UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF AUTOMOTIVE AIR SCOOP MICRO TURBINE

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Mechanical Engineering Technology (Automotive Technology) with Honours

By

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **DEVELOPMENT OF AUTOMOTIVE AIR SCOOP MICRO TURBINE**

SESI PENGAJIAN: **2016/17 Semester 1**

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I hereby, declared this report entitled “Development of Automotive Air Scoop Micro Turbine” is the results of my own research except as cited in references.

Signature : …………………………………..
Name of Student : Mohd Syakirin Bin Khalid
Date :

APPROVAL

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

………………………………

(Project Supervisor)

ABSTRAK

Turbin angin adalah alat yang digunakan untuk menjana tenaga elektrik daripada tenaga angin. Tenaga elektrik boleh dihasilkan apabila daya angin memutarkan bilah turbin angin dan kemudian medan magnet terhasil. Daripada projek ini, ia akan dapat mengurangkan penggunaan bahan api dengan mengurangkan beban dari alternator. Apabila penggunaan bahan api dapat dikurangkan, ia juga akan membantu untuk melindungi alam sekitar. Turbin angin dikaji dalam pelbagai aspek seperti dimensi, seret aerodinamik, tekanan angin dan sebagainya. Pembolehubah-pembolehubah adalah sangat penting bagi menentukan tempat untuk memasang turbin angin pada kereta dan untuk menentukan voltan yang boleh dihasilkan. Untuk merealisasikan projek ini, satu kajian telah dilakukan melalui perisian dan eksperimen. Komputer perisian Dynamic Fluid digunakan untuk menentukan aliran angin dan tekanan angin di permukaan kenderaan. Berdasarkan keputusan ini, ia boleh digunakan untuk menentukan kedudukan tepat untuk memasang turbin angin. Seterusnya, kereta akan dijalankan dalam eksperimen pemanduan sebenar untuk mengukur voltan yang boleh dihasilkan. Voltan akan diukurkan dengan menggunakan multimeter digital.

ABSTRACT

Wind turbine is a device that used to generate electrical energy from the wind force. The electrical energy can be generated when the wind force rotates the blades of wind turbine and then the magnetic field will be produce. From this project, it will able to reduce the fuel consumption by reducing the load from the alternator. When the fuel consumption can be reduce, it will also help to protect the environment. The wind turbine is being study in many aspects such as dimension, aerodynamic drag, wind pressure and so on. Those variables are very important in order to determine the place to install the wind turbine on a car and to determine the voltage that can be generated. To realize this project, a research has been done through the software and experimental. Computer Fluid Dynamic software was used to determine the wind flow and wind pressure on vehicle surface. Based on this result, it can be determine the accurate position to install the wind turbine. Next, the car will be run in real driving experiment to measure the voltage that can be generated. The voltage will be measure by using digital multimeter.

DEDICATION

To my parents especially and friends, also for whom with their effort to support me in order for me to pursue study in higher education, and also in order to complete this project and project report to fulfil the requirement for Bachelor Degree in Mechanical Engineering Technology (Automotive Technology) award.

To my supervisor too, Mr. Ir. Mohamad Hafiz bin Harun and all the Mechanical Department Staff with their helpful suggestions, guidance and assistance in order for me complete this Final Year Project for degree course.

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First of all, I present my gratitude to Allah the Almighty for His blessings on me that enable me to finish this project.

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Besides, thanks go to all my classmates and members of the staff of the Mechanical Engineering Technology Department, UTeM, who assisted me in many ways and made my stay at UTeM pleasant and unforgettable. I also want to acknowledge my appreciation to anybody for spending his or her time and energy to help me endure my hard times in finishing this project.

Then, I acknowledge my sincere indebtedness and gratitude to my parents for their love, dream and sacrifices throughout my life. I cannot find the appropriate words that could properly describe my appreciation for their devotion, support and faith in my ability to reach my goals.

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LIST ABBREVIATIONS, SYMBOLS AND NOMENCLATURES

2D	=	Two Dimension
3D	=	Three Dimension
AC	=	Alternate Current
CAD	=	Computer Aided Design
CAE	=	Computer Aided Engineering
CATI	=	Computer Assistee Tridimensionelle Interactive
CATIA	=	Computer Aided Three Dimensional Interactive Application
CFD	=	Computer Fluid Dynamics
DC	=	Direct Current
DES	=	Detached – Eddy Simulation
DWG	=	Drawing
GMAW	=	Gas Metal Arc Welding
GTAW	=	Gas Tungsten Arc Welding
HVAC	=	Heating, Ventilation, Air Conditioning
HW	=	HyperWorks
IGES	=	Initial Graphics Exchange Specifications
Km/h	=	Kilometre Per Hour
m	=	Metre
m/s	=	Meter Per Second
MicroCAD	=	Micro Computer Aided Design
mm	=	Multimetre
PC	=	Computer
PD	=	Product Design

RANS	=	Reynolds – Averaged Navier - Strokes
STEP	=	Standard for the Exchange of Product Data
V	=	Volts
Vs.	=	Versus
W	=	Watt

CHAPTER 1

INTRODUCTION

1.0 Background

Nowadays, low fuel consumption requirement on a vehicle have risen because of the fuel price. A lot of study has been done to achieve this requirement. Due to the requirement, a study of wind energy technology has been developed because wind energy can be converts into electricity by using the correct tools. Wind energy is being study in many dimensions such as aerodynamics, structural mechanics and mechanical engineering.

Each car has its own design to fulfill the customer requirement. In winning exterior design, it is not just for the best look, but the maker also study about the aerodynamic drag when designing the shape of the car. The aerodynamic drag is depending on the car’s shape, height and surface. Those parameter are being study very deep so that when the car is finished in design, it will produce less aerodynamic drag and it will help in lowering fuel consumption. The design of a car then will simulate in the wind tunnel by using CFD software. The CFD software used in this study is to obtain the data of wind velocity, wind vector, and flow of the wind. Each of these data will be different based on the car speed. If the aerodynamic is improved, it can reduce the engine load and fuel consumption too.

The first point concerning in this research is to identify the shape of Proton Perdana V6 model so that it can be draw by using any software. Secondly, the drawing model will be simulated in CFD software to determine the wind flow on the front hood of this vehicle. Next, after the car has been simulate, the results will be used to study the area to attach or mount the wind turbine on the front hood so that it is able to get the air flowing around the front hood to turn the blades, therefore gain the energy. When the turbine has been mounted, the vehicle will be test to determine the maximum current can be generated based on different speed.

1.1 Problem Statement

Based on the observation, the electric current that being delivered to the battery is come from the alternator based on its motion when the engine is started because the alternator's pulley is connected to the crankshaft's pulley by using a belting. The main issue in this study is, an alternator has to work over limit to restore the current when a vehicle use too much electricity. When this is happen, the load in the alternator will become higher, and so it will affect the engine load too. The higher engine load will affect the fuel consumption. A turbine will be mount to the vehicle to solve the problem. The usage of the turbine is to generate electric current from the wind flow when the vehicle is in a motion. Then, the generated electric current will be deliver to the alternator to reduce its load and in the same time it will help to reduce engine load and fuel consumption.

1.2 Objective

- **i.** To identify shape vehicle model of Proton Perdana V6.
- **ii.** To determine the fastest wind speed on the front hood.
- **iii.** To determine the maximum voltage that can be generated.

1.3 Scope of Project

The study will discuss about:

i. Potential of wind energy to generate electric current on a front hood of Proton Perdana V6.

ii. Utilization of CATIA software in designing the 3D model of Proton Perdana V6.

iii. Carry out wind tunnel test to validate the CFD simulation.

iv. After the simulation, turbine will be mounted at the high potential of the wind to flow on a hood.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This part examined about the work of past analysis. This part would discuss about the streamlined drag, feign body, wind turbine, wind turbine profile, cutting edge plan and the past work of research. In the past research, a few sub-subjects will be examined, for example, the approach, results and examination lastly the finish of past research.

Liquid streamed conduct could be examined all through the examination and exact reviews. To concentrate the attributes of the liquid streams, a software called Computational Fluid Dynamics (CFD) was created. All through the improvement of CFD, quantities of liquid issue were tackled, despite the fact that it was an entangled issue. (Abdul Halim, 2015)

2.1 Design Software

Design software is a software that being use to draw a model by an engineer. In this era, a lot of software has been published to be used by any user according to their skills and comfortness. Each of the software has their own advantages and disadvantages. So, when a designer wants to draw something, they will choose which software is suitable for them.

2.1.1 AutoCAD

AutoCAD is a business programming application for 2D and 3D PC supported plan (CAD) and drafting accessible since 1982 as a desktop application and since 2010 as a portable, web-and cloud-based application advertised as AutoCAD 360. Created and promoted via Autodesk, AutoCAD was initially discharged in December 1982, running on microcomputers with interior design controllers. Before the presentation of AutoCAD, most business CAD programs kept running on centralized computer PCs or minicomputers, with every CAD administrator (client) working at a different design terminal. AutoCAD is utilized over an extensive variety of businesses, by draftsmen, extend supervisors, engineers, visual creators, and different experts. <https://en.wikipedia.org/wiki/AutoCAD>

It is upheld by 750 preparing focuses worldwide starting 1994. As Autodesk's leader item, by March 1986 AutoCAD had turned into the most omnipresent CAD program around the world. AutoCAD was gotten from a program started in 1977 and discharged in 1979 called Interact CAD, additionally alluded to in early Autodesk archives as MicroCAD, which was composed before Autodesk's (then Marinchip Software Partners) development via Autodesk fellow benefactor Mike Riddle. The primary form via Autodesk was shown at the 1982 Comdex and discharged that December. The 2016 discharge denoted the 30th real arrival of AutoCAD for Windows. The 2014 discharge denoted the fourth continuous year of AutoCAD for Mac. The icon of latest version is shown in figure 2.1.

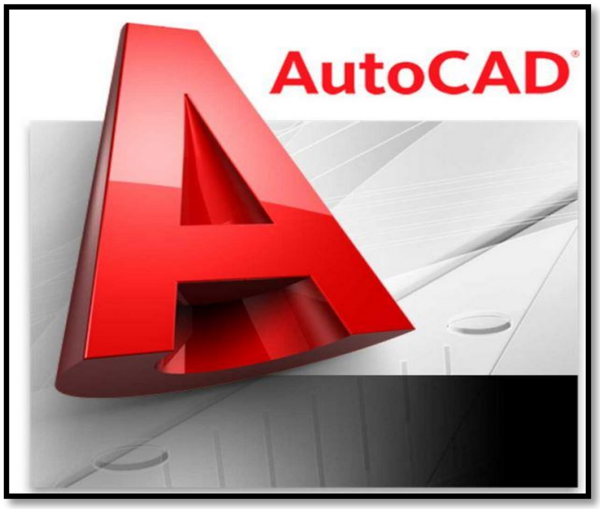

Figure 2.1: AutoCAD icon

An AutoCAD software have many favorable position for the client. For instance, the first is AutoCAD programming contain standard mechanical segments which is If a working is going ahead with apparatus that requires hundreds or a huge number of parts, it may take weeks or even months to draw them without any preparation. The product underpins a few made parts, for example, nuts, screw, washers, bolts, pins, plugs, bushings, heading, auxiliary steel shapes, shaft segments, keyways and some more. The second preferred standpoint of AutoCAD programming is the product is effective and brisk measurement. With the utilization of improved instruments we can create measurements to effectively control and grow just imperative factors for assembling. With programmed dimensioning, we can produce a few with less info and constrain covering measurements to naturally put themselves separated legitimately and even drive and alter plan geometry to settle in certain size. Third preferred standpoint of AutoCAD is it can do a 'U over all drawings'. This implies AutoCAD consequently redraw geometry to show dashes and shrouded lines of parts that are obstructed by different parts in mechanical plan. The shrouded lines include consequently overhauls every single pertinent drawing when a change happen, for all intents and purposes expelling long manual redrawing of geometry because of rehash changes. This implies you spare time and endeavors your 2D plan. Next, an AutoCAD programming make the client simple to swap information over various CAD frameworks which is AutoCAD Mechanical suite accompanies in-assembled industry-standard STEP (Standard for the Exchange of Product Data) and IGES (Initial Graphics Exchange Specification) designs for trading information between CAD frameworks.

