CLIMATE CONTROL UTILIZING SOLAR POWERED VENTILATION SYSTEM FOR PARKED CAR

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ABSTRACT

The heating phenomenon produces by hot weather caused the car's compartment to gain the heat from the surrounding and the sunlight radiation, while inside the compartment will have a higher temperature compared to the outside surroundings. The high heat trapped in the enclose compartment will bring uncomfortable and suffocation feel for the driver and passengers when they enter the parked car at the open parking areas. This occurs due to the process of heat transfer from the external environment to the interior of the car. Higher air condition power is necessary to cope with this situation. However, it only functions when the engine is running. Therefore, this research intended to invent a ventilation system and use the application of solar energy as the power source during the engine is not operating. The aim of this system is to eliminate and mitigate the effects of heat in the car when parked. This research also is to determine the temperature increment inside the car compartment under direct sunlight. The heat analysis was done to determine the total heat flux produced in the parked car compartment. The value then are used to determine the flow rate, cubit feet per minutes (CFM) that needed by the ventilation fan and used to determine the sizing of the solar panel and the battery capacity. Result from this study shows that this system manages to reduce temperature inside the car compartment from 49.6°C less to 41.3°C with 53% of the effectiveness. As a conclusion, the model of the ventilation system is successfully built with the AC blowing fan and a set of electronic circuit board to control the motor level of the blower speed and powered by the solar energy. The bigger area of solar power source produces a high of electricity to generate power to ensure the system can operate with high efficiency.

ABSTRAK

Fenomena pemanasan yang dihasilkan oleh cuaca panas menyebabkan peningkatan haba di dalam ruangan kereta kesan oleh haba dari sekeliling dan sinaran cahaya matahari, manakala ruang di dalam kereta akan mempunyai suhu yang lebih tinggi berbanding dengan persekitaran luar. Haba tinggi yang terperangkap di dalam ruangan tertutup akan menyebabkan rasa tidak selesa dan lemas untuk pemandu dan penumpang apabila mereka memasuki kereta yang diletakkan di kawasan tempat letak kereta terbuka. Ini berlaku disebabkan oleh proses pemindahan haba dari persekitaran luar ke dalam ruangan kereta. Penggunaan penyaman udara pada kelajuan yang tinggi adalah perlu untuk menangani masalah ini. Walaubagaimanapun, ianya hanya berfungsi apabila enjin sedang beroperasi. Oleh itu, kajian ini dilakukan bertujuan untuk mencipta sebuah sistem pengudaraan dan menggunakan aplikasi tenaga solar sebagai sumber kuasa semasa enjin tidak beroperasi. Objektif sistem ini adalah untuk mengurangkan kesan haba dalam kereta apabila kereta berada di tempat letak kereta. Kajian ini juga adalah untuk menentukan kenaikan suhu di dalam ruangan kereta di bawah pancaran terus cahaya matahari. Analisis haba telah dilakukan untuk menentukan jumlah fluks haba yang dihasilkan dalam ruangan kereta di tempat letak kereta. Kemudiannya, data berkenaan digunakan untuk menentukan kadar aliran, kaki hasta per minit (CFM) yang diperlukan oleh kipas pengudaraan dan digunakan untuk menentukan saiz panel solar dan kapasiti bateri. Keputusan daripada kajian ini menunjukkan bahawa sistem ini berjaya untuk mengurangkan suhu di dalam ruangan kereta dari 49.6 $^\circ$ C kepada 41.3 $^\circ$ C iaitu dengan kecekapan sebanyak 53%. Kesimpulannya, model sistem pengudaraan berjaya dibina dengan menggunakan kipas penghembus AC dan satu set litar elektronik untuk mengawal tahap kelajuan kipas penghmbus yang dikuasai oleh tenaga solar. Semaikin luas kawasan solar yang terdedah, semakin tinggi tenaga elektrik yang dihasilkan untuk menjana sistem ini pada kecekapan yang lebih tinggi.

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LIST OF ABBREVIATIONS

Do_{sp} -   Daily output of solar panel (*W h per day at 12V*)

I_I -   Current at load or other current specification of solar panel (*A*)

D_i -   Daily Insolation (*peak-hour per day*)

N_{sp} -   Minimum number of solar panel

Re -   Daily equipment of appliances (*W h per day*)

Do_{sp} -   Daily output of one module(*W h per day at 12V*)

$Ŋ_{bc}$ -   Charging effiency of battery (%)

C_t -   Total usable capacity needed (*A h at 12V*)

R_e -   Daily requirement of appliances (*W h per day*)

S_d -   Period of storage required (*days*)

N_b -   Minimum number of 12V batteries needed

C_t -   Total usable capacity needed (*A h at 12V*)

C_b -   Full capacity specified for one 12V battery (*A h*)

R_{maks} -   maximum depth of cycle (*%*)

RPM   -   Rotation Per Minutes

W   -   Power (Watt)

V   -   Voltage (Volt)

I   -   Current (Ampere)

AC   -   Alternating Current (Ampere)

CFM   -   Cubit Per Minutes (*ft³/min*)

Q   -   Total Heat Flux (Btu/ hr)

T_i -   Temperature Inside (^{o}C)

T_o -   Temperature Outside (^{o}C)

A_s -   Area of the window surface expose to sunlight, ft^2

F   -   Film coefficient of heat transfer

I_t -   Transmitted intensity

U	-	The average heat transfer coefficient through the window framed
α	-	Absorptivity
τ	-	Transmittivity
C_n	-	Whether brightness number
C	-	Radiation diffusion factor
A	-	Solar radiation
B	-	Atmospheric extinction coefficient,
β	-	Degrees declined
ε	-	Slope angle of the surface

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CHAPTER 1

INTRODUCTION

1.1   Overview of the Project

Global warming of earth has faced many problems due to the high temperature that can cause adverse effect including the car that we used every day. A car that's been exposed to direct sunlight for an extended period will develop a temperature built up inside it. The factors contributing to this is the temperature outside of the car, the temperature inside of the car directly proportional with the temperature outside. It is also depends on the inlet condition of a car, the place with more air circulation will have the highest temperature rise.

Most of the vehicle nowadays has very efficient and reliable heating ventilating, and air conditioning (HVAC) system. Ventilation was simple to arrange by opening the window. However the air entering was as hot, cold, or dusty as the air outside. Sheathing paper, weather windows and shading curtains can be used to control an automobile's temperature, but they are not very effective. When the weather turned hot, most drivers simply put up with the discomfort. Moreover, the instrumentation panel, leather seats and plastic accessories, among other items, age rapidly if exposed to these temperatures for a long period. It also causes a rise in fuel consumption due to higher power of air conditioning needed to cool down the car cabin, the interior of the car such as the dashboard, leather seats and the plastic accessories will age rapidly under the exposure to high temperature and there are also minor cases of child death while trapped inside the vehicle. The ventilation system is designed to provide comfort for the driver and passenger. It is intended to maintain

in-car temperature and humidity within a range that is comfortable for the people inside and provide fresh, clean air for ventilation. This temperature range helps keep the driver alert and attentive.

