.handle.net<br>Internet Source | <1 % |
| 30 | Submitted to Swinburne University of Technology<br>Student Paper | <1 % |
| 31 | eprints.usm.my<br>Internet Source | <1 % |

| | | |
|---|---|---|
| 32 | scholar.colorado.edu<br>Internet Source | <1 % |
| 33 | www.hillandassoc.com<br>Internet Source | <1 % |
| 34 | Submitted to City University of Hong Kong<br>Student Paper | <1 % |
| 35 | N S Hamdan, M F M Radzi, A A M Damanhuri, S N Mokhtar. "Dual direction blower system powered by solar energy to reduce car cabin temperature in open parking condition", Journal of Physics: Conference Series, 2017<br>Publication | <1 % |
| 36 | etd.uum.edu.my<br>Internet Source | <1 % |
| 37 | www.ijrte.org<br>Internet Source | <1 % |
| 38 | InCIEC 2014, 2015.<br>Publication | <1 % |
| 39 | William L. Luyben, I - Lung Chien. "Design and Control of Distillation Systems for Separating Azeotropes", Wiley, 2010<br>Publication | <1 % |
| 40 | repositorio.ug.edu.ec<br>Internet Source | <1 % |
| 41 | sportdocbox.com<br>Internet Source | |

| | | |
|---|---|---|
| | | <1% |
| 42 | www.iaeme.com<br>Internet Source | <1% |
| 43 | www.perfectwriters.co.uk<br>Internet Source | <1% |
| 44 | Sumit Badotra, Lokesh Gundaboina, Ansh Trehan, Devansh Mishra, Prakrit Srivastava, Anil Kumar Dhaiya, Sharique Anwar. "Smart Irrigation System using Internet of Things (IoT) and Machine Learning", 2021 9th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO), 2021<br>Publication | <1% |

Exclude quotes On Exclude matches Off
Exclude bibliography On

# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA

TAJUK: **OPTIMIZING THE AUTOMOBILE HEAT EXTRACTION CONTROL USING ARDUINO.**

SESI PENGAJIAN: **2020/21 Semester 1**

Saya **MUHAMMAD ISMANAJMI BIN ROZI**

mengaku membenarkan tesis ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

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

| | | |
|---|---|---|
| ☐ | SULIT | (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972) |
| ☐ | TERHAD | (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan) |
| ☑ | TIDAK TERHAD | |

Disahkan oleh:

Alamat Tetap:
B33, KG PANTAI DALAM,
JALAN BELIMBING DALAM,
76100 MELAKA

Tarikh: 28/01/2022

Cop Rasmi:
MOHD FAEZ BIN ZAINOL
Jurutera Pengajar
Jabatan Teknologi Kejuruteraan Mekanikal
Fakulti Teknologi Kejuruteraan Mekanikal dan Pembuatan
Universiti Teknikal Malaysia Melaka

Tarikh: 28/1/2022

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