AutoCAD software additionally has its own disadvantge. The first is the product is restricted record positions on the grounds that the AutoCAD is one of the main CAD programs, it restrains the quantity of document arrangement it can import and fare, in light of the fact that Autodesk anticipates that different projects will fare to AutoCAD configurations, for example, DWG and DXF. Sadly, this makes issues when utilizing different projects with all the more intense devices and trading the program to an AutoCAD design; geometry, shading and the impacts are lost regularly. Second burden of AutoCAD is it is non-parametric. AutoCAD gives apparatuses to make three - dimensional models, yet altering the models requires many strides, not at all like BIM parametric models, which consequently conform the greater part of the model segments while altering components. Next, the AutoCAD programming have issue with the line which is AutoCAD produces drawing utilizing line and shape instruments. Bends, circular segments and straight lines deliver the shapes, however AutoCAD can't alter the line and area as unreservedly as delineation program where altering and covering lines and line weights is restricted to a couple of choices. AutoCAD additionally have issue with shading, fill and surface where the application is limits the quantity of conceivable shading to 256 and the gives just a modest bunch of surfaces, which implies it can't make photograph sensible pictures like representation projects. Rather, you can import picture records and make material maps for AutoCAD renderings, however AutoCAD's rendering capacities can't contend with three – dimensional displaying projects or outline programs.
<https://en.wikipedia.org/wiki/AutoCAD>

2.1.2 CATIA

CATIA (Computer Aided Three-Dimensional Interactive Application) is a multi-stage Computer-Aided Design (CAD) or Computer-Aided Manufacturing (CAM) or Computer-Aided Engineering (CAE) programming suite created by the French organization Dassault Systèmes. It is composed in the C++ programming dialect. CATIA (Computer Aided Three-Dimensional Interactive Application) began as an in-house advancement in 1977 by French air ship producer Avions Marcel Dassault, around then client of the CAD/CAM CAD programming to build up Dassault's Mirage warrior stream. It was later embraced in the aviation, car, shipbuilding, and different ventures.
<https://en.wikipedia.org/wiki/CATIA>

Figure 2.2: Icon of CATIA software

CATIA first name was CATI (Conception Assistee Tridimensionnelle Interactive – French for Interactive Aided Three-dimensional Design), it was renamed CATIA in 1981 when Dassault made a backup to create and offer the product and marked a non-select dispersion concurrence with IBM. The software will start running by showing the icon as shown in Figure 2.2.

In 1984, the Boeing Company picked CATIA V3 as its primary 3D CAD device, turning into its biggest client. In 1988, CATIA V3 was ported from centralized computer PCs to UNIX. In 1990, General Dynamics Electric Boat Corp picked CATIA as its fundamental 3D CAD instrument to outline the U.S. Naval force's Virginia class submarine. Likewise, Lockheed was offering its CADAM CAD framework worldwide through the channel of IBM since 1978. In 1992, CADAM was acquired from IBM, and the following year CATIA CADAM V4 was distributed. In 1996, it was ported from one to four Unix working frameworks, including IBM AIX, Silicon Graphics IRIX, Sun Microsystems SunOS, and Hewlett-Packard HP-UX. In 1998, V5 was discharged and was an altogether changed form of CATIA with support for UNIX, Windows NT and Windows XP (since 2001). In the years before 2000, issues brought on by contrariness between renditions of CATIA (Version 4 and Version 5) prompted to $6.1B in extra expenses because of years of venture postponements underway of the Airbus A380. In 2008, Dassault Systèmes discharged CATIA V6. While the server can keep running on Microsoft Windows, Linux or AIX, customer bolster for any working framework other than Microsoft Windows was dropped. In November 2010, Dassault Systèmes propelled CATIA V6R2011x, the most recent arrival of its PLM2.0 stage, while keeping on supporting and enhance its CATIA V5 programming. In June 2011, Dassault Systèmes propelled V6 R2012. In 2012, Dassault Systèmes propelled V6 2013x. In 2014, Dassault Systemes propelled 3DEXPERIENCE Platform R2014x and CATIA on the Cloud, a cloud variant of its product.
<https://en.wikipedia.org/wiki/CATIA>

The extent of utilization in CATIA is regularly alluded to as a 3D Product Lifecycle Management programming suite, CATIA underpins various phases of item advancement (CAx), including conceptualization, plan (CAD), designing (CAE) and assembling (CAM). CATIA encourages synergistic building crosswise over controls around its 3DEXPERIENCE stage, including surfacing and shape outline, electrical liquid and hardware frameworks plan, mechanical

designing and frameworks designing. CATIA encourages the plan of electronic, electrical, and disseminated frameworks, for example, liquid and HVAC frameworks, the distance to the creation of documentation for assembling. In outlining a model, CATIA offers an answer for shape configuration, styling, surfacing work process and perception to make, alter, and approve complex creative shapes from mechanical plan to Class-A surfacing with the ICEM surfacing innovations. CATIA bolsters various phases of item plan whether began starting with no outside help or from 2D draws. CATIA v5 can read and deliver STEP design records for figuring out and surface reuse. CATIA additionally being utilized as a part of car businesses since it have a considerable measure of advantages. Numerous car organizations utilize CATIA to fluctuating degrees, including BMW, Porsche, McLaren Automotive, Chrysler, Honda, Audi, Jaguar Land Rover, Volkswagen, SEAT, Skoda, Bentley Motors Limited, Volvo, Fiat, Benteler International, PSA Peugeot Citroen, Renault, Toyota, Ford, Scania, Hyundai, Tesla Motors, Rolls-Royce Motors, Valmet Automotive, Proton, Elba, Tata engines and Mahindra and Mahindra Limited. Goodyear utilizes it as a part of making tires for car and aviation furthermore utilizes a modified CATIA for its outline and advancement. Numerous car organizations utilize CATIA for auto structures – entryway bars, IP underpins, guard pillars, rooftop rails, side rails, body segments in view of CATIA's abilities in Computer representation of surfaces. Bombardier Transportation of Canada is utilizing this product to outline its whole armada of Train motors and mentors. Webasto utilizes CATIA to plan its rooftop.
<https://en.wikipedia.org/wiki/CATIA>

2.1.3 SolidWorks

SolidWorks (adapted as SOLIDWORKS), is a strong displaying PC helped plan (CAD) and PC supported building (CAE) PC program that keeps running on Microsoft Windows. SolidWorks is distributed by Dassault Systemes. As indicated by the distributer, more than 2 million architects and creators at more than 165,000 organizations utilized SolidWorks starting 2013.The icon of the software is as shown in Figure 2.3.

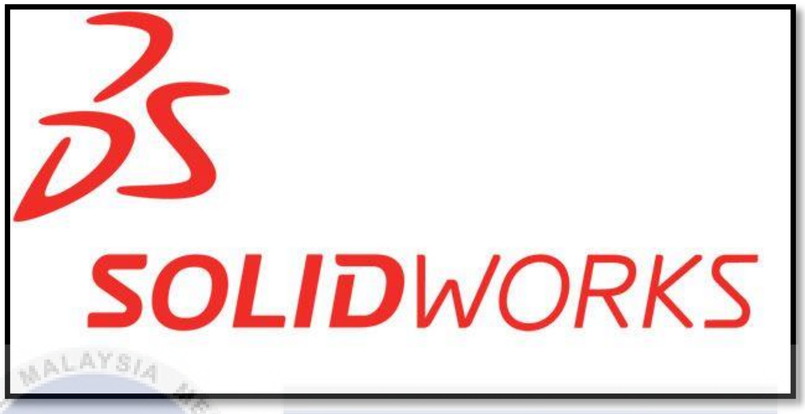

Figure 2.3: SolidWorks icon

SolidWorks Corporation was established in December 1993 by Massachusetts Institute of Technology graduate Jon Hirschtick. At first situated in Waltham, Massachusetts, USA, Hirschtick enrolled a group of designers with the objective of building 3D CAD programming that was anything but difficult to-utilize, moderate, and accessible on the Windows desktop. Working later from Concord, Massachusetts, SolidWorks discharged its first item SolidWorks 95, in November 1995. In 1997 Dassault, best known for its CATIA CAD programming, gained SolidWorks for $310 million in stock. SolidWorks right now showcases a few variants of the SolidWorks CAD programming notwithstanding eDrawings, a joint effort instrument, and DraftSight, a 2D CAD item.
<https://en.wikipedia.org/wiki/SolidWorks>

2.2 Vehicle Aerodynamic Analysis Software

Vehicle aerodynamics analysis software is used in many industries to study to the flow of wind travel on any vehicle. It also can determine the aerodynamic drag of any vehicle in any motion. This software are very sensitive in calculation because it can calculate up 100 000 points on a vehicle.

2.2.1 Altair Hyperwork

Altair Engineering is an American item outline and improvement, building programming and distributed computing programming organization. Altair was established by James R Scapa, George Christ, and Mark Kistner in 1985. Altair Engineering is the maker of the HyperWorks suite of CAE programming items. Altair is partitioned into three business divisions: Product Design (PD), HyperWorks CAE Software (HW), and PBS Works (PBS).
<https://en.wikipedia.org/wiki/Altair_Engineering>

Figure 2.4: Icon of Altair HyperWorks

Altair was set up in 1985. The designer utilize logo (Figure 2.4) as a logo for the product. In 1990, HyperMesh was discharged. In 1994, Altair gets

IndustryWeek's "Innovation of the Year" grant for OptiStruct. In 2011, it started with another procurement, ACUSIM Software, with their CFD Solver, AcuSolve. In September 2011, Altair ProductDesign divulged BUSolution, a half breed water powered transport. In June 2014, Altair gained EM Software and Systems – S.A. (Pty) Ltd and its universal wholesaler workplaces in the United States, Germany, and China, with their electromagnetic reenactment programming, FEKO.
<https://en.wikipedia.org/wiki/Altair_Engineering>

2.2.2 ANSYS Fluent

ANSYS Fluent is the most capable computational liquid elements (CFD) programming instrument accessible, enabling you to go further and speedier as you upgrade your item execution. Familiar incorporates very much approved physical displaying abilities to convey quick, precise outcomes over the most extensive scope of CFD and multiphysics applications.

2.2.3 Virtual Wind Tunnel

A HyperWorks wind passage is a vertical answer for outer optimal design. The streamlined work process in blend with adaptable programmed comes about reporting guarantees speedy turnaround times amid the improvement cycle. HyperWorks virtual wind passage is fueled by Altair's computational liquid progression solver, AcuSolve, a broadly useful, limited component based stream solver giving quick turnaround times, exactness and power. Architected for parallel execution on shared and conveyed memory PC frameworks, utilizing a half and half parallelization strategy, AcuSolve gives

quick and proficient transient and enduring state answers for unstructured matrices, and it is fit for scaling over countless centers.
<http://www.altairhyperworks.com/product/Virtual-Wind-Tunnel>

HyperWorks virtual wind burrow uses Reynolds-Averaged Navier-Stokes (RANS) and Detached-Eddy Simulation (DES) innovation to display turbulent streams and to anticipate the stream field. DES innovation joins tweaked, measurable RANS innovation for demonstrating close dividers and connected limit layers with the capacity of substantial vortex recreation (LES) to display the isolated districts in the wake behind the vehicle. Exact outer streamlined features results are accomplished for both, unfaltering state reenactment utilizing the RANS approach when material science permits and transient reproduction utilizing the DES approach.
<http://www.altairhyperworks.com/product/Virtual-Wind-Tunnel>

AcuSolve's liquid structure collaboration (FSI) capacities are incorporated into virtual twist passage to bolster investigations of adaptable segments in an outer stream field. Turning parts, e.g. wheels, are demonstrated by recommending a digressive divider speed to incorporate rotational impacts into the reenactment. For car utilize cases, warm exchangers or condensers are demonstrated with a permeable material model to consider the weight drop through the segments. The liquid material utilized amid the recreation is characterized through thickness and consistency, and can be adjusted to demonstrate for instance water or air at a particular temperature.
<http://www.altairhyperworks.com/product/Virtual-Wind-Tunnel>

HyperWorks virtual wind burrow accompanies a quick and proficient unstructured volume mesher including limit layer era. Client characterized volume work refinement zones are utilized to make a privately refined volume work to catch essential stream wonders, e.g. the wake of a vehicle or a building.

Parameters for limit layer cross section can be characterized universally or on a section premise to have greatest control of the aggregate component tally and utilize refined layers just in locales where it is fundamental. Volume coinciding for an outer car streamlined features examination (counting under body, under hood compartment and limit layers) is normally done in a couple of hours.
<http://www.altairhyperworks.com/product/Virtual-Wind-Tunnel>

Virtual wind burrow accompanies an agreeable and natural client environment. It is a holding nothing back one environment where clients can import the surface work (water tight work), set up the issue, present the reenactment and get a last report. The setup procedure is exceptionally computerized, with a base number of parameters, and without bargaining the arrangement quality. Extra controls over the different parameters are given in the client environment.