Figure 1.1 shows the type of accidents among children from 2006 until 2011 at United State. From this observation, the pie chart shows the number of accidents involving children left in the car showed the highest percentage compared to other accidents such as underage driver, car theft, backovers, frontovers, vehicle in motion and etc. This caused the child left in a car in the hot condition inside the vehicle. This causes them to drown and can cause occurrence Hyperthermia.
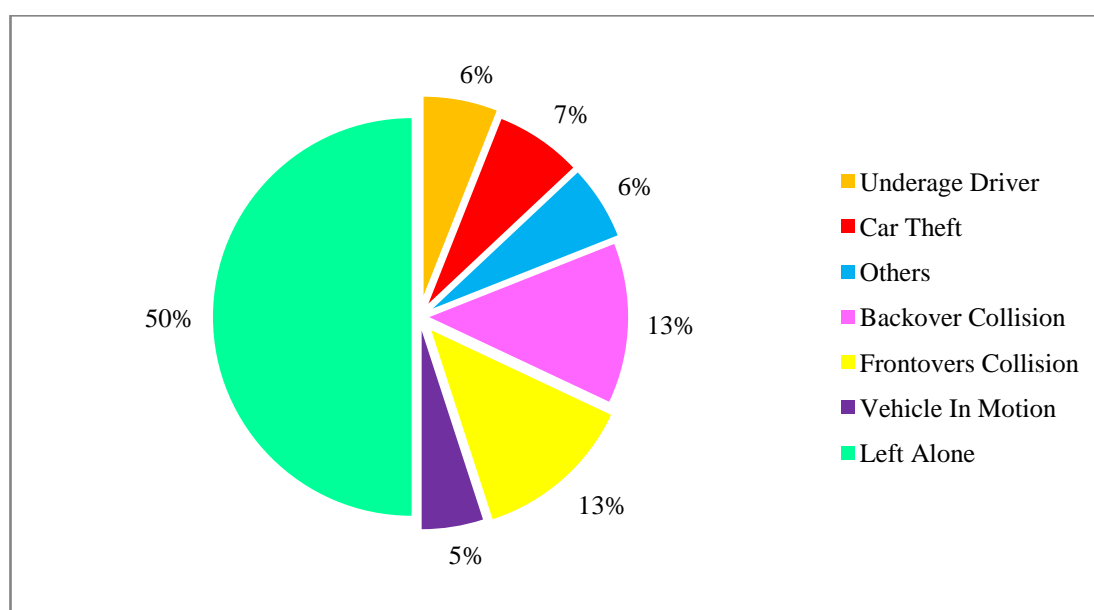
Figure 1.1: Type of accidents among children from 2006 until 2011

Studies indicate that, each year children die from hyperthermia as a result of being left in parked vehicles. Hyperthermia is an acute condition that occurs when the body absorbs more heat than it can dissipate. Hyperthermia can occur even on a mild day. Studies have shown that the temperature inside a parked vehicle can rapidly rise to a dangerous level for children, adults and pets. Figure 1.1 shows the graph of number death among children that cause by hyperthermia due to suffocation inside the vehicle.
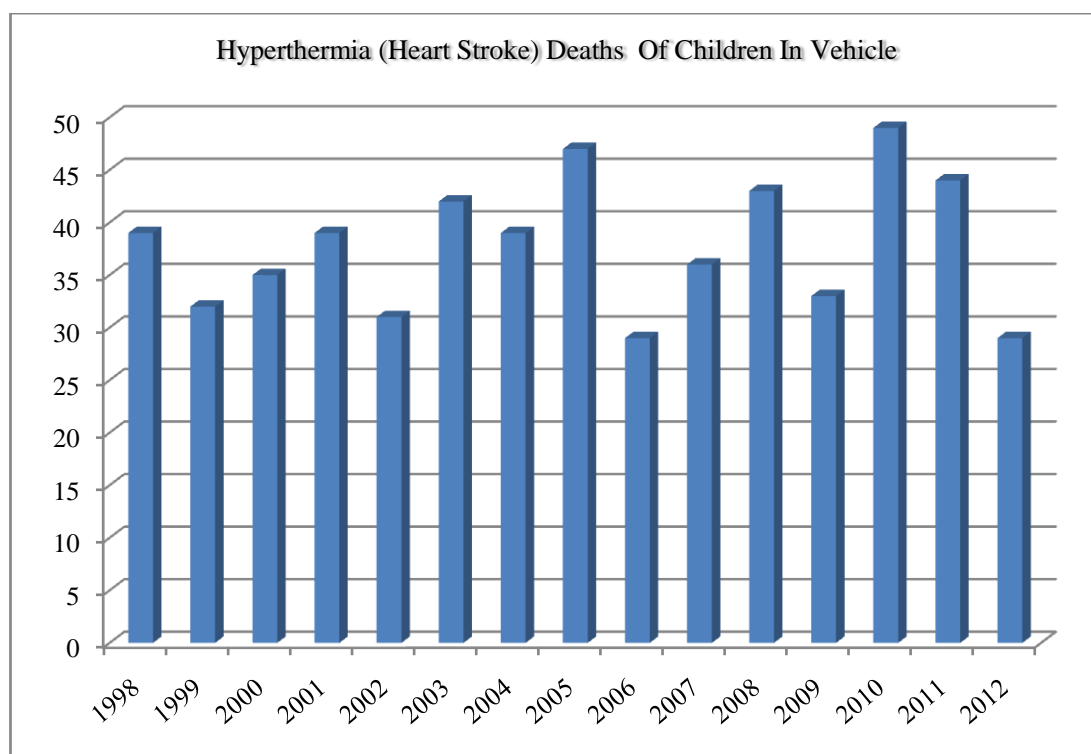
Figure 1.2:Graph the Number Death of Children in Vehicle cause by Hyperthermia

Therefore, this 'Climate Control Utilizing Solar Powered Ventilation System For Parked Vehicle' was specifically designed to overcome heat problems occur in while their vehicles parked. The objective of this system is to eliminate or mitigate the effects of heat in the car while the car is parked. The project is intended for an invention of an independent ventilation system to maintain the thermal comfort range of a compartment car for pleasure of the passenger, for the safety precaution if there a case of self-lock happen, and it is also financially positive for fuel consumption and interior investment of the car.

