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Tandatangan : .....
Nama Penyelia I : Dr. Mohd Yusoff Sulaiman
Tarikh : 12/12/05

Tandatangan : .....
Nama Penyelia II : .....
Tarikh : .....

PROPELLER POWERED SOLAR VEHICLE

BY

WAN FAIRUZ BIN WAN YUSOF

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ADMISSION

" I admit that this report was done all by myself except the summary and passage that I have clearly stated the source on each one of them"

Signature : .....

Author Name : WAN FAIRUZ BIN WAN YUSOF

Date : 12/12/2005

This project is dedicated to my parents...

Wan Yusof Bin Wan Ngah...

Fatimah Binti Abu Bakar...

Brothers and...

Sisters...

They gave me all the courage, inspiration, motivation, and financial aid for the success and accomplishment of this project.

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ABSTRACT

Solar cars are powered by the sun's energy. The main component of a solar car is its solar array, which collect the energy from the sun and converts it into usable electrical energy. The solar cells collect a portion of the sun's energy and store it into the batteries of the solar car. Before that happens, power trackers converts the energy collected from the solar array to the proper system voltage, so that the batteries and the motor can use it. After the energy is stored in the batteries, it is available for use by the motor & motor controller to drive the car. The motor controller adjusts the amount of energy that flows to the motor to correspond to the throttle. The motor uses that energy to drive the wheels. Basically, normal solar car uses that energy to drive the wheels but for this project the author had a different concept. The concept is the solar car will driven by a propeller. That's mean the motor uses that energy to rotate the propeller. Then, the propeller will drive the wheels. The theory is same with others application transportation such as hovercraft and swamp boat. The propeller will give a thrust force to drive the solar car but it depends on other criteria. The criteria are how much thrust force compares with the weight of a solar car, the motor's speed, torque rotation and others.

In chapter 2 will discuss about solar cells, how's it work and relates to solar car. Chapter 3 is more about design a solar car including the design process, aerodynamics and others. Systems considerations such as electrical systems, mechanical systems and drive controls will be discuss on chapter 4. Then, chapter 5 is about electric motor and other considerations such as the purpose and selecting the suitable motor. Propeller systems including momentum theory, aerodynamic characteristics, blades and others are on chapter 6. Chapter 7 shows the experiment analysis with graph and calculation to get the thrust force. Lastly, a model solar car with propeller on chapter 8 is built to prove that this project is realized.

ABSTRAK

Kereta solar dijanakan oleh tenaga matahari. Komponen paling penting ialah panel solar, yang mana tenaga diperolehi daripada matahari dan menukarkannya kepada tenaga elektrik. Sel solar pula mengutip bahagian tenaga matahari dan menyimpannya di dalam bateri. Selepas itu, tenaga tersebut digunakan oleh motor untuk menggerakkan kereta. Motor tersebut menggunakan tenaga untuk menggerakkan roda. Secara asasnya, kereta solar biasanya menggunakan motor untuk menggerakkan roda tetapi bagi projek ini penulis mempunyai konsep yang berlainan. Konsepnya ialah kereta solar tersebut digerakkan oleh propeller. Ianya bermaksud motor yang menggunakan tenaga tersebut akan memutarkan propeller. Kemudian, propeller tersebut akan menggerakkan roda. Teorinya adalah sama dengan aplikasi kenderaan yang lain seperti *hovercraft* dan *swamp bot*. Propeller tersebut akan memberikan daya tujahan untuk menggerakkan kereta solar dan bergantung kepada beberapa kriteria seperti kelajuan motor, putaran tork, berat kereta solar tersebut dan lain-lain.