The reproduction can be effectively submitted to superior figuring frameworks to facilitate memory and register escalated errands, for example, volume cross section, settling and post-handling. A report containing issue setup, work measurements and results is produced consequently after finish of the reenactment. Furthermore, progressed CFD post-preparing might be performed for the most perplexing and huge CFD information representation, intuitively or by means of group handling mode.
<http://www.altairhyperworks.com/product/Virtual-Wind-Tunnel>

2.3 Fabrication Process

In producing or manufacturing a product, sometimes a certain product will be undertaking with fabrication process. The fabrication process consumes cutting and joining process. In cutting process, there a lot of tool that can be used to cut any material in any dimension such as disc cutter, grinding machine and much more. The usage of any tool to cut the material is depend on the hardness of the material. In joining process, there is also a lot way to join two or more parts to be one part. Examples of tools that use to join any material are welding machine, bolts and nuts, riveting and much more.

2.3.1 Cutting Process

With regards to machining, a power cutter or cutter is any instrument that is utilized to expel material from the work piece by method for shear twisting. Cutting might be proficient by single-point or multipoint apparatuses. Single-point apparatuses are utilized as a part of turning, molding, arranging and comparative operations, and evacuate material by method for one bleeding edge. Processing and penetrating instruments are regularly multipoint devices. Pounding devices are additionally multipoint apparatuses. Every grain of rough capacities as a minuscule single-point bleeding edge (despite the fact that of high negative rake edge), and shears a modest chip.

Cutting tool must be made of a material harder than the material which is to be cut, and the apparatus must have the capacity to withstand the warmth created in the metal-cutting procedure. Additionally, the apparatus must have a particular geometry, with freedom edges planned so that the front line can contact the work piece without whatever is left of the instrument delaying the work piece surface. The point of the cutting face is likewise critical, just like the flute width, number of woodwinds or teeth, and edge estimate. Keeping in mind the end goal to have a long working life, the greater part of the above must be enhanced, in addition to the rates and sustains at which the device is run.

i. Angle Grinder

An angle grinder, as shown in Figure 2.5, also known as a side grinder or disc grinder, is a handheld power tool used for cutting, grinding and polishing. Angle grinder can be controlled by an electric engine, petrol motor or packed air. The engine drives an equipped head at a right-edge on which is mounted a grating circle or a more slender cut-off plate, both of which can be supplanted when worn. Edge processors normally have a flexible protect and a side-handle for two-gave operation. Certain point processors, contingent upon their speed range, can be utilized assanders, utilizing a sanding circle with a sponsorship cushion or plate. The support framework is commonly made of hard plastic, phenolic gum, or medium-hard elastic relying upon the measure of adaptability wanted.

Figure 2.5: Angle grinder

Angle grinder might be utilized for expelling abundance material from a piece. There are a wide range of sorts of plates that are utilized for different materials and errands, for example, cut-off circles (jewel sharp edge), grating pounding circles, crushing stones, sanding circles, wire brush haggles cushions. The edge processor has substantial course to counter side powers created amid cutting, not at all like a power penetrate, where the constrain is axial.Angle processors are broadly utilized as a part of metalworking and development, and in addition in crisis salvages. They are regularly found in workshops, benefit carports and auto body repair shops.

The grinding wheel is the business end of a grinder, much like the bit of a bore or the cutting edge of a jigsaw. As the turning wheel is squeezed into a surface, it quickly evacuates material to change the look or feel of the surface. The higher the voltage of the engine, the speedier the wheel turns. Similarly, the more weight that is put onto the wheel as it presses into a surface, the more material it expels. Pounding wheels come in various sizes, contingent upon which estimate the processor itself is perfect with. The most mainstream processors are those that utilization 4.5-inch wheels.

There are a few distinct sorts of wheels that can join to a grinder. Each extraordinary wheel is intended to play out a particular sort of work. This incorporates molding, sanding, cleaning, cutting, and a great deal more. The materials a wheel is most appropriate to work with relies on upon the material that specific wheel is produced using. Be that as it may, there are a few wheels that are viewed as universally useful, however they are still constrained in what they can do. The accompanying is a rundown of a portion of the all the more ordinarily utilized crushing haggles they are regularly utilized for.

ii. Aviation Snips

Aviation snips, otherwise called compound snips, are perfect for cutting aluminum and sheet metal. Case of flying cuts device is appeared in Figure 2.6. Their handles are shading coded and it's not only for embellishment. Here's the manner by which to pick the correct cuts for the employment utilizing the right shading assignment.

Cutting curves in sheet metal is difficult. The material is awkward and unforgiving, as well as extremely sharp. There are three types of aviation snips that are designed to make three different cuts much easier.

Yellow handled snips are made to cut in a straight line. They can also cut wide curves and are ideal for flat pieces of metal. Green handled snips are designed to make straight and right (clockwise) cuts and are perfect for right handers cutting duct. Red handled snips cut best straight and to the left (counter-clockwise). You can use any of the snips in either hand but they will only perform well when cutting in the direction they were intended for.

Look for offset snips as they keep your hands up and away from the sharp metal and always wear leather gloves when handling and cutting metal and aluminum.

Figure 2.6: Aviation snips tool

2.3.2 Joining Process

Distinctive materials can be participated in a wide range of courses relying upon whether the joint should be lasting or semi-perpetual. Changeless: once this sort of joint has been developed, it can't be turned around without making harm the material/item. Semi-perpetual: this kind of joint is a technique for joining that is intended to be changeless; be that as it may, it can be dismantled without harmed the materials.

2.3.2.1 Welding

The primary technique for all time joining metals is by welding. There are numerous varieties of welding including GMAW and GTAW, oxyacetylene welding, electric curve and spot and crease welding. All include forever joining metals by the utilization of warmth, creating the 2 fundamental bits of metal to wind up distinctly liquid and utilizing a joining material to blend them before they cement, framing a perpetual, solid joint.

i. Arc Welding

A welding power supply is utilized to make and keep up an electric circular segment between a terminal and the base material to soften metals at the welding point. In such welding forms the power supply could be AC or DC, the cathode could be consumable or non-consumable and the channel material might possibly be included. The most well-known sorts of circular segment welding are Shielded Metal Arc Welding (SMAW), Gas Metal Arc Welding (GMAW) and Gas Tungsten Arc Welding (GTAW). Example of arc welding machine is shown in Figure 2.7.

Figure 2.7: Arc welding machine

ii. Riveting

Rivets are utilized to join two sheets or plates of metal together. At least two pieces are joined by embeddings a headed shank through a gap and shut by shaping a head on the anticipating part of the shank.Rivet size will be choosing depends on thickness of the metal sheet. Different size of rivet is shown in Figure 2.8.

Figure 2.8: Rivet

iii. Nuts, bolts and washers

Bolts and nuts are utilized to hold at least two bits of materials together in a semi-changeless strategy for joining. Jolts have a tendency to be produced using high pliable steel and are strung (square or hexagonal strung) for all or part of the length of the pole. Nuts utilized with fasteners must have coordinating distance across and string structure. They come in different structures, from wing nuts (made for simple evacuation by hand) to hexagonal nuts and uncommon locking nuts that oppose coming free. Washers are utilized to secure the surface when nuts are fixed. They spread the heap connected to the surface and forestall extricating that can be brought about by vibrations. Examples of bolts and nuts are shown in Figure 2.9.

Figure 2.9: Bolt and nut

2.4 Development of CFD Method

The goal of the advancement of the CFD technique was to make a virtual wind tunnel in which the power yield of a wind turbine could be explored with changing plan parameters (counting turbines whose size was too extensive to be in any way tried inside the wind burrow). The technique created here is additionally anticipated that would be utilized as a part of future reviews where no reasonable wind burrow offices are promptly accessible. As the CFD display ascertained for all the stream factors, for example, the weight, the speed segments, and turbulent components more than 100,000 focuses, selecting different could see more about the stream field.(F.Wang et al., 2008)

2.5 Aerodynamic Drag

The outer stream is the stream over bodies that are submerged in a liquid, with accentuation on the subsequent lift and drag strengths. At the point when a liquid moves over a strong body, it applies weight powers ordinary to the surface and shear powers parallel to the surface of the body. We are generally inspired by the resultant of the weight and shear strengths following up on the body as opposed to the points of interest of the dispersions of these powers along the whole surface of the body. The part of the resultant weight and shear drives that demonstrations in the stream heading is known as the drag constrain, and the segment that demonstrations ordinary to the stream bearing is known as the lift compel. (Rexca Anak Jamit, 2014)

Drag is typically an undesirable impact, similar to grating, and we do our best to minimize it. Diminishment of drag is firmly relate whit the lessening of fuel utilization in vehicle, submarines, and air ship; enhanced security and sturdiness of structures subjected to high winds; and decrease of clamor and vibration. The drag and lift powers rely on upon the thickness ρ of the liquid, the upstream speed V, and the size, shape, and introduction of the body, in addition to other things, and it is not down to earth to rundown strengths for an assortment of circumstances. (Rexca Anak Jamit, 2014)

2.6 Wind Turbine

A wind turbine is a device that proselytes dynamic vitality from the twist, additionally called twist vitality, into mechanical vitality; a procedure known as wind power. On the off chance that the mechanical vitality is utilized to deliver power, the gadget might be known as a wind turbine or wind control plant. On the off chance that the mechanical vitality is utilized to drive hardware, for example, for pounding grain or pumping water, the gadget is known as a windmill or wind pump. Correspondingly, it might be alluded to as a wind charger when utilized for charging batteries.
(Sofian et al., 2014)

Wind turbines are divided into two general sorts which are either in horizontal or vertical axis. Case on kind of wind turbine is shown in Figure 2.10. An even pivot machine has its cutting edges turning on a hub parallel to the ground. A vertical pivot machine has its cutting edges turning on a hub opposite to the ground. There are various accessible outlines for both and every sort has certain focal points and inconveniences. Be that as it may, contrasted and the level hub sort, not very many vertical pivot machines are accessible economically. (Rexca Anak Jamit, 2014)

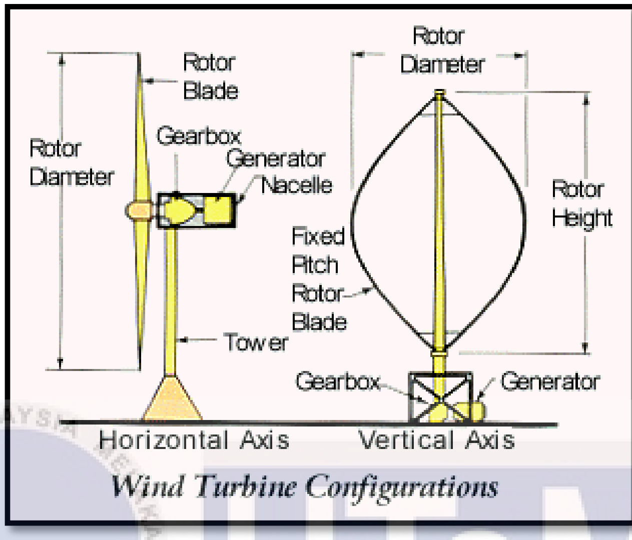

Figure 2.10: Types of wind turbine. (Rexca Anak Jamit, 2014)

2.7 Wind Turbine Profile

The twist turbine under study is as shown in Figure 2.11 which is smaller scale fan bladed wind turbine. Not the same as ordinary a few sharp edge wind turbines, this smaller scale wind turbine utilizes a fan-sort cutting edge design as opposed to an aerofoil-sort, which has a useful favorable position of expanded power productivity. The edgewise see characterizes the sharp edge thickness circulation over the cutting edge length. Numerous substantial wind turbines use straight decrease sharp edges from the root to the tip for inflexibility. Since the sharp edge of the smaller scale wind turbine is not long, it is intended to be in mono thickness along the edge length. The turn degree of the turbine sharp edge is obviously shown in the exchange see. Most wind turbines utilize wound sharp edges to catch a more productive torque in various wind conditions, and the small scale twist turbine in this review is no special case. The curve edge of the miniaturized scale wind turbine is a basic parameter for the present.(Leung et al., 2010)