This system will use the solar energy as a power source. Refers to the world of solar energy map as shown in (Appendix A), Malaysia receives direct sunlight during peak hours on average four to five hours a day. This makes Malaysia among one of the countries that receive the longest high levels of sunlight in the world. For saving electricity, the use of solar energy is very effective because duration sunlight receives in Malaysia is sufficient to generate electric power to an optimum level.

Solar was used to generate the energy as a power to move a fan to blow the fresh air inside the car that will make good air ventilation in the vehicles. The use of solar system thus can save the use of electricity and fuel consumption as fuel price is

going higher nowadays. Thus it would be a great way for vehicle to reduce air conditioning uses, thus increasing fuel economy.

Therefore, the study of the use of solar energy as a power source for ventilation systems for passenger cars is very important. Solar energy is used to ensure that the ventilation system is always working when the car engine is turned off thereby saving energy and costs as solely derived power from the sun is always available.

1.2 Problem Statement

The temperature inside the car cabin is easily controlled while the engine if the car is running. This can be achieved by using the air conditioning system. However, what happens if the passenger is waiting inside the car while the engine is not operating, is the passenger managing to be comfortable inside the car while the car is parked directly under sunlight and the heats inside the car cabin is increasing.

The main question that leads to this research is 'how to employ an effective system by managing the flow inside the car compartment. This is because the heat built inside car compartment can cause a lot of problems such as reducing comfort when entering the blazing hot compartment. Besides that, it also can increase the safety preventing case such child asphyxiated and dehydrated in the car. Furthermore, it is prohibited to use a window tinted film in Malaysia as its state of the governing law. With this, we cannot put a protection layer at the vehicle windows to prevent direct UV heat from the outside as it will be very more dangerous to babies and pregnant woman that enter the car. However, if the person intend to stay in the car with the air-conditioning on, they can prevent their vehicle to get overheat by the cool air produce but this is consider as wastage because high power use by the air-conditioning to produce cool air consume high petrol usage. Another effect due to the increased heat in the car will reduce the lifespan of the car interior due to exposure to high temperatures. It also causes the inner surfaces of the car, cushions and steering wheel become hot. So we had to wear glove on occasion just to hold the steering wheel.

1.2   Objectives

The purposes of this project are;

(i)   To determine the temperature increment inside the compartment car under direct sunlight.

(ii)   To design a solar powered ventilation system that can eliminate and mitigate the effects of heat and suffocating inside car compartment.

(iii)   To develop the heat analysis by determining the total heat flux produced in the static car compartment.

1.4   Scope of Work

This project is primarily concerned with theclimate control utilizing solar powered ventilation system for parked car.Scopes of this project are:

(i)   Search, review and gather information about literatures reviews of car cabin ventilation from the journal and references book.

(ii)   Run the experiment to determine the temperature distribution and its increment inside car cabin.

(iii)   Modelling the intelligent actual climate control utilizing solar panel system by using Proteusand MPLAB software.

(iv)   Design and implementation of the heat control algorithm with solar panel.

1.5   Thesis Structure

This thesis is divided into five main chapters, which in the first chapter is the introduction of the study. It covers topics such as sub-objectives and scope of the study.

Whereas in Chapter 2, involves the theories that relate to the study. In addition, the literature review also infused at this chapter as a reference for the development of this project and comparison of the results obtained from the research.

For this study to be organized, structured work plan had placed in Chapter 3. Methodology and procedures work such as experimental steps carefully arranged. Selection of components and equipment also explained in this chapter. In addition,

the design of this project is also shown to explain more clearly how the experiment was conducted.

After statistical work is done, the process of retrieval of information or data attached in Chapter 4. Data were recorded in the form of tables and graphs to analyze the process. In this part, the analysis and discussion were critically described.

Then all the results obtained will be summarized into a simple and compact conclusion in Chapter 5 and provided suggestions for improving the study to be undertaken in the future

CHAPTER 2

LITERATURE REVIEW

2.1   Overview

According to research Wan Mohd kamil Bin Yacob from Universiti Malaysia Pahang conducted in late 2009 on Waja Car, the maximum temperature inside the car that fully closed under direct of sunlight can be increased up to 72.7 °C. At temperature with that high it can cause of our car tax tag damaged when it frequently expose to the sun and the materials are made of plastic release Nox (Nitrogen monoxide mixing and nitrogen dioxide) that affect our health and damage cell membranes, proteins and acute inflammation of the respiratory tract in lung and cause asthma.

How many years ago there Vint brand car accessories install in the car which allows the car to breathe. It will draw cold air from the outside and remove the hot air in the car to lower the heat in the car. However it is not practical due to the fan using a car battery power. This is because, when the car is not moving for a period of two days (Saturday and Sunday) cause's users burdened when they have work on Monday. Car battery is not capable of giving power to turn on the car engine.

Leno sales companies have introduced a small fan placed in the window to remove the hot air. But it has various drawbacks which is just with small open window and only covered by rubber. Rubber can be pulled out with this it allows easy car stolen or invaded. Solar cell placed vertically on the window. When the sun is positioned in the middle of the sky, sunlight will not exposed the solar panel because protected by the door visor. This will cause the system can not function as

expected. Moreover, there were no air holes for blowing hot air out of the car. How could little fan will be able to create a vacuum in the car.

Therefore, the planning studies take a leading role in the definitions of an issue. In this project, this system is designed to overcome these weaknesses. Due to several variables involved in the method and process, the planning activities had been before the actual product can be implemented.