Dalam bab 2 membincangkan tentang sel solar, bagaimana ianya berfungsi dan kaitannya dengan kereta solar. Bab 3 pula mengenai rekabentuk kereta solar termasuk proses rekabentuk, aerodinamik dan sebagainya. Pertimbangan sistem seperti sistem elektrik, sistem mekanikal dan kawalan pemanduan dibincangkan dalam bab 4. Kemudian, bab 5 mengenai motor elektrik termasuk beberapa pertimbangan seperti tujuan dan pemilihan motor yag sesuai. Sistem propeller merangkumi teori momentum, sifat aerodinamik, bilah dan sebagainya dibincangkan dalam bab 6. Bab 7 menunjukkan analisis experimen dengan graf dan pengiraan untuk mendapatkan daya tujah. Akhirnya, model kereta solar dengan propeller dalam bab 8 dibina untuk membuktikan projek ini dapat direalisasikan.

TABLE OF CONTENTS

LIST OF FIGURES

Chapter	Contents	Page
7.1	Weighing Equipment	56
8.1.1	Solar Cells	61
8.1.2	Solar Motor	61
8.1.3	Solar Battery	62
8.1.4	Sealed Lead Acid Battery	62
8.1.5	Solar Propeller	63
8.1.6	Model Car	63

CHAPTER 1
INTRODUCTION

1.1 Problem Backgrounds

Many specifications must to know about solar car from solar array, motor, propeller and so on. Each specification has theory and calculation to make it function correctly and able to move perfectly. The most important thing is the propeller because before this, there is no solar car driven by a propeller. This project a lot depends on propeller because it using influence if the solar car can drive or not.

Using brainstorming techniques to generate ideas, several initial designs may be considered. A common place to start is with the shape of the car since it will dictate the designs of many other systems. Initial design concepts are also developed for chassis designs, mechanical system designs, electrical system designs, drive train designs, and solar array designs. Designs that show promise are investigated further so that designs can be compared through trade off studies. The concepts must be eliminated until a final design can be agreed upon. There are many factors to consider with each design, for example:

- cost
- efficiency
- manufacturability
- rule compliance
- system compatibility
- time constraints
- weight

It is up to the author rank the importance of these factors and others. Rarely will a design be clearly the best in all areas. For example, using a propeller design may offer better efficiency and weight, but the cost may be considerably more, making it less reliable and time consuming. The author must therefore decide which option is the best alternative.

1.2 Problem Statement

Basically, research about propeller to drive a solar car was a something new. Success or not depends on questions that will answer it later from the research. This research is carrying out to get an answer from the question as follows:

(a) How to build a solar car with propeller? In this research, the author will build a prototype to prove the fact.

(b) How a propeller can drive a solar car? Connection between propeller and motor is important thing.

(c) How much thrust force is use to move a solar car with a weight and other specification?

1.3 Significance

Knowledge about solar array also important because the array is a made up of many photovoltaic solar cells that convert the sun's energy into electricity. The cell types and dimensions of the array depending on the vehicle size and class.

Moreover, knowledge about drive train in solar car is very different from that a conventional car. Through this research, the drive train will consist of the electric motor and the means by which the motor's power is transmitted to the propeller causing the vehicle to move.

1.4 Objective

This project is to design a solar – propeller powered vehicle with objective as follows:

a) To design use photovoltaic cells as the source of power.
b) To use a motor and propeller system to create the thrust.
c) To fabricate and assemble a working prototype model.

1.5 Scope

This project is more focus on solar – propeller powered vehicle. The scope of this project as follows:

a) Selection of solar panels, storage medium.
b) Selection of propeller.
c) Cost of build a solar car with propeller.

1.6 Literature Review

1.6.1 Solar Cars - Solar Energy and Photovoltaic

During the 1990s, regulations requiring an approach to "zero emissions" from vehicles increased interest in new battery technology. Battery systems that offer higher energy density became the subject of joint research by federal and auto industry scientists. Solar cars were first built by universities and manufacturers. The sun energy collector areas proved to be too large for consumer cars, however that is changing. Development continues on solar cell design and car power supply requirements such as heater or air-conditioning fans.