Computation and optimization work, and it has a strong relationship with the blade subtend-angle of the micro wind turbine. Important geometric parameters of a typical micro wind turbine under investigation are shown in the nomenclature. (Leung et al., 2010)

Figure 2.11: Micro fan bladed micro turbine. (Leung et al., 2010)

2.8 Wind Turbine Position

Three different models were utilized to determine the best position to mount wind turbine on a vehicle which is at the front bumper, on top of the front hood and on the rooftop as appeared in Figure 2.12 beneath. The span of the auto models are 4.2 m long, 1.7 m width and 1.8 m in height. The front territory for the wind turbine framework is set to be 0.2 X 0.75 meter square for every model. For this situation, the limit size to be utilized is 15 m x 15 m square delta and outlet region with 30 m length. Each of the three models will be recreated under comparable parameters where speed bay is 25 m/s (90 km/h) to decide the drag coefficient, Cd and lift coefficient, Cl.
(Sofian et al., 2014)

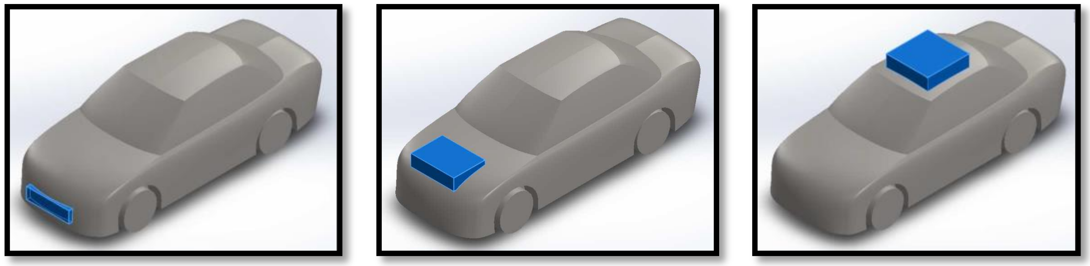

Figure 2.12: Different position of turbine (Sofian et al., 2014)

2.9 Wind Turbine to Generate Electric Current for Vehicle

Stephen Kwasi Adzimah completed the plan of a wind turbine that will be mounted on the electrical car to produce electrical energy to charge the auto batteries when in movement. The turbine is situated on the top of the car close to the wind screen, where the speed of air streaming around the car is at most elevated because of its streamlined nature. A versatile flat pivot diffuser increased wind turbine is received for the outline to empower it to create a higher power yield when contrasted with the traditional uncovered sort wind turbine. The air current is produced by the auto when it starts to move. (Hazila, 2015)

2.10 Blade Design

A segment of an edge at range r is delineated together with the related speeds, powers and points in Figure 2.13 and Figure 2.14. The relative twist vector at sweep r, signified as W, is the resultant of a hub segment UP, and a rotational part UT. The rotational part is the total of the speed because of the cutting edges movement rO, and the whirl speed of the air ra0O. The pivotal speed UP, is diminished by a segment U0a, because of the wake impact or blockage forced by the cutting edges, where U0 is the upstream undisturbed wind speed. The a0 and a term speak to the rotational and pivotal acceptance variables, individually. The approach is meant by a, the pitch edge of the

sharp edge by y, and the point of the relative twist to the plane of revolution, by F. The resultant lift and drag powers are spoken to by L and D, and guided opposite and parallel to the relative twist as appeared. The downstream wind speed is lessened down to U0(1-2a) in light of the fact that the turbine separates vitality from the wind. Take note of that over the rotor circle, the precise speed of the air with respect to the sharp edge increments from O to O (1+a0) on account of the wake turn of the stream.
(F.Wang et al., 2008)

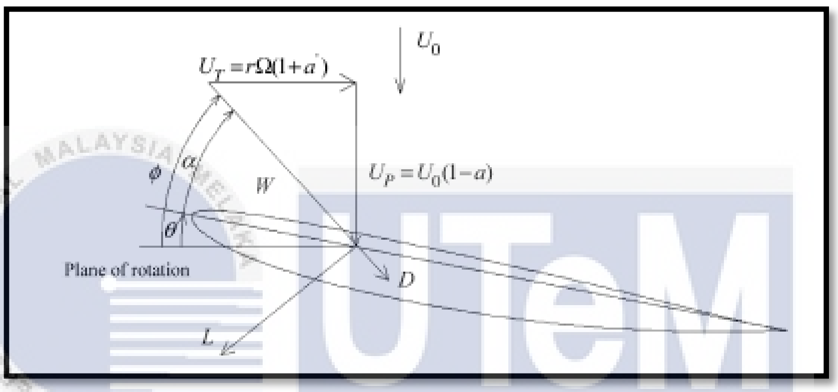

Figure 2.13: Schematic diagram showing the section of a blade at radius r. (F.Wang et al., 2008)

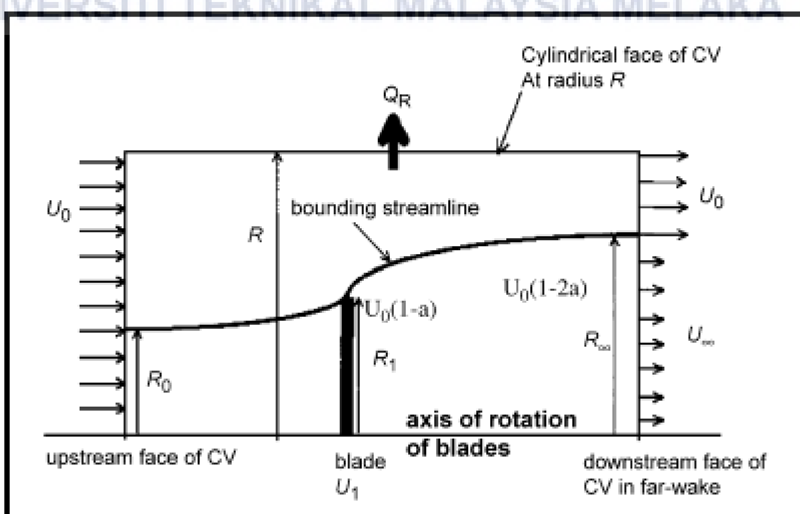

Figure 2.14: A cross section of the flow through the rotor. (F.Wang et al., 2008)

2.11 Maximum Power

F. Wang says that the greatest force of a wind turbine is tuned for a given wind speed by changing the rotational speed of the rotor. Figure 2.15 represent the most extreme shaft control produced in the two wind burrow test. The chart indicates result for two models which is unified with the scoop and another is without scoop. The figure indicates obviously that the higher wind speeds create more prominent power for the both test and the utilization of the scoop enhances control yield. A nearby look demonstrates that such change could be as great half increment in moderate winds, from slice in accelerate to around 10 ms-1. In higher winds, such increments were lower at around 25%. This change at low speed could be exceptionally important for small scale wind turbine working in developed ranges, where winds are frequently low speeds. The power bends tests additionally uncovered that the execution was diminished after the sharp edges were made short. Indeed, even with the scoop, the power yields were 12W and 71W at 5.15 ms-1 and 9.8 ms-1.(F.Wang et al.,2008)

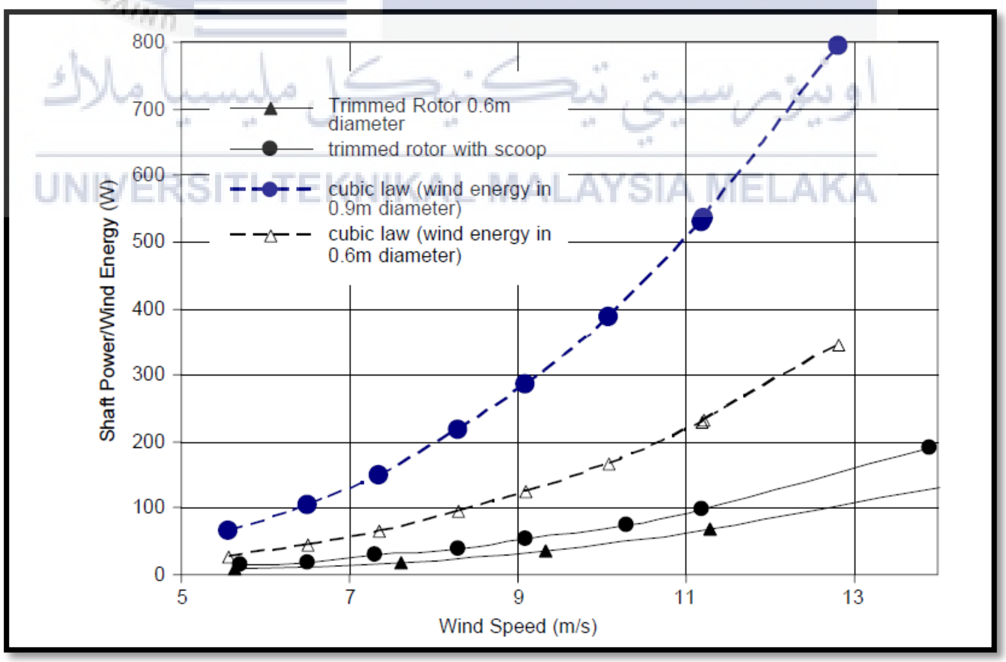

Figure 2.15: Results of the shaft power vs. wind speeds. (F.Wang et al.,2008)

CHAPTER 3

METHODOLOGY

3.0 Introduction

This chapter includes a review of the research method and the appropriate design use for this study. The steps that will be used in this study are based on the objective of this project. The flow will be as in flow chart below.

3.1 Flowchart

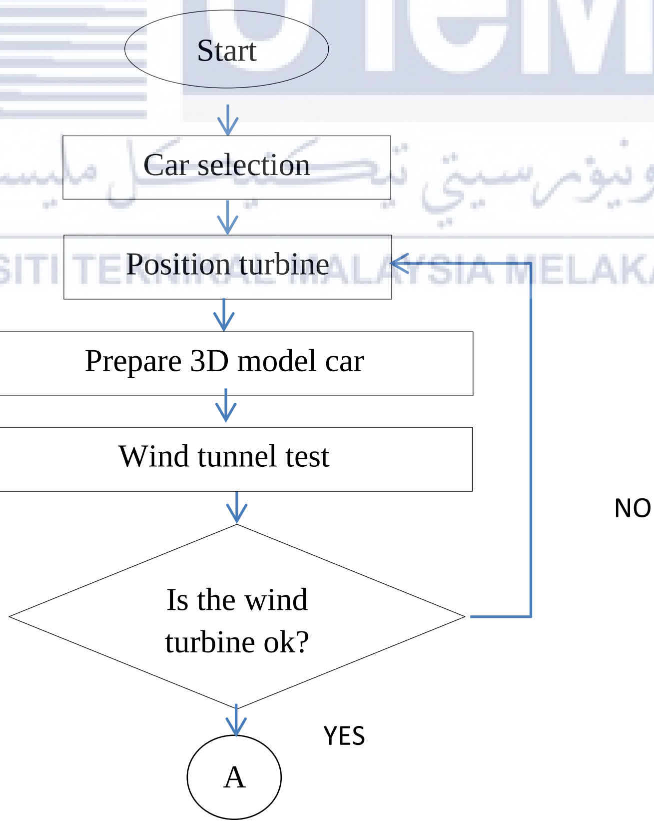

Figure 3.1: Flowchart part 1

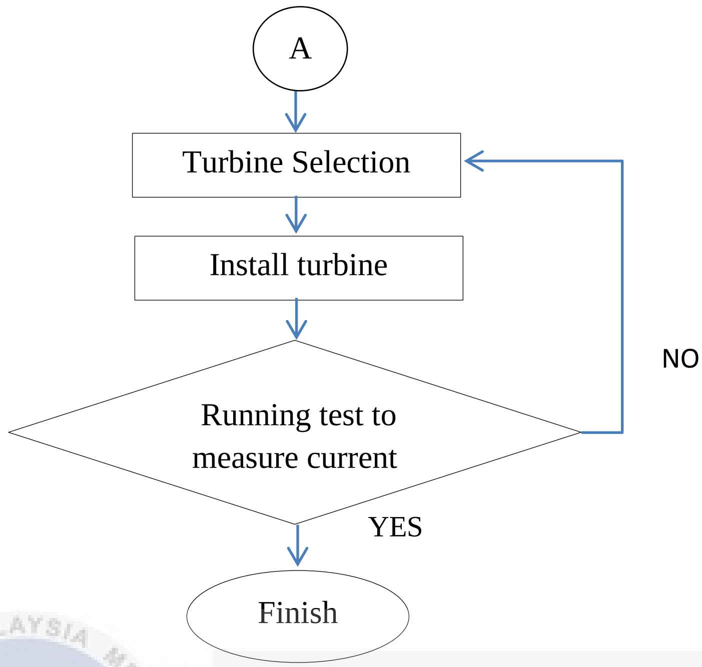

Figure 3.2: Flowchart part 2

3.2 Literature Review

Based on this project title, internet is use to search for the journals, thesis and magazines that related to the project title. The paper that have been search is about the study of micro turbine, aerodynamic drag, software use for designing 3D model, how the wind flow on a car, wind turbine, and the maximum current that can be generate through the wind energy. After reading all those papers, the important point were selected to be used.