2.2   Previous Study

Khan M.U et al, (1991) in [1] was developed development of ventilation technique to limit the car cabin temperature under a blazing sun. The temperature variation inside car cabin had been discussed in their investigation. From Figure 2.1 it shows the different of temperature at the top of the front panel and at the air temperature near driver head. These two places are the two highest temperatures in the car cabin. The same result achieved with simulation as shown in figure below. The simulation was did using three-dimensional Navier-Stokes equations. The software used is CFD2000, a Multi-disciplinary CFD and heat transfer software. The boundary condition is set to replicate the actual car used in the experiment. Mesh number is set to be 37x25x31 and the heat was radiate from roof, windows and seats. The air flows of the device also same with the experiment. The airflow rate of the fan is change in each simulation for 50, 100, 150 and 200 m3/h.
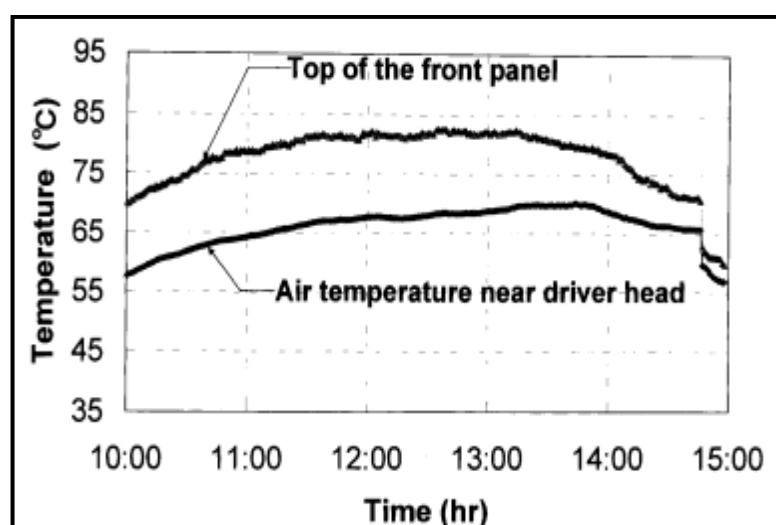
Figure 2.1: Temperature variation with the time at different locations

The results from the simulation showed in Figure 2.2 and 2.3 shows almost the same pattern as experimental data. The maximum temperature taken is at the front dashboard that is 81°C and followed by the air space near the driver head, 66°C[1].
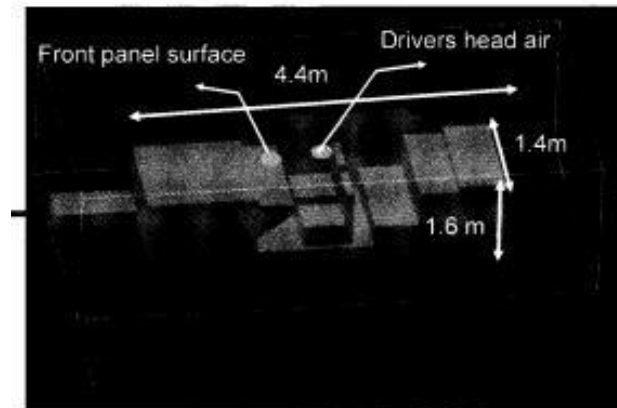
Figure 2.2: Part of the simulation model
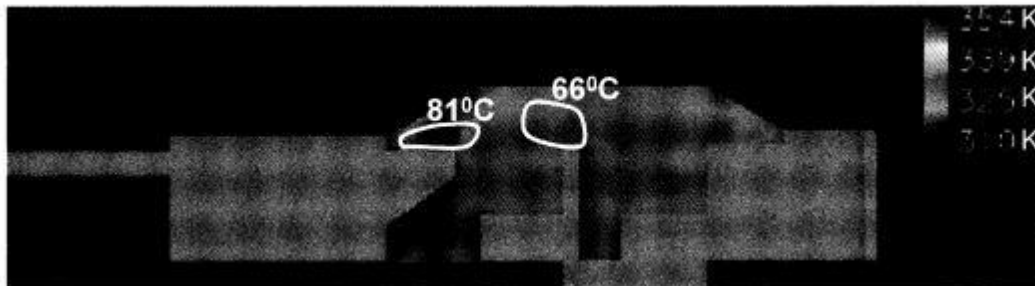
Figure 2.3: Temperature distribution in the car without ventilation rear view

Beside that, Bjorn Jenssen Wachenfldt et al, (2006) in [2] was investigated about air flow rate ane energy saving potential in school with demand controlled displacement ventilation. Figure 2.4 shown the heating temperature against volume flow rate, the efficiency is dropping with the flow rate of ventilation is increasing. The heat in a room is continuous replace by fresh air from outside so the energy loss because of the heat is being transfer out during the ventilation blower is running. From this concept, the ventilation process could reduce the temperature inside the compartment of a car when parking under the sun as a heating source. The main reason is the reduce heat recovery efficiency for the higher airflow rate. The graph taken from Bjorn Jenssse Wachenfeldt [2] is strongly to back up my research that the

temperature will fall to certain temperature with is lower than the temperature before ventilation.
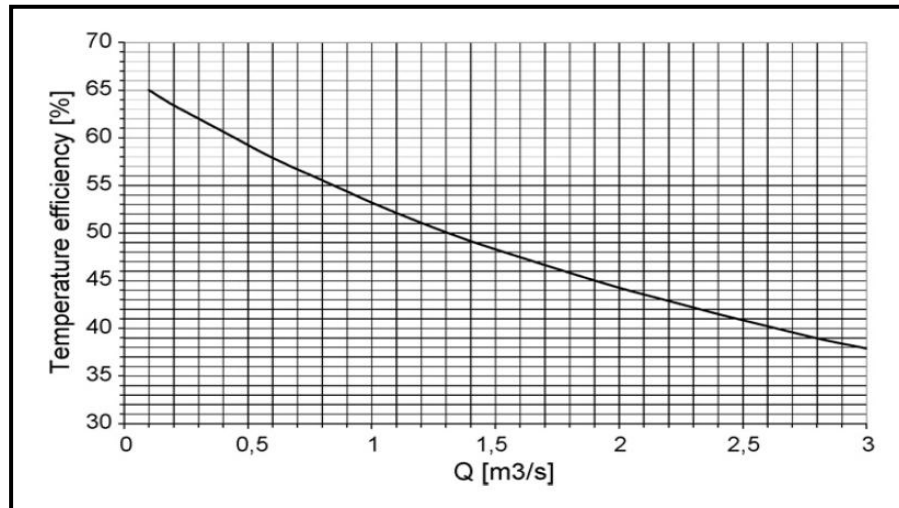
Figure 2.4: The Diagram of Percentage Temperatures Efficiency versus Flow Rate Q
BJORN JENSSEN WACHENFELDT