In the 1987 race, the GM Sunraycer completed the 3010km trip with an average speed of 67kmh, setting the scene for an extensive research and development program among the teams (World Sun Energy Official Site). The MIT team is a student organization dedicated to educating students about solar car design and construction by providing a hands-on environment in which students are encouraged to apply theories learned in the classroom (MIT Sun Electricity Vehicle Team).

1.6.2 Sun Energy

Solar panels are devices that convert light into electricity. They are called solar after the sun or "Sol" because the sun is the most powerful source of the light to use. They are sometimes called photovoltaic which means "light-electricity". Solar cells or PV cells rely on the photovoltaic effect to absorb the energy of the sun and cause current to flow between two oppositely charge layers.

1.6.3 History of Photovoltaic

Photovoltaic (or PV) systems (Mary Bellis) convert light energy into electricity. The term "photo" is a stem from the Greek "phos," which means "light." "Volt" is named for Alessandro Volta (1745-1827), a pioneer in the study of electricity. "Photo-voltaics," then, could literally mean "light-electricity." Most commonly known as "solar cells," PV systems are already an important part of our lives. The simplest systems power many of the small calculators and wrist watches we use every day. More complicated systems provide electricity for pumping water, powering communications equipment, and even lighting our homes and running our appliances. In a surprising number of cases, PV power is the cheapest form of electricity for performing these tasks.

Photovoltaic cells convert light energy into electricity at the atomic level. Although first discovered in 1839, the process of producing electric current in a solid material with the aid of sunlight wasn't truly understood for more than a hundred years. Throughout the second half of the 20th century, the science has been refined

and the process has been more fully explained. As a result, the cost of these devices has put them into the mainstream of modern energy producers. This was caused in part by advances in the technology, where PV conversion efficiencies have improved considerably.

French physicist Edmond Becquerel first described the photovoltaic (PV) effect in 1839, but it remained a curiosity of science for the next three quarters of a century. At only 19, Becquerel found that certain materials would produce small amounts of electric current when exposed to light. The effect was first studied in solids, such as selenium, by Heinrich Hertz in the 1870s. Soon afterward, selenium PV cells were converting light to electricity at 1% to 2% efficiency. As a result, selenium was quickly adopted in the emerging field of photography for use in light-measuring devices.

Major steps toward commercializing PV were taken in the 1940s and early 1950s, when the Czochralski process was developed for producing highly pure crystalline silicon. In 1954, scientists at Bell Laboratories depended on the Czochralski process to develop the first crystalline silicon photovoltaic cell, which had an efficiency of 4%.

1.6.4 Inventor (Alessandro Volta, 1745 – 1827)

In 1800, Alessandro Volta of Italy built the voltaic pile and discovered the first practical method of generating electricity. Constructed of alternating discs of zinc and copper, with pieces of cardboard soaked in brine between the metals, the voltic pile produced electrical current. The metallic conducting arc was used to carry the electricity over a greater distance. Alessandro Volta's voltaic pile was the first battery that produced a reliable, steady current of electricity.

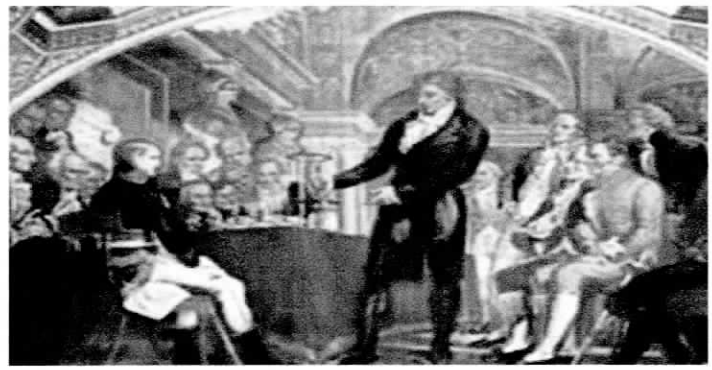

Figure 1: Alessandro Volta demonstrating the battery (generating electricity).