3.3 Designing 3D Model of A Car

In this process, in order to achieve the first objective of this project, a software will be used to draw the 3D model of a car. The software that will be use is CATIA V5R21. CATIA software has been choose because it can draw 3D model better than AutoCAD software because in CATIA, the drawing can be rotate in any angle as the author want to adjust and fix the dimension of the drawing. In this project study, the model of a car that has been chosen is a sedan car (Proton Perdana).

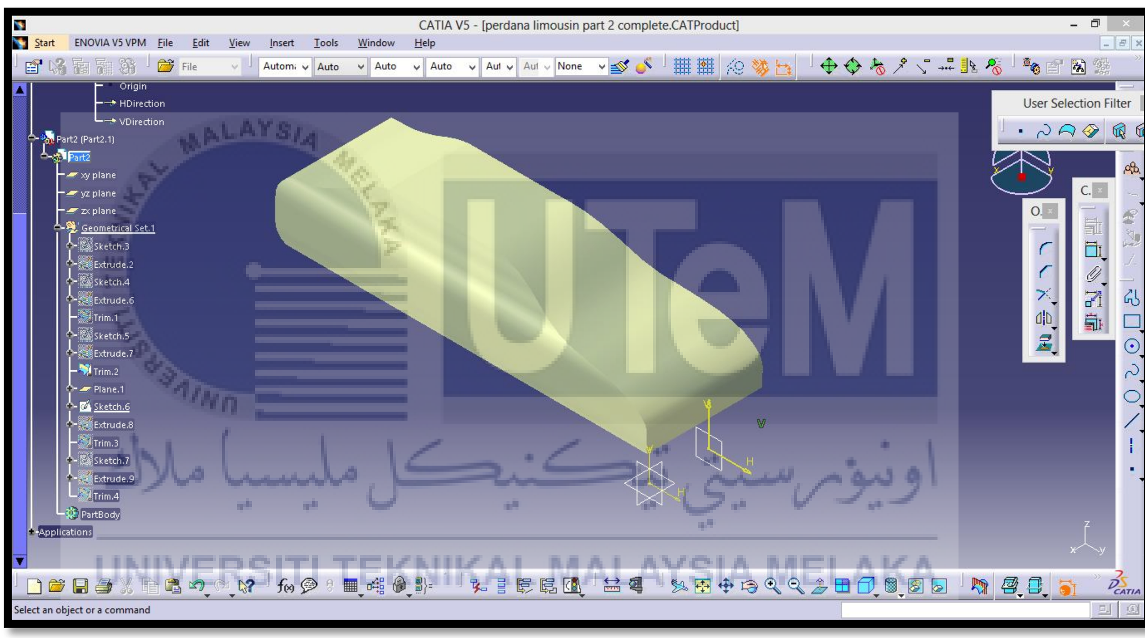

Figure 3.3: Design of 3D model

3.2.1 Process to develop 3D model of Proton Perdana

Step 1: Run CATIA software

I. Click start , then choose shape , and Sketch Tracer.

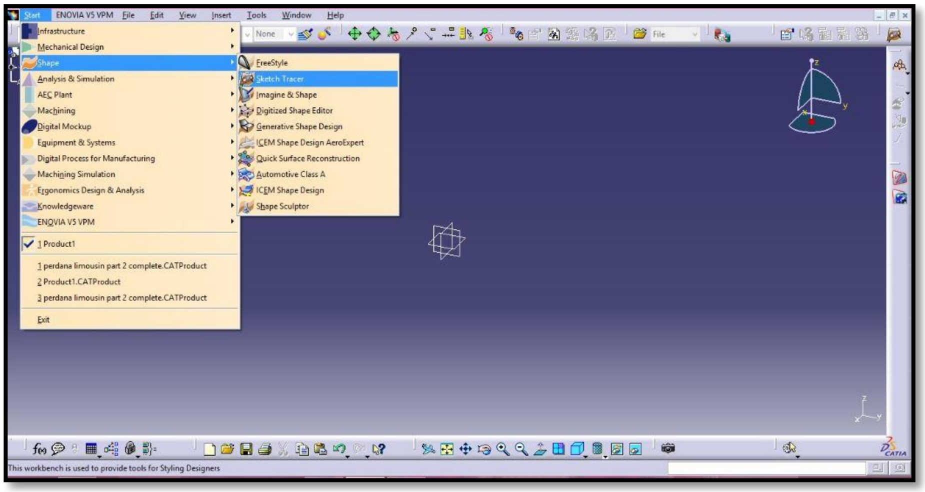

Figure 3.4: Run CATIA software

Step 2: Export Blueprint of Vehicle

I. Click on the right button orange colour (create an immersive sketch)

II. Select blueprint file want to use and open.

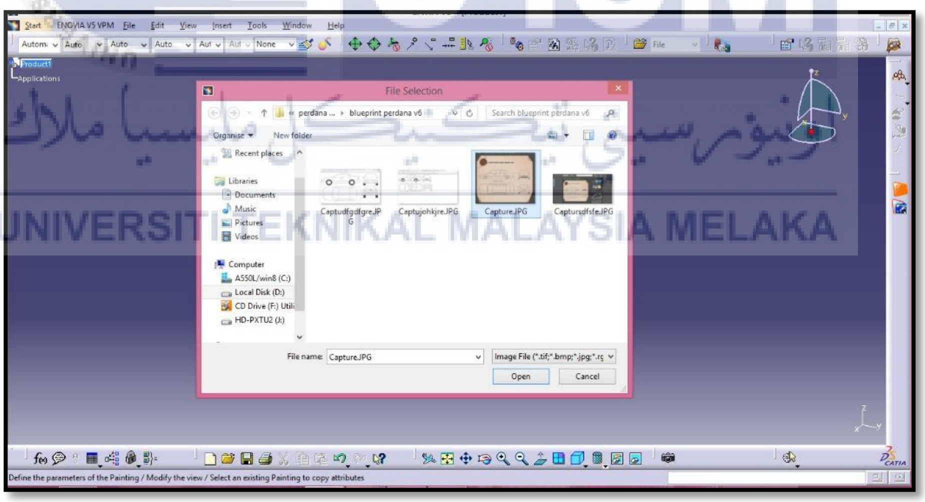

Figure 3.5: Exporting blueprint file

Step 3: Crop the image.

I. On the bottom toolbar, click the left view icon.

II. Crop the image into desirable size.

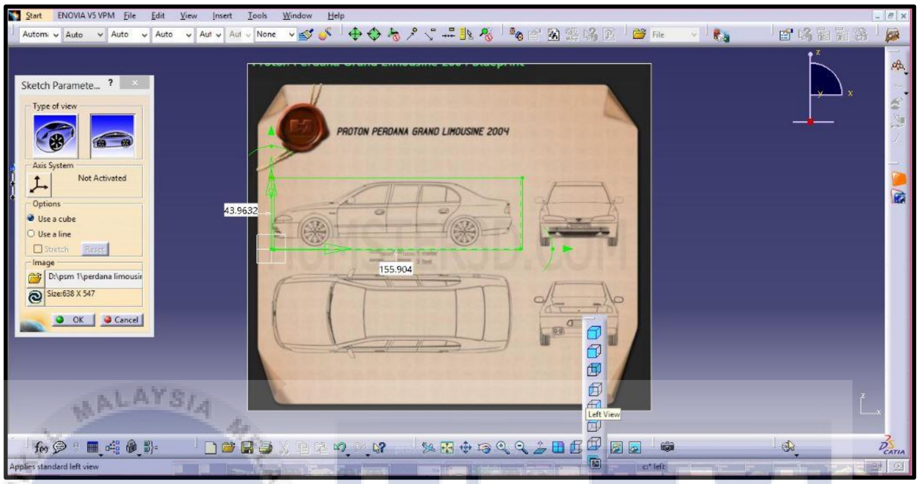

Figure 3.6: Cropping the image

Step 4: Insert new part.

I. After finish cropping the image, click at product, component and click new part

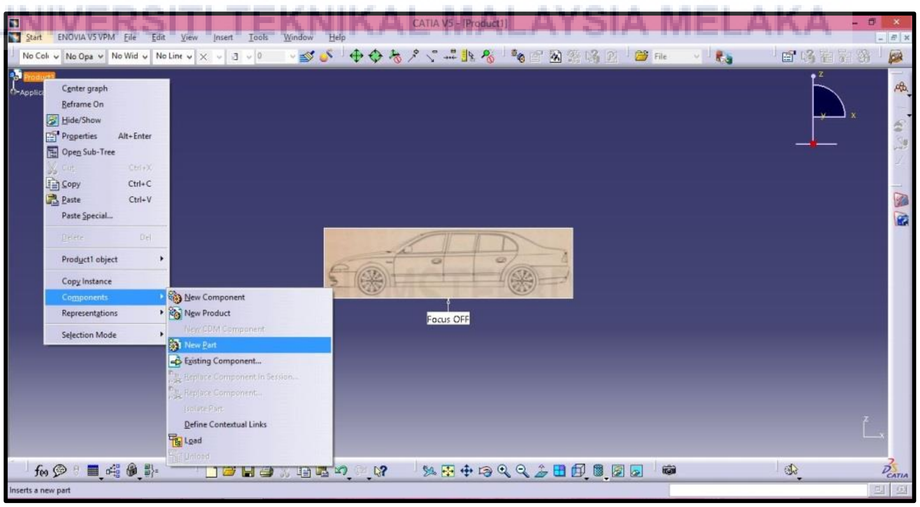

Figure 3.7: Inserting new part

Step 5: Click plane to sketch.

I. Choose plane.

II. Click sketch

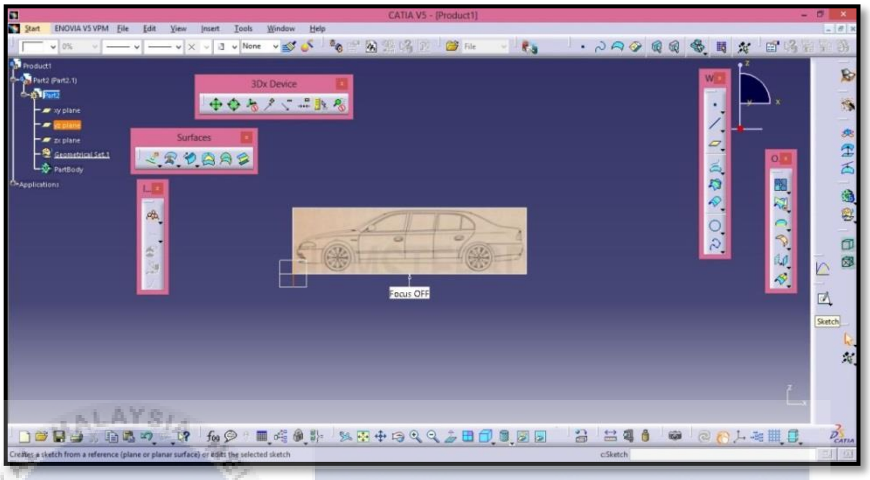

Figure 3.8: Plane to sketch

Step 6: Draw a line on vehicle body.