Maurizio, C and Centro, R.F, (1999) in [3], was investigated the thermal in cab and measurement problems. Results from this study showed the dashboard temperature changes in space vehicles is dependent on ambient temperature, which affects the environment temperature rise of internal temperature rise, as shown in Figure 2.5. In this study, found that the criteria and limits for existing thermal comfort for the application environment is not suitable structures applied to the car cabin environment. This is because the thermal condition of the vehicle is a complex of relations to a normal condition. Furthermore, the building environment, it is easy to determine the quantity and the environmental differences are difficult to measure for the vehicle because it is a body that can change position.
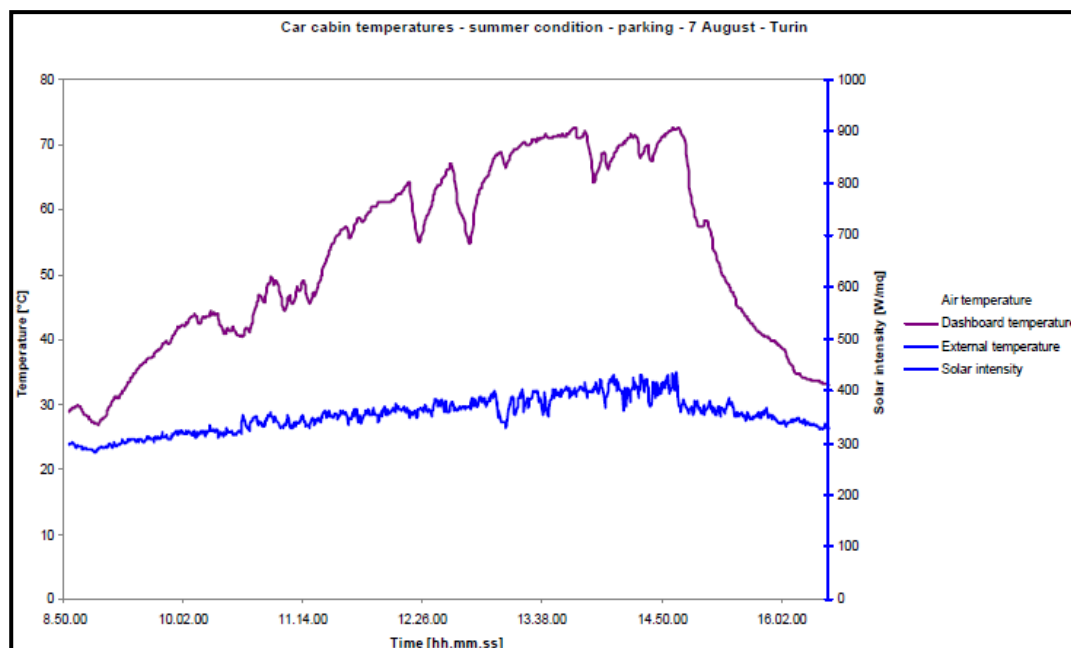
Figure 2.5 : Typical trend of dashboard surface temperature during parking conditions in summer

Another study case was about automatic Ceiling fan using PIR sensor by Mohd Rasidi Md Radzi, (2009/2010) in [4]. His project is to make the ceiling fan become 'smart' where it can sense the human present in the specific area and can turn on or off automatically. The main component that must be used to make sure the ceiling fan controller can switch the interested speed itself is by using microcontroller PIC16F877A. The way it working is as follow, when a user waves their hand, the PIC16F877A will analyse the signal given. After that, the output motor will receive the analog signal so that the motor driver can make the fan blow to reduce, increase and turn off based on the signal given by the user.

2.3 Studies on Preliminary Design of Ventilation System inThe Car Using Solar Energy

This study was conducted to produce a preliminary design of the ventilation system in the car using solar energy. In this study, an analysis was done to determine the air flow rate, CFM in the car through the method of calculation. This value is then applied to the selection of ventilation fan. Experiments were also conducted to temperature changes in the car before the ventilation system is installed where

comparisons have been made between these experiments with temperature changes after experimental ventilation system installed.

2.3.1   Studies on Solar Energy

Now, many people use solar energy or photovoltaic energy as an alternative power because it's vastly available and renewable. In solar photovoltaic, sunlight is actually converted into electricity. Solar panels are made of silicon which will produce an electric charge when receiving direct sunlight or light.

Electrical charge from the solar panel is routed to the output terminals to produce low-voltage alternating current or direct current, generally between six to 24 volts. Normally the value of nominal output is 12 volts while the effective output value will increase up to 17 volts. Nominal output voltage of 12 volts is the reference voltage but operating voltage can be up to 17 volts or more as a system of charging a car battery Charger battery voltage of 12 volts above 12 volts. This shows that there is a difference between the reference voltages with the actual operating voltage [5].

Sun radiation intensity change by the hour every day and weather conditions. To make the analysis of a solar system, the amount of solar radiation is shown in the full sun hours per m² or peak sun hours. Term peak sun hours mean an average enrolment of sunlight per day in the year.

2.3.2   Solar Panel

The solar panels were made from silicon which is will produce an electric charge when receiving direct sunlight or light. An electric charge from the solar panel is routed to the output terminals to produce low-voltage alternating current or direct current, generally between 6 to 24 volts. Normally the nominal output is 12 volts. This is the nominal output voltage as the reference voltage but operating voltage can be up to 17 volts or more as a system battery charger capable of charging the battery voltage exceeds 12 volts. This shows that there is a difference between the reference voltages with the actual operating voltage.

The output of a solar panel is usually stated in watts, and the wattage is determined by multiplying the rated voltage by the rated ampere.So for example, a 12 volt 60 watt solar panel measuring about 20 X 44 inches has a rated voltage of

17.1 and rated current 3.5 ampere.If an average of 6 hours of peak sun per day is available in an area, then the above solar panel can produce an average 360 watt hours of power per day; 60w times 6hrs. = 360 watt-hours. Since the intensity of sunlight contacting the solar panel varies throughout the day, we use the term "peak sun hours" as a method to smooth out the variations into a daily average. Early morning and late-in-the-day, sunlight produces less power than the mid-day sun. Naturally, cloudy days will produce less power than bright sunny days as well. Electricity produced by a panel calculated using the equation [5]:

$$\text{Do}_{sp} = I_I \text{ x } D_i \text{x } 12\text{v} \tag{2.1}$$

Where :

Do_{sp} =Daily output of solar panel (*W h per day at 12V*)

I_I = Current at load or other current specification of solar panel (*A*)

D_i = Daily Insolation (*peak-hour per day*)

To determine the number solar panel require, the power loses when charging the batteries must be consider. This is the efficiency of the battery charger. The suitable value is 80 per cent for leaded acid batteries and 70 percent for nickel-cadmium batteries. The sizing formula for the minimum number of solar panels require is shown in equation (2.2)[5] :

$$N_{sp} = \frac{\left[\dfrac{R_e \text{ x } 100\%}{\text{Do}_{sp}}\right]}{\eta_{bc}} \tag{2.2}$$

Where :

N_{sp} = Minimum number of solar panel

Re   = Daily equipment of appliances (*W h per day*)

Do_{sp} = Daily output of one module(*W h per day at 12V*)

η_{bc} =Charging effiency of battery (*%*)

2.3.3 Battery

Internal cycle batteries are designed to be re-charged and charge thousands of times. The battery is measured in Ampere-hours and usually at 20 hours and 100 hours. In summary, the ampere-hour is the amount of current in amperes at which they can be supplied by a battery in a long time. For example, a 350 amp hour battery can supply 17.5 Amp continuous current for 20 hours or 35 Amp continuous current for 10 hours. To quickly identify the total wattage supplied in battery 6 volt 360 amp-hour, 360 Amp-hours multiplied by 6 volt equal to 2160 watts or 2.16 kWh (kilowatt-hour).