One contemporary of Alessandro Volta (figure 1, Mary Bellis) was Luigi Galvani, in fact, it was Volta's disagreement with Galvani's theory of galvanic responses (animal tissue contained a form of electricity) that led Volta to build the voltaic pile to prove that electricity did not come from the animal tissue but was generated by the contact of different metals, brass and iron, in a moist environment. Ironically, both scientists were right.

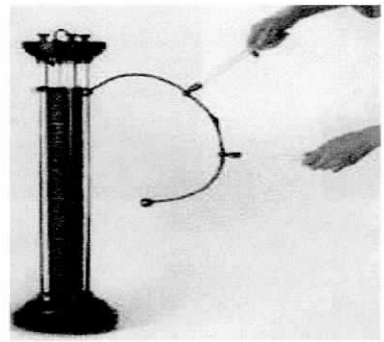

Figure 2: Alessandro Volta
Voltaic Pile.

1.6.5 History of Solar Battery

In the early 1950s R.S. Ohl discovered that sunlight striking a wafer of silicon would produce unexpectedly large numbers of free electrons. In 1954, G.L. Pearson, C.S. Fuller, and D.M. Chapin created an array of several strips of silicon (each about the size of a razorblade), placed them in sunlight, captured the free electrons and turned them into electrical current. This was the first solar battery. It could convert only six percent of the sunlight into useful energy; people wondered what it was

good for. Today, the solar cells we use to power calculators, highway emergency phones, and satellites can convert over 25 percent of the sunlight that hits them into useful energy.

1.6.6 Solar Applications

Many applications of solar cells used today. Figures below show a variety of solar cells applications.

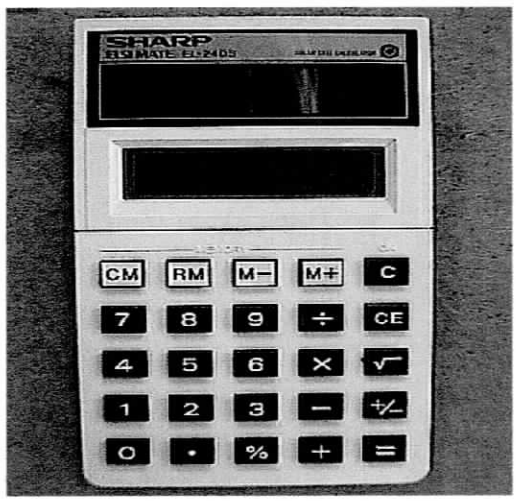

Figure 3: Calculator

Figure 4: Solar 'Carriage' Lantern Light.

Figure 5: Solar Car UKM (Universiti Kebangsaan Malaysia)

CHAPTER 2
SOLAR CELLS

2.1 History

According to the Sian, 1983, the discovery of the solar cell can be traced back to Becquerel, who in 1839 discovered that photovoltaic could be obtained from the action of light on an electrode in an electrolyte solution. The first photovoltaic effect on solid was discovered in 1877 by Adams and Day, on a material called selenium. This was later developed and used widely for many years in photographic exposure meters. The first report on the silicon single-crystal solar cell was published in 1954 by Chapin et al.

2.2 Function of a Solar Cells

Not only is the sun a source of heat and light, it's a source of electricity too! Solar cells, also called photovoltaic cells, are used to convert sunlight to electricity. Solar cells are used to provide electricity all kinds of equipment, from calculators and watches to roadside emergency phones and recreational vehicles.

Solar cells are most commonly made from silicon, the same material used to make computer chips. Silicon is one of the Earth's most common elements, and is a major component of sand and many kinds of rocks. A solar cell is built like a sandwich, with two layers of silicon separated by a thin layer of insulating material. All three layers work together to convert sunlight into electricity.