I. On the right tool bar, find a spline and click spline.

II. Draw points of spline based on figure above.

III. After finish create point, click exit work bench on the top right tool bar.

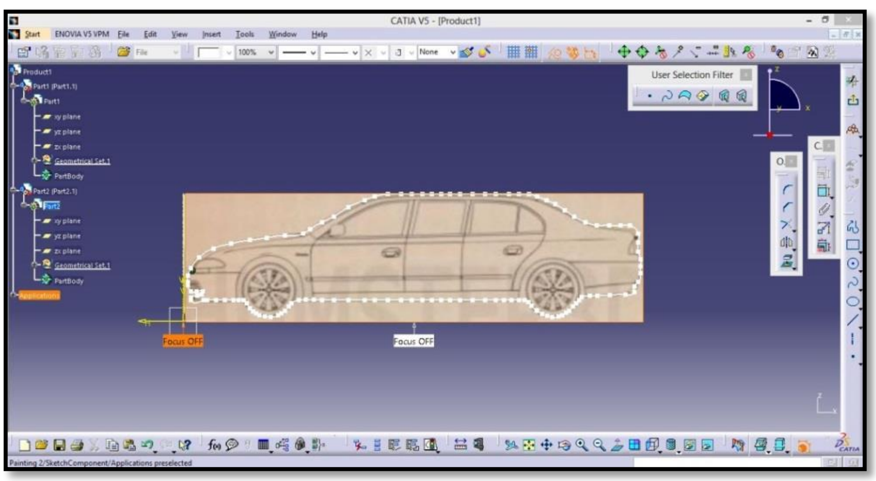

Figure 3.9: Drawing a line on vehicle body

Step 7: Time to extrude.

I. Click tool bar surface and click extrude.

II. Insert dimension to extrude.

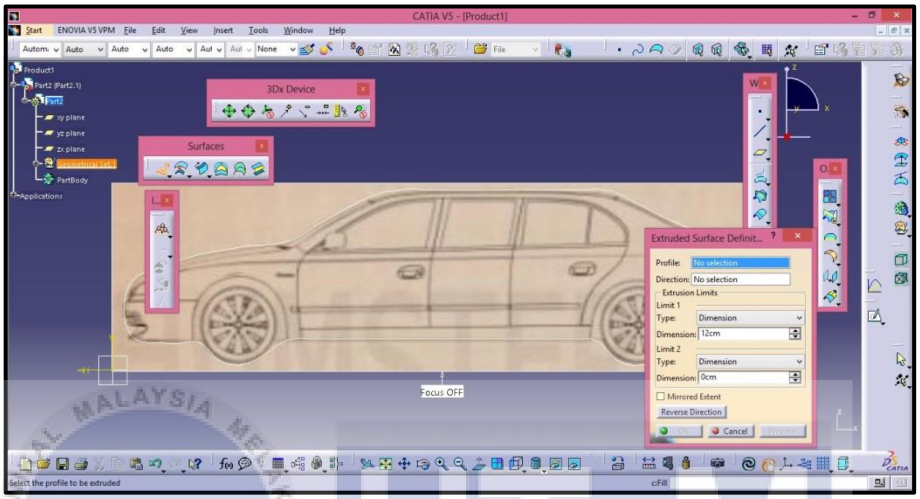

Figure 3.10: Setting of extruding a model

Step 8: Side model has been extruded

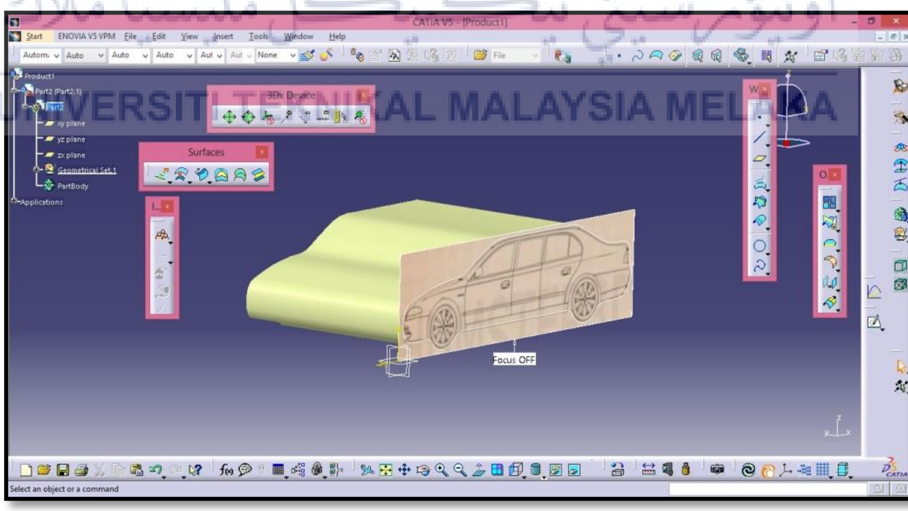

Figure 3.11: Side model has been extruded

Step 9: Repeat the step from step 1 until step 6.

I. Draw a construction line at the centre

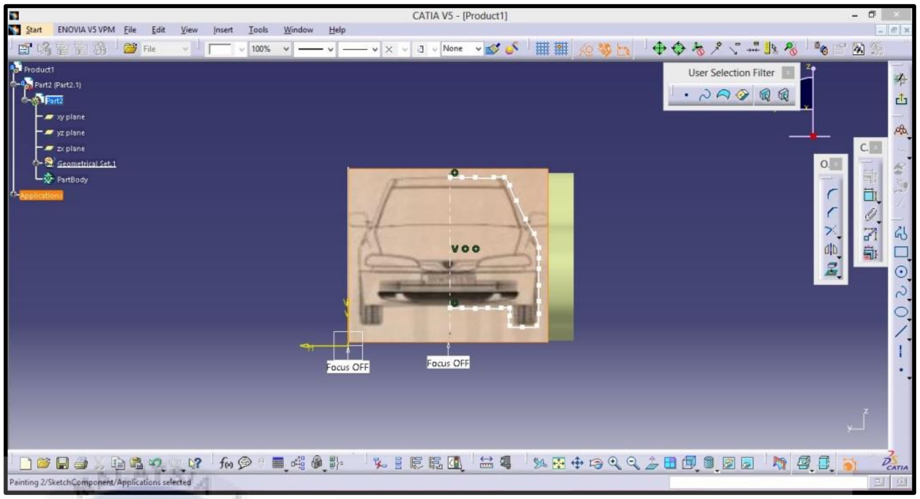

Figure 3.12: Drawing a construction line

Step 10: Mirror line on construction line

I. Click on the mirror icon

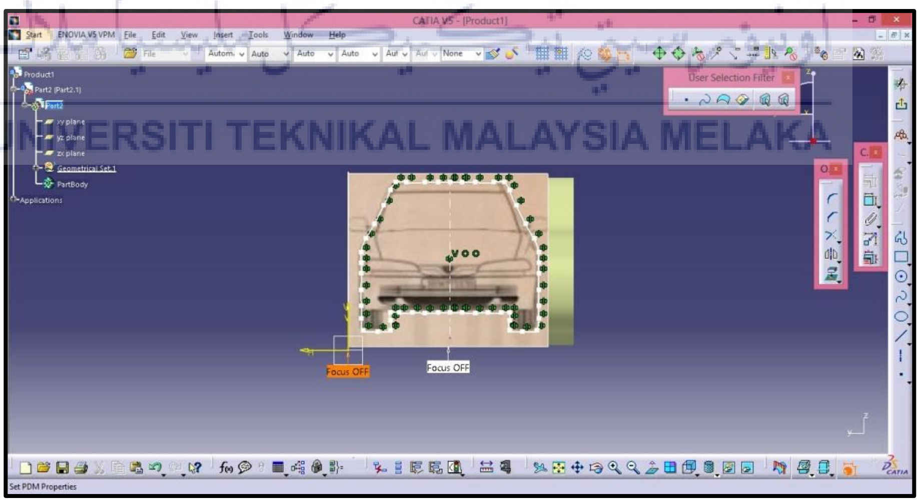

Figure 3.13: Mirror the construction line

Step 11: The model after being completely extruded without trimming.

I. Repeat step 6 and 7.

II. Make sure the extruded model has no hole to ensure the trimming process will be easy.

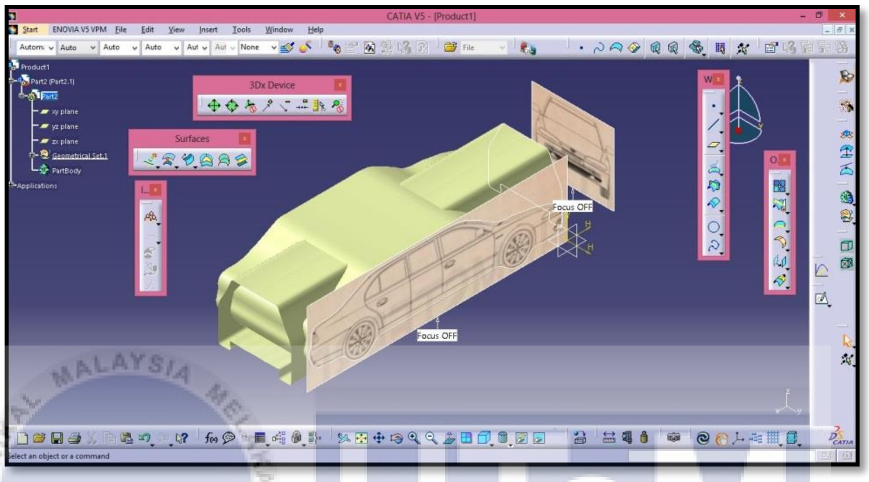

Figure 3.14: Model before trimming

Step 12: Trimming process.

I. On the right tool bar, click trim.

II. Click on the surface that wants to be trim.

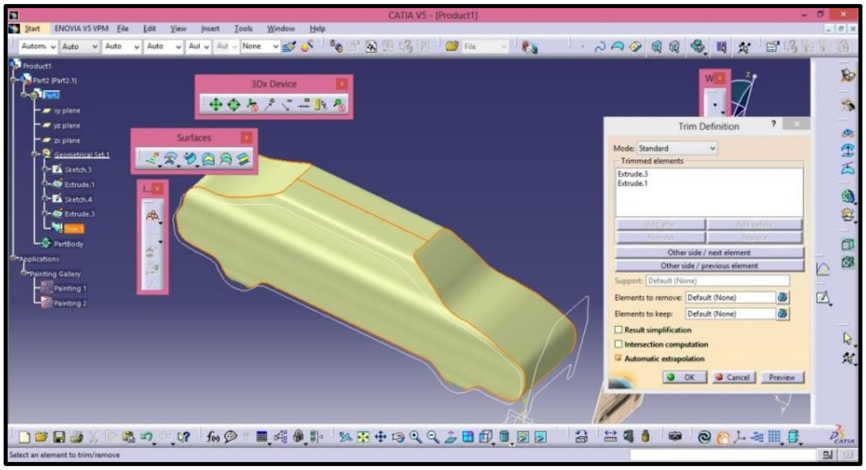

Figure 3.15: Model has been trimmed

Step 13: Ready to study analysis process

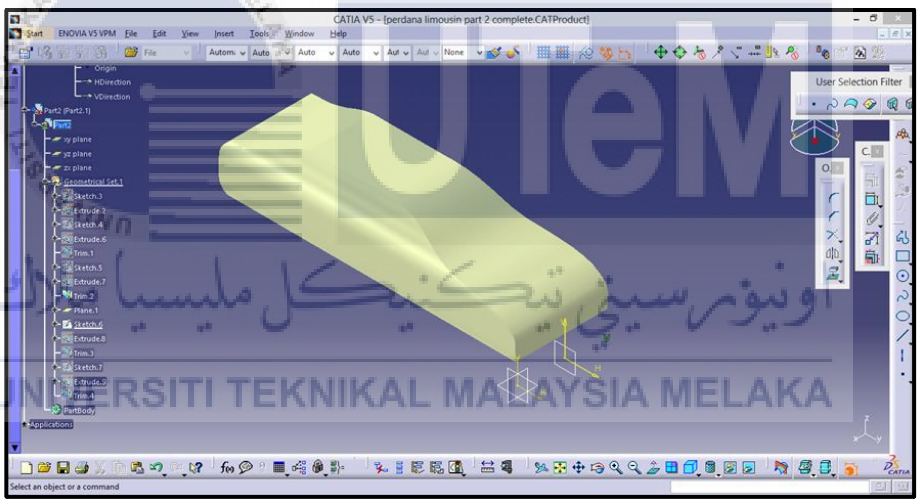

Figure 3.16: Ready to analyze

3.3 Development of CFD

After the model of a car is finished draw in CATIA and save in correct format, it will be export to another software, which is Altair Hyperwork. In Altair Hyperwork, the sub-software that will be use is AcuSolve (Virtual Wind Tunnel). The usage of wind tunnel in this software is to study and analysis the wind flow on a sedan car. The wind tunnel will calculate and determine the highest wind speed that flow on a car. In this study, the area that being focus is on the front hood.