The usable capacity required is calculated from the daily electrical requirement and period of usage as follows equation (2.3) [5] :

$$C_t = \frac{(R_e \times S_d)}{12V} \tag{2.3}$$

where;

C_t = Total usable capacity needed (*A h at 12V*)

R_e = Daily requirement of appliances (*W h per day*)

S_d = Period of storage required (*days*)

Therefore, the number of batteries that are needed is calculated from the usable capacity and cycle depth as follows [5]:

$$N_b = \frac{\left(\dfrac{C_t \times 100\%}{C_b}\right)}{R_{maks}} \tag{2.4}$$

where;

N_b = Minimum number of 12V batteries needed

C_t = Total usable capacity needed (*A h at 12V*)

C_b = Full capacity specified for one 12V battery (*A h*)

R_{maks} = maximum depth of cycle (*%*)

2.4   Car Air Ventilation

Ventilation is a removing process that allows clean air accessing the car cabin and removing stale air. The process begins when the clean air, is allows entering the car cabin whether by it is force by mechanical system available or flowing naturally inside to the car. This ventilation system is important to keep the passenger compartment at a comfortable temperature. For health and comfort, some fresh air must pass through the passenger compartment. This replaces the stale and sometimes smoke-filled air inside the vehicle. The process is called ventilation. Most of people use to closed compartment car as a solution on preventing dusty air from entering the car. Then people start to use ducting system to allow air enter their car. Figure 2.6show the earliest closed cabin ventilation was the cowl air intake. When air coming over the hood scooped into the car interior through the space provided when the ventilator raise. However when the vehicles stopped or move slowly, just a little fresh air enters. This is one reason most vehicles have a power ventilating system which actually used a fan or blower and the fan is located in the dashboard. A blower assembly is attached to the motor shaft and the entire unit is placed inside the blower housing. As the squirrel cage blowers as shown in Figure 2.7 rotates, its produces a strong suction in the intake. A pressure is also created on the output. When the fan motor is energized by using the temperature control on the dashboard, air is moved through the passenger compartment [6].
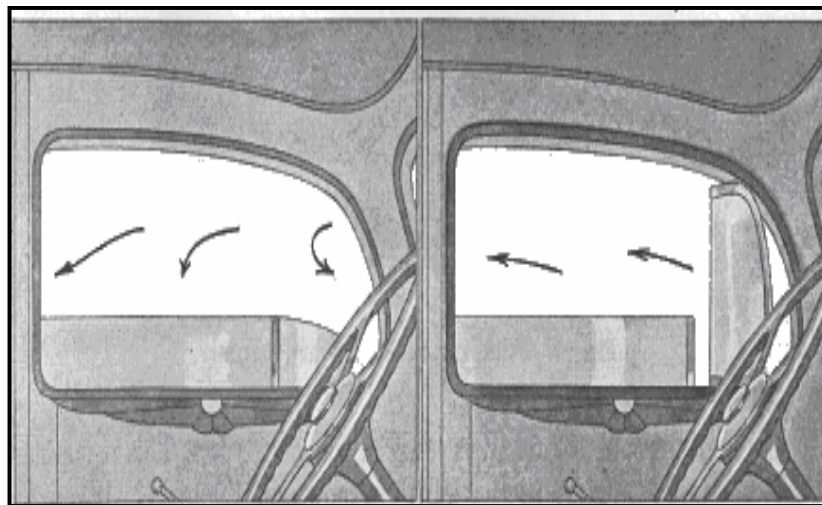
Figure 2.6 : Flow of air when the vehicle moves forward

Figure 2.7 : Squirrel cage that used to help move air throughout the passenger compartment.

2.5   Ventilation with Solar Energy

Fans are nearly ideal solar powered loads. They can run directly off direct current. Solar powered fans run when they are most needed, when the sun is shining. During summer months, the temperature can reach to very high temperature. High temperatures cause an increase in temperature in the living space and an increase in energy consumption by air conditioning equipment. Forced ventilation will circulate cooler air through the attic space and lower the temperature. Fan and solar module combination allow daytime ventilation and air circulation anywhere the sun shines. They are great for green houses, kennels, barns and attic where alternative current (AC) power is not available. The solar module runs the fan at full power in full sun and at a slower speed in overcast weather. Operation is automatic. When the sun shines on the solar module, the fan begins to operate.

2.5.1   Ventilation Fan

In the design of solar energy systems, the load that had been applied is a ventilation fan. This ventilation fan only requires direct current to function. To analyse the direct current loads, the value of watt (W) multiplied by the number of hours per week (hours/week) for total watt-hours per week (watt-hours/week) for each load used. This means that the number of fans have to be determined prior to analysis.

Besides that, for the requirement of ventilation system, fan selection is determined by calculating the fan flow rate, CFM. Flow rate, CFM of the fan is determined using the method of heat removal (Heat-Removal Method) [3] as in equation (2.5) [7]:

$$\text{CFM} = \frac{Q}{1.085(T_i - T_o)} \qquad (2.5)$$

where;

      CFM   = Fan flow rate (ft^3/min)

      Q   = Total heat increase (Btu/ hr)

      T_i = Maximum tolarance inside temperature (˚C)

      T_o = Average outside temperature (˚C)

To calculate the daily requirement in W h per day for a solar system, as system designer, must first list all the appliances that are expected to be used in the system. For each appliance, find its power and decide the amount of time in hours that it will be used each day. The calculation of daily requirement for each appliance is as follows [5]:

$$R_e = P_e \times T_d \qquad (2.6)$$

dimana;

      R_e = Daily requirement of one appliance (*W h per day*)

      P_e = Power of appliance (*W*)

      T_d = Expected daily use of appliance (*hours per day*)

2.6 Theory of Heat analysis in Cars Based Solar Radiation

Analysis of the increase of heat in the car is based on the average estimate model sunny days, ASHRAE. General equation for heat increase is [8] :

$$Q_w = As \ [FI_t + U \ (T_0 - T_i)] \tag{2.8}$$

Where ;