When sunlight falls onto the solar cell, it produces a small electric charge. Like a battery, the charge is positive on one side of the cell, and negative on the other. A wire connects the two sides of the cell, allowing electricity to flow. This flow, or current, of electricity can be used to power a small light bulb, turn an electric motor, or recharge a battery.

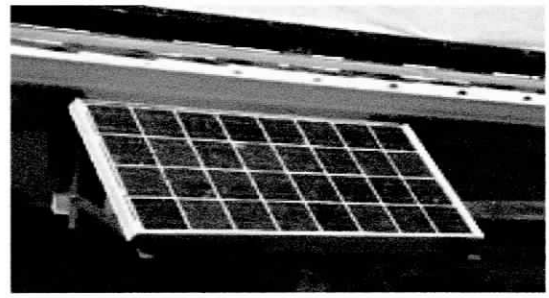

Figure 1: Solar Panel.

Solar cells are often used in locations where there isn't any electricity and where electricity is needed in small amounts. In such cases, solar cells are usually connected to batteries, allowing electricity to be stored for use during times when the sun isn't shining.

A single solar cell is able to produce only a small amount of electricity. But solar cells can be connected together on a multi-cell panel to produce larger amounts of electricity. As with batteries, the more cells that are connected to one another, the greater the current of electricity that can be produced. Solar panels (figure 1) can produce enough electricity to power satellites, recreational vehicles, and equipment for other applications where electricity is used in large amounts.

2.3 Material of Photovoltaic Cells

Visible light can be converted directly to electricity by a space-age technology called a photovoltaic cell (figure 2), also called a solar cell. Most photovoltaic cells are made from a crystalline substance called silicon, one of the Earth's most common materials. Solar cells are typically made by slicing a large crystal of silicon into thin wafers and putting two separate wafers with different electrical properties together, along with wires to enable electrons to travel between layers. When sunlight strikes the solar cell, electrons naturally travel from one layer to the other through the wire because of the different properties of the two silicon wafers.

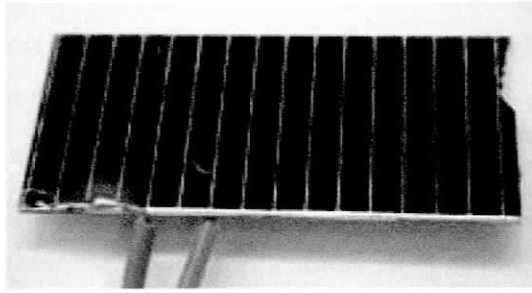

Figure 2: A photovoltaic cells.

A single cell can produce only very tiny amounts of electricity-barely enough to light up a small light bulb or power a calculator. Nonetheless, single photovoltaic cells are used in many small electronic appliances such as watches and calculators.

2.4 Photovoltaic Arrays

To capture and convert more energy from the sun, photovoltaic cells (figure 2) are linked to form photovoltaic arrays. An array is simply a large number of single cells connected by wires. Linked together in an array, solar cells can produce enough electricity to do some serious work. Many buildings generate most of their electrical needs from solar photovoltaic arrays.

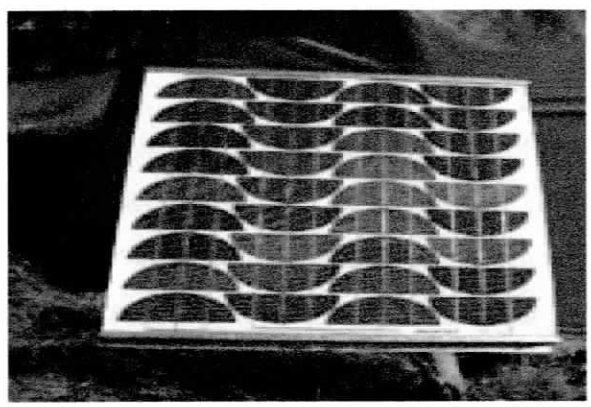

Figure 3: Photovoltaic Arrays.