Step 1: Open a Virtual Wind Tunnel Software

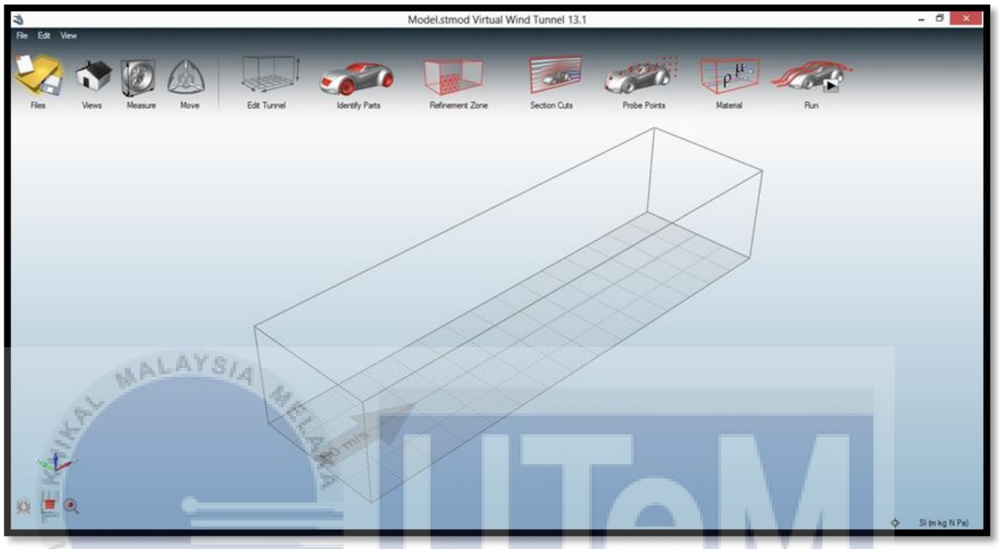

Figure 3.17: Virtual Wind Tunnel Software

Step 2: Import the car model that have been sketched

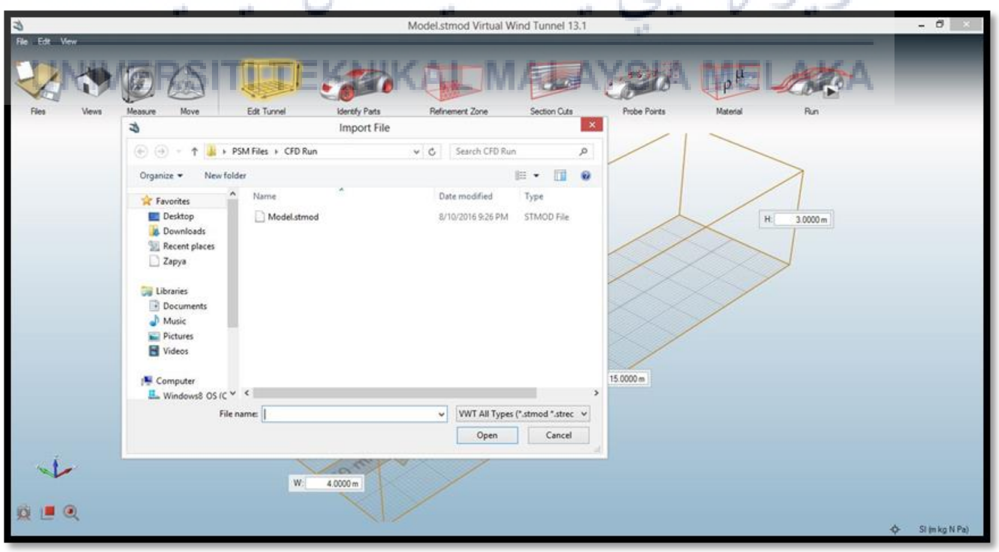

Figure 3.18: Car model imported into wind tunnel

Step 3: Edit and set up the size of the wind tunnel

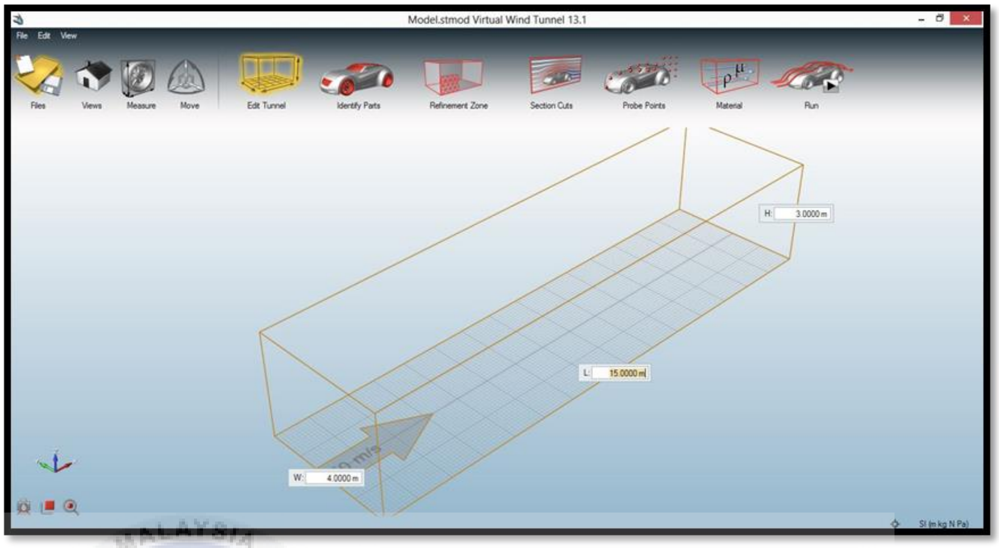

Figure 3.19: Wind tunnel was edited and set up

Step 4: Put the refinement zone at the car

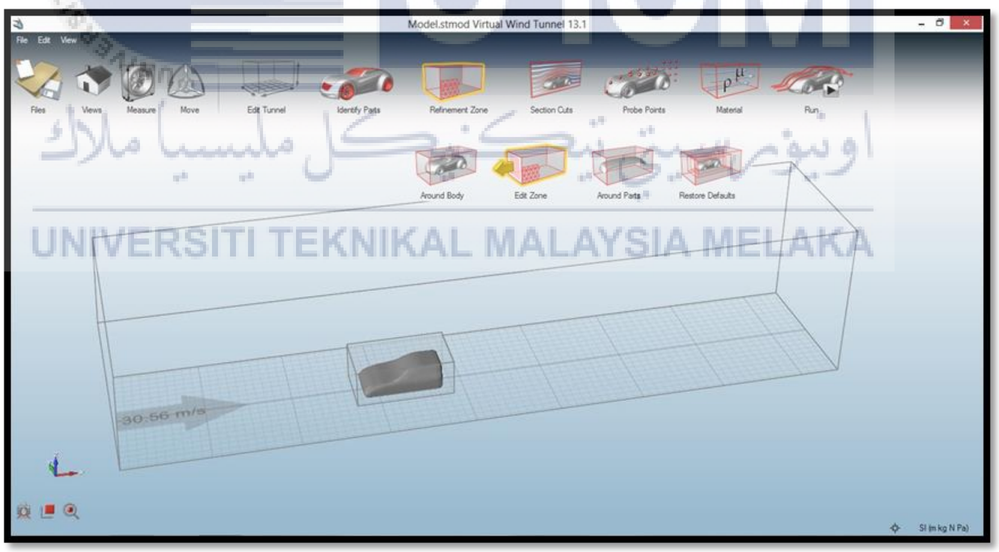

Figure 3.20: Set up the refinement zone

Step 5: Set up the run process parameters

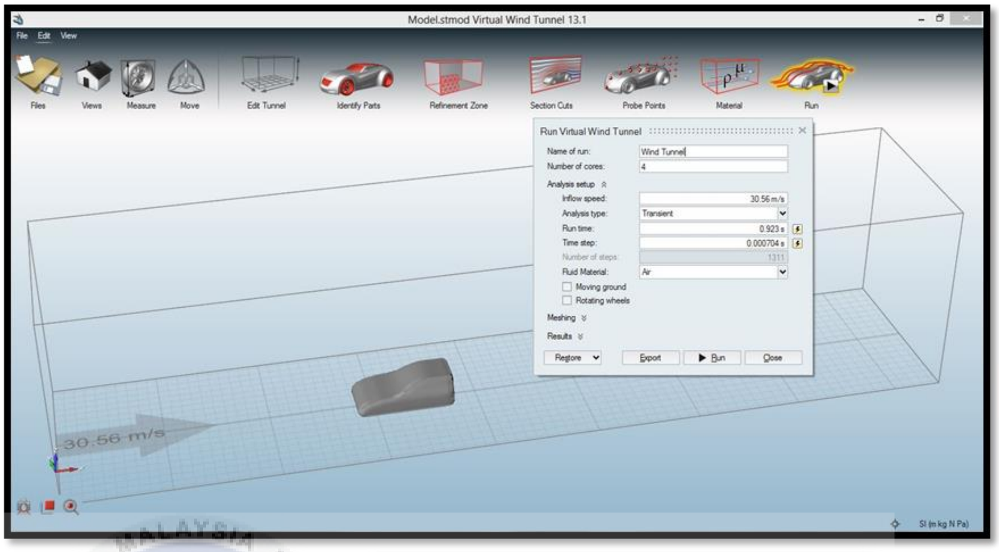

Figure 3.21: Set up parameters before run the process

Step 6: Run the process and wait for the result

Figure 3.22: Results of the analysis

3.4 Turbine Position

When the highest speed can be determine in the CFD software, it will be easy to determine the right place to install the wind turbine on the hood. Wind turbine then will be attach to the scoop that will be mounted on the front hood.

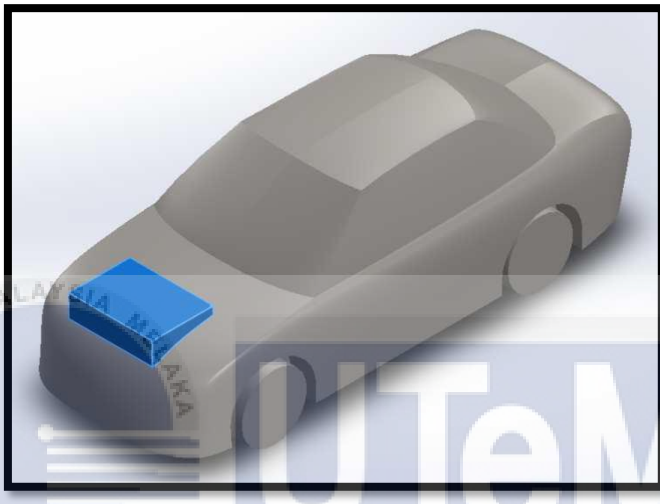

Figure 3.23: Turbine is attach on the front hood

3.5 Turbine Selection

The selection of the turbine is very important to generate the electricity from the wind energy. The selection of the turbine is including the size of turbine, the type of the fan blade and the number of the fan blade. Those criteria need to be select very properly because it can influence the results of the maximum current that can be generated.

Figure 3.24: Turbine with diameter 93mm

Figure 3.25: Turbine with diameter 69mm

3.6 Installing turbine

After study and select the best turbine to be used, the fabrication process can be start. First process to begin is the cutting process. The scoop will be placed on the hood to draw a line of outer its outer shape. Then, the grinding machine will be used to cut the area that has been labeled and then the scoop will be join to the front hood by using bolt and nuts. Next, the turbine will be attached to the scoop by facing the wind that will flow into the scoop. The turbine will be attached to the scoop in vertical position.

Figure 3.26: Wind turbine without air scoop

Figure 3.27: Wind turbine with air scoop

3.7 Running test to measure current

By finishing every step in the fabrication process, next progress can be start which is to determine the maximum current that can be generated. The car will be run to test the turbine results so that it can be compared to the theoretical value. The car will be run in different speed such as 80km/h, 100km/h, and 120km/h. In this test, a digital multimeter will be used to measure the electric current. Each of the speed will give the different results because wind energy is depending on the car speed to rotate the turbine.

Figure 3.28: Digital multimeter was used to measure the voltage

CHAPTER 4

RESULTS AND DISCUSSIONS

4.0 Introduction

Nowadays, people are concern about fuel consumption. One of the alternative to improve fuel consumption is by minimizing the electrical load from the alternator. It can be realized by harvesting the energy from the wind force. The wind force is related to air flow on the vehicle surface. Because of that, a study on the aerodynamic drag has been performed.