As = Area of the window surface expose to sunlight, ft^2

F = Film coefficient of heat transfer

I_t = Transmitted intensity

U = The average heat transfer coefficient through the window framed

= 1.11 Btu/hr.ft^{2}.^{0}F

T_0 = Outside temperature, ^{0}F

T_i = Inside temperature, ^{0}F

Equation for area of the window surface expose to sunlight is [8]:

$$As = (\ X\text{-}x \ )(\ Y\text{-}y \ ) = (\ X\text{-} D_x \tan \alpha \ ) \left[Y - D_y \frac{\tan \beta}{\cos \alpha} \right] \tag{2.9}$$

Equation for Film coefficient of heat transfer [8];

$$F = \tau + \frac{u\alpha}{h_\circ} \tag{2.10}$$

Where ;

h_0 = Heat transfer coefficient for the outer surface of the glass

= 1.11 Btu/hr.ft^{2}.^{0}F

α = Absorptivity

τ = Transmittivity

Light Intensity can be determined by multiply within direct intensity, I_D and diffusse intensity, I_d as shown in equation (2.11) [8]:

$$I = I_D + I_d \tag{2.11}$$

$$I_D = \frac{AC_n}{\exp\left(\dfrac{B}{\sin \beta}\right)} \tag{2.12}$$

Where ;

C_n = Whether brightness number = 0.9

 C = Radiation diffusion factor   = 0.122

 A = Solar radiation is significant when the air mass equal to zero

  = 351 Btu/hr.ft^2

 B = Atmospheric extinction coefficient, which depends on the amount of

   vapor content in the atmosphere

  = 0.201

β = Degrees declined

$$I_d = \frac{CI_DF_{ss}}{C_N{}^2} \tag{2.13}$$

$$F_{ss} = \frac{1.0 + \cos \varepsilon}{2} \tag{2.14}$$

Where ;

ε = Slope angle of the surface

Figure 2.8 shows the radiation of light through glass or glass that will be taken into the analysis to be carried out. In theory, the formula involved is as in equation (2.13) [8].

$$I = \tau I_t$$

$$I_t = I\cos\theta$$

$$I_t = \alpha I\cos\theta \qquad\qquad (2.15)$$
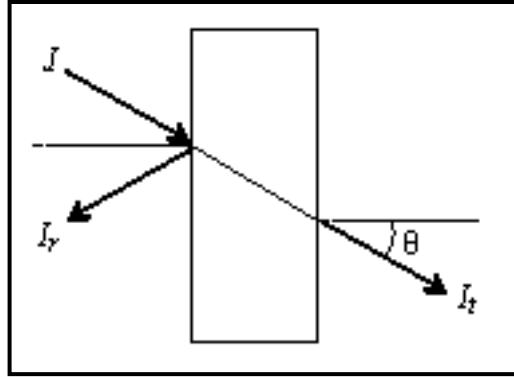
Figure 2.8: Schematic diagram of light radiation through the glass.

CHAPTER 3

METHODOLOGY

3.1 Introduction
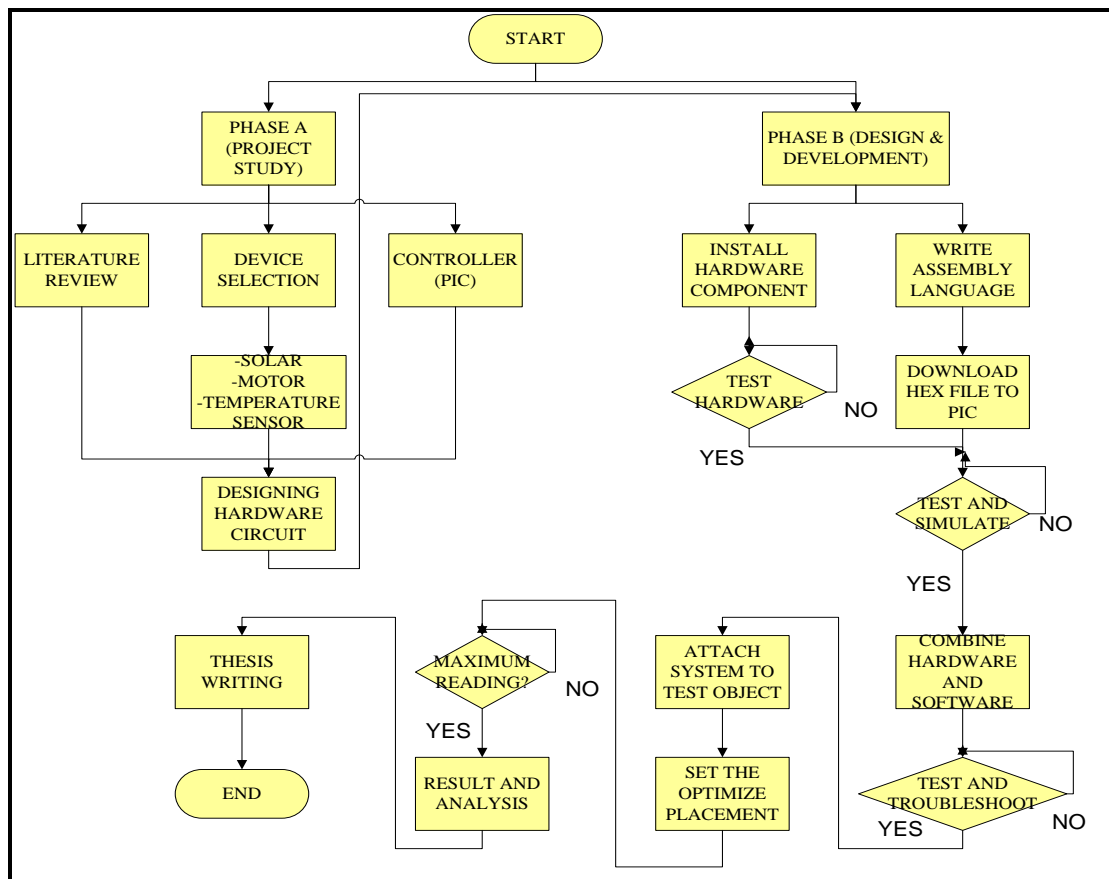
Figure 3.1:General Flow Chart of The Project

Figure 3.1 shows the flow chart of the methodology flow for this project. This project is divided into two parts which is phase A and phase B. For project study phase A is where determines the objective, scope and do the literature review. Research and studies of all information from the specific sources are being filtered and simplified in this chapter. It also included the steps of planning and several phases to ensure the project can be working successfully. Further, the selection of appropriate device for this project and is available such as solar panel, blower motor, and temperature sensor. The third part is the system controller. Here, the PIC microcontroller has taken over this task. Further, proceed with designing hardware circuit using Proteus.

This project continued in the Master Project 2, starting with phase 2. Phase 2 is the designing and development. Firstly install the hardware to PCB board and then test the hardware to make sure the output normal. Next, create the assembly language and downloads to the PIC. After this stage, hardware and software will be combined and test. If success, the system will be attached to the test object. The result will be analysis to obtain the system effectiveness of working. Finally the thesis writing process implemented.

3.2   Project Planning Flowchart

```
┌─────────────────────────────────┐
│              START              │
└─────────────────────────────────┘
                 ↓
┌─────────────────────────────────┐
│   SUNLIGHT COMPOSE SOLAR        │
│   ENERGY AND GENERATE           │
│   ELECTRICITY TO THE SYSTEM     │
└─────────────────────────────────┘
                 ↓
┌─────────────────────────────────┐
│   MICROCONTROLLER READ THE      │
│   INPUT DATA FROM               │
│   TEMPEREATURE SENSOR           │
└─────────────────────────────────┘
                 ↓
┌─────────────────────────────────┐
│   MICROCONTROLLER PROCESS       │
│   THE DATA AND DECIDE DESIRE    │
│   OUTPUT DATA                   │
└─────────────────────────────────┘
                 ↓
┌─────────────────────────────────┐
│   DC MOTOR MOVE THE FAN TO      │
│   BLOWS HOT AIR FROM INSIDE     │
│   OF THE CAR                    │
└─────────────────────────────────┘
                 ↓
┌─────────────────────────────────┐
│   LCD DISPLAY SHOWING THE       │
│   TEMPERATURE, SOLAR            │
│   VOLTAGE, BATTERY VOLTAGE      │
│   AND MOTOR STAGE               │
└─────────────────────────────────┘
                 ↓
┌─────────────────────────────────┐
│   DO ANALYSIS,  PLOTTING GRAPH  │
│   AND COMPARING THE DATA        │
└─────────────────────────────────┘
                 ↓
┌─────────────────────────────────┐
│              END                │
└─────────────────────────────────┘
```
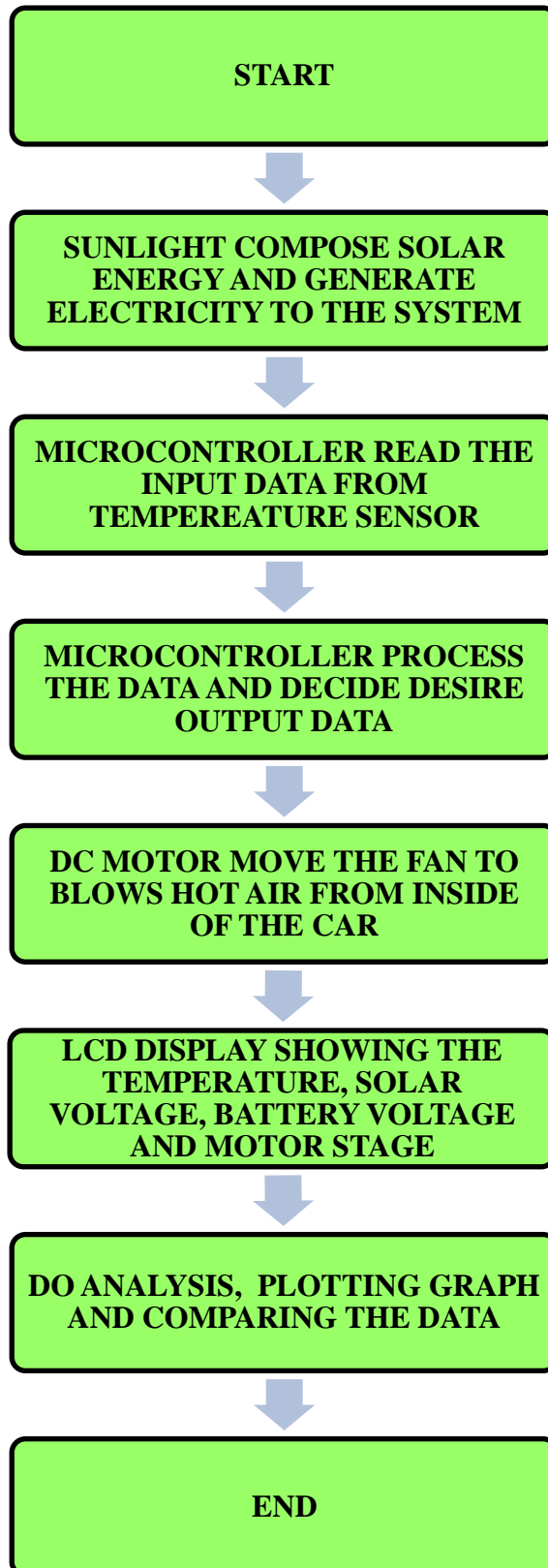
Figure 3.2:Flow Chart of Project Planning

Figure 3.2above shows the flow of the project planning for this system. Since the solar panel as the main part of this system, the sun must emit the light so this system can be operated. This solar panel is connected directly to the voltage regulator to obtain an output of 5 volts as require by the microcontroller PIC16F877A.This system cannot be operating at night and during raining day. The battery charge was used as a backup power supply in this project to ensure the project keep running in circumstances where there is no sunlight. This project works in two systems which are in the Manual mode and Automatic mode.

Manual mode is, when LM 35 temperature sensor detects the temperature rise, it will send the data to the microcontroller. Microcontroller will process the data and send digital signals to the ventilation motor circuit. The speed of motor has been programmed by the microcontroller to function according to the stage-set temperature levels in the program. There are five levels of motor speed which is the first level is set to a temperature of 30°C, the second level temperature was set to 35°C, the third level temperature was set to 40°C, the fourth temperature set to 50°C and the fifth temperature set to 60°C. Motor speed is controlled by using Pulse Width Modulation (PWM). Then the Liquid Crystal Display will display the outputs of temperature readings, the motor speed level, solar voltage and battery voltage. After that, the data has been recorded for the purposes of analysis.

In automatic mode, it is set for a motion detector purpose. If there is any movement, it will be detected by PIR sensor and data will be sent to the microcontroller. Subsequently microcontroller will process the data and send the digital signal to the ventilation motor circuit. This automatic mode, when motion is detected by the PIR sensor, the ventilation motor that control by PWM will rotate based on speed of the level 5 only. It has been programmed on the microcontroller with the intention of giving more comfort and better ventilation in the car. This is an automated system for the case where if there are children, pregnant women or animal residue in the car. Besides that it also can be applied for purpose item or foods which are sensitive to high temperatures when it is left in a car. Then LCD will displays temperature readings, the motor speed level, solar voltage and battery voltage. After that, the data are taken for the analysis.

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