4.1 Computer Fluid Dynamic Analysis

In vehicle design, aerodynamic drag is very important because it affected the performance of vehicle, especially during driving. To analyze the aerodynamic drag, a vehicle will be simulated by using Computer Fluid Dynamic (CFD) analysis software. In this research, a vehicle will be simulated through the wind tunnel to identify the wind pressure that flows on a vehicle surface.

Figure 4.1 represent the result of analysis that have been obtained by using CFD software. From the results, the streamline was produced and it shows the different colours of air pressure. For the highest part of the vehicle, the streamline produced is in blue colour. It shows that the low air pressure is created within that area. While at the lowest part of the vehicle, the air pressure was increased. The part with highest wind pressure was presented in red colour streamline.

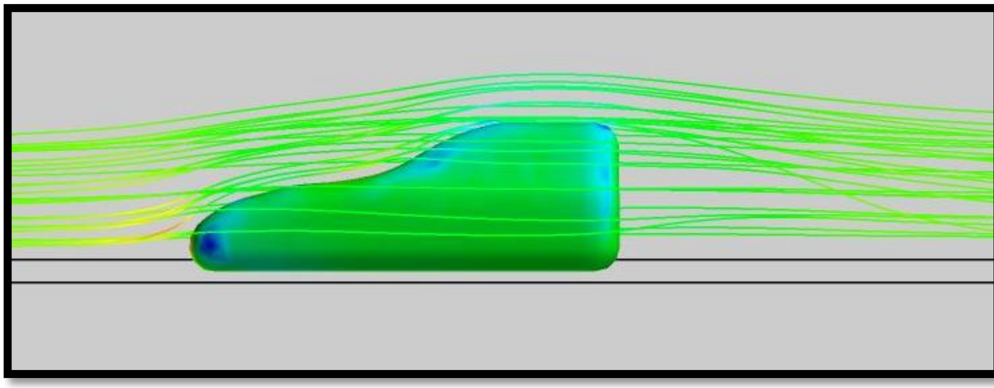

Figure 4.1: Side view of streamline

Figure 4.2 shows the maximum air pressure when the wind hit the frontal area of the vehicle. At the starting part of front hood, the air pressure remains high, so the wind turbine was mounted at this position. After this position, the air pressure starts to decrease.

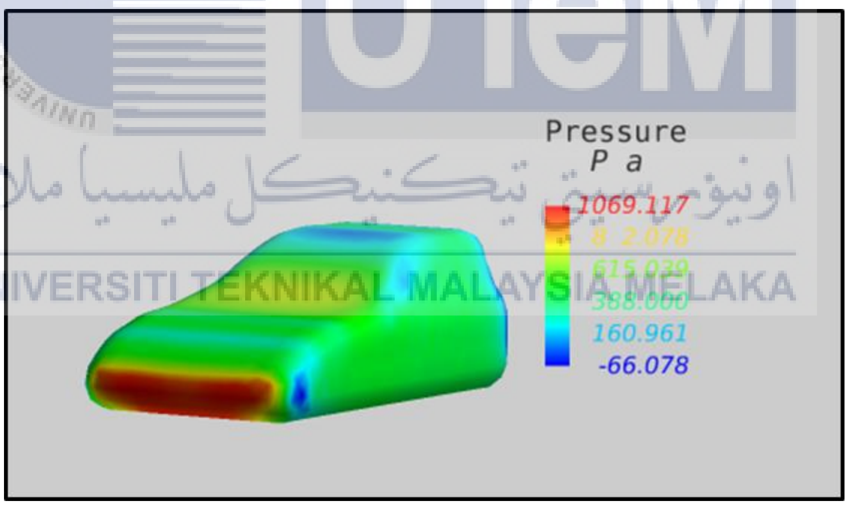

Figure 4.2: Wind pressure flow on vehicle surface

4.2 Experiment Data

To measure the maximum voltage generated by the wind turbine, real drive experiment has been performed. To harvest, the electrical energy from the wind flow, wind turbine has been utilized to generate the electrical current. The dimension and characteristic of the wind turbine was selected based on the position of the wind turbine mounting. The best position to install the wind turbine has been determined by using CFD software. An experiment was conducted by driving a vehicle from 0 km/h to 140 km/h. The voltage generated by the wind turbine was recorded as shown in Table 4.1 and 4.2.

Table 4.1: Results of wind turbine with diameter 69mm

Speed (km/h)	Voltage (V)
10	0
20	0
30	0
40	0
50	1.8
60	1.9
70	1.9
80	2.0
90	2.0
100	2.0
110	2.0
120	2.0
130	2.0
140	2.0

10	0
20	0
30	0
40	0
50	1.8
60	1.9
70	1.9
80	2
90	2
100	2
110	2
120	2
130	2
140	2

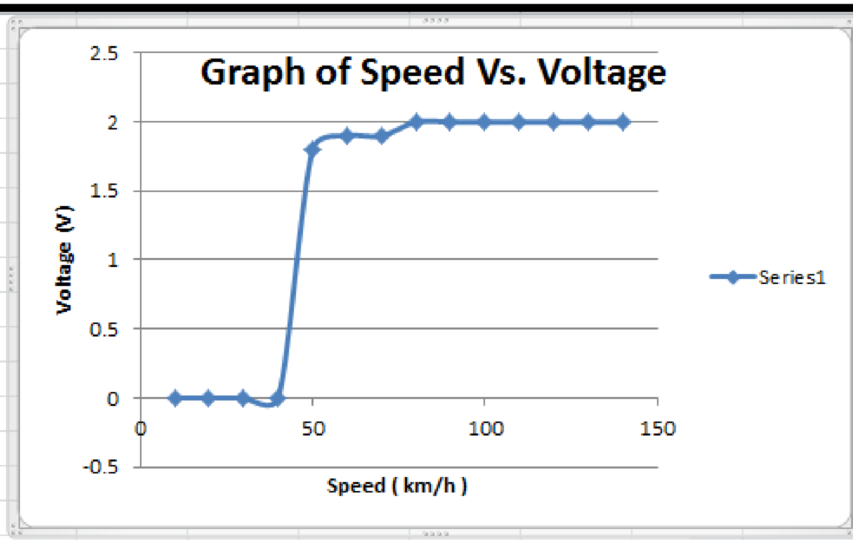

Figure 4.3: Graph of Speed Vs. Voltage

Table 4.1 and Figure 4.3 shows that when the vehicle moves from 0 km/h to 40 km/h, there is no voltage generated. It is because the wind velocity is not strong enough to rotate the blades of wind turbine. In order to rotate the blades of wind turbine, the speed of vehicle has been increased to receive higher wind velocity. At the speed of 50 km/h, the blades of wind turbine start to rotate and the voltage generated is 1.8 V. The voltage increased as the speed of the vehicle increased. Even though the speed has reached 140 km/h, the maximum voltage generated still at 2.0 V. This situation occur because the turbine has reached its maximum output voltage.

Table 4.2: Results of wind turbine with diameter 93mm

Speed (km/h)	Voltage (V)
10	0
20	0
30	0
40	0
50	0.8
60	2.0
70	2.7
80	3.5
90	4.0
100	4.7
110	5.3
120	6.1
130	6.9
140	7.5

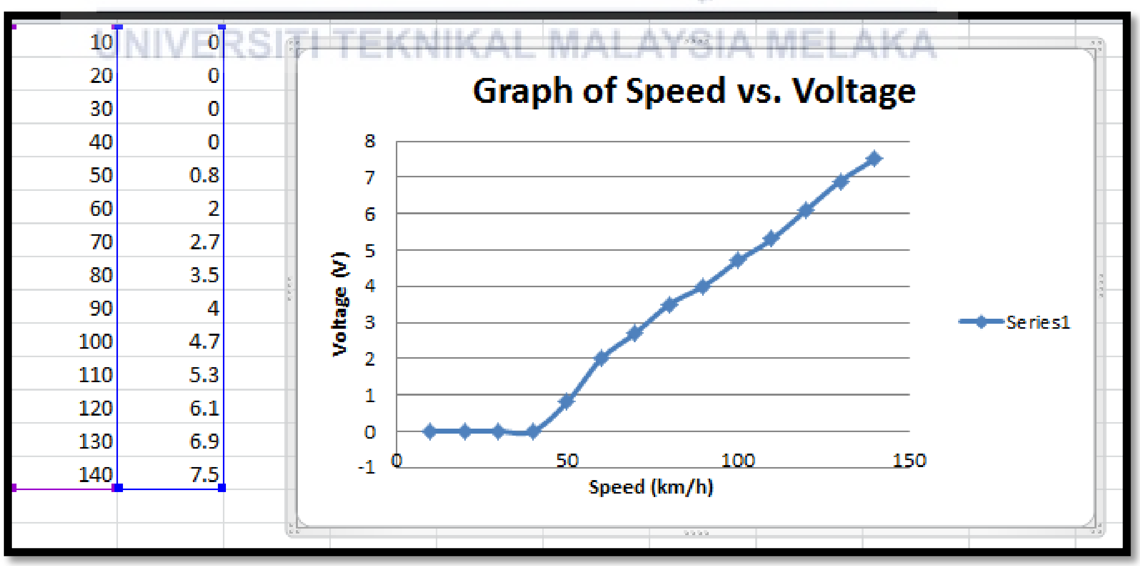

Figure 4.4: Graph of Speed Vs. Voltage

Table 4.2 and Figure 4.4 shows the results of voltage generated by the wind turbine with in diameter. At the speed of 0 km/h to 40 km/h, the results is same with other wind turbine where there is no voltage generated. Likewise, the vehicle speed must be increased. At the speed of 50 km/h, the wind turbine started to generate the voltage with 0.8 V. The results of voltage generated increased when the speed of vehicle increased. At the speed of 140 km/h, the wind turbine has generated 7.5 V.

4.3 Conclusion

From the CFD analysis, the position of wind turbine on the front hood can be predicted accurately. Indirectly, this process significantly reduce cost and time of the experiment. For the voltage generation, the wind turbine has to be selected properly because it gives a big impact and influence data of experiment. Proper selection of wind turbine is to ensure the voltage can be generated effectively.

CHAPTER 5

CONCLUSION

This chapter is to conclude overall project of Development of Air Scoop Micro Turbine based on the objectives that have been mentioned in Chapter 1 of this thesis.

The experiment of Development Air Scoop Micro Turbine was successfully performed when every research and procedure of the experiment was completely setup. The first objective of this project is to identify the shape of a vehicle which is Proton Perdana V6. The purpose to get the shape of this vehicle is because each car has different shape and dimension. Next objective of this project is to identify the highest wind pressure on the front hood. The pressure of wind was identified by using CFD software. Next objective is to choose and design the most suitable wind turbine that can be used to be mounted on the front hood. This is because if the wind turbine is not selected properly, it will influence the data of the experiment. Lastly, the objective of this experiment is to determine the maximum voltage that can be generated by the wind turbine. The voltage is being measured when the real driving experiment is being perform by driving a vehicle from 0 km/h to 140 km/h. The vehicle speed is incremented with 10 km/h. Each speed has shown different results of voltage that can be generated by the wind turbine.

Although the results of the voltage generated can be considered high, there are still some recommendation that should be apply to this project. The first recommendation is regarded to the wind turbine. The wind turbine can still be modified so that it can start to generate voltage as soon as the vehicle starts to move. The purpose of this modification is to make the wind turbine lighter and thus can produce higher voltage when the vehicle speed increased.

Next recommendation is the shape of the air scoop. The shape of air scoop also play an important role in capturing wind pressure to rotate the blades of wind turbine. Current air scoop that have been used have a height that cause a big gap between the wind turbine and air scoop. A big gap causes the loss of air pressure when the wind enters the air scoop. If the gap can be reduce, the maximum air pressure can make the wind turbine rotate faster and generate more voltage. Furthermore, the front hood also can be modified by make a horizontally hole so that the wind flow will not stuck at the end of the air scoop. If the front hood have a horizontally hole, it will make the wind flow smoothly and can improve the speed of the wind turbine.

Lastly, this project also need an airflow meter because it can measure the speed of wind that flow towards the turbine and the speed of wind after pass the turbine. With this device, it can measure the loss for the wind pressure after pass the wind turbine. Different type of wind turbine will obtained different results of the loss of wind pressure because each wind turbine have different size and characteristics.

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APPENDICES

Wind turbine setup without air scoop

Wind turbine setup with air scoop