DEVELOPMENT OF A MINI RACE BOAT POWERED BY SOLAR

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This report is submitted in order to fulfill a part of the requirements for award of Degree in Bachelor of Mechanical Engineering (Thermal-Fluid)

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"I hereby declared that I have read this thesis, and in my opinion, this thesis is sufficient in terms of scope and quality for achieving award of

Degree in Bachelor of Mechanical Engineering (Thermal-Fluid)"

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"I hereby declared that this report and all that comes with it is my own work, except the ideas and summaries in which I have clarified their sources"

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Date : …….

Special dedication is dedicated to my family, supervisor, lecturers, friends and all others that aid me in completing this thesis.

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ABSTRACT

The project is about research of the usage of photovoltaic cells for use in a direct current circuit, which are then attached to a mini prototype boat that is to be tested and run in water, and based on yearly competition of solar-powered boat that is held in National Science Centre.

Several boat prototypes are designed using the Computer Aided Design (CAD) software that is abundance in designing technology. Such software is SolidWorks 2008, CATIA V6 and Autodesk Inventor Professional 2010, whereby the main software that is applied for drawings in this research is Autodesk Inventor software. The solar boat is then fabricated and tested for it to meet the criteria of best design through analysis done.

Tests are conducted using Computational Fluid Dynamics (CFD) software, which analyzes the overall fluid flow around the models tested. The models is then constructed using the materials and correct tools for it to achieve the proper flow properties as analyzed, which is then attached with the purposed solar circuits.

The results of flow analysis using CFD software is recorded between three purposed designs, which are RB1, RB2 and RB3. It is concluded that the best design is RB3 by referring to the drag coefficient of CFD analysis. Solar circuit designs are also concluded to be using 6.0 V solar panel pairings for maximum voltage and current generated. Combined together, this can produce the best mini race boat that moves using solar power, and is able to achieve estimated target time of 36.6 second, which is ahead of previous year's winning record time.

ABSTRAK

Projek ini adalah berdasarkan penggunaan sel berkuasa solar yang akan diaplikasikan dalam sesuatu litar arus terus, yang dimana kemudiannya akan disambungkan pada bot prototaip yang akan diuji dan dijalankan atas air berdasarkan pertandingan bot berkuasa solar yang dianjurkan di Pusat Sains Negara setiap tahun.

Beberapa bot prototaip telah direka bentuk dengan menggunakan perisian Lukisan Berbantu Komputer (CAD) yang banyak terdapat dalam teknologi lukisan. Contoh-contoh bagi perisian tersebut adalah SolidWorks 2008, CATIA V6 dan Autodesk Inventor Professional 2010, dan dilukis terutamanya dengan menggunakan perisian Autodesk Inventor dalam penyelidikan ini. Bot berkuasa solar ini kemudiannya difabrikasi dan diuji agar ia memenuhi criteria rekabentuk terbaik dari segi analisa yang akan dijalankan.

Ujian-ujian yang dijalankan adalah dengan menggunakan perisian Perkomputeran Dinamik Bendalir (CFD), dimana ia berupaya menganalisa segala peraliran bendalir disekeliling model yang diuji. Model yang dipilih ini kemudiannya dibina dengan menggunakan bahan-bahan dan peralatan yang sesuai agar ia dapat mencapai pengalian yang baik seperti yang dianalisa, dan kemudiannya disambungkan dengan litar solar yang dipilih.

Keputusan yang didapati daripada analisa pengaliran bendalir dengan menggunakan perisian CFD direkodkan antara tiga rekabentuk, iaitu RB1, RB2 dan RB3. Konklusi dibuat berdasarkan pekali seretan didalam analisa CFD, dimana rekabentuk RB3 telah dipilih. Rekabentuk litar solar disimpulkan agar dipilih panel berkembar berkuasa 6.0 V untuk menghasilkan voltan dan arus maksima. Digabungkan kedua-duanya, ini mampu menghasilkan bot lumba mini berkuasa solar yang bagus dan mencapai masa 36.6 saat, lebih laju dari masa yang direkodkan oleh pemenang tahun-tahun sebelumnya.

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I	=	Current, Ampere (A)
V	=	Voltage, Volt (V)
R	=	Resistance, Ohm (Ω)
P	=	Power, Watt (W)

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CHAPTER 1

INTRODUCTION

1.1 Background

Solar, or photovoltaic (PV), cells are electronic devices that essentially convert the solar energy of sunlight into electric energy or electricity. The physics of solar cells is based on the same semiconductor principles as diodes and transistors, from which it form the building blocks of the entire world of electronics.

Solar cells convert energy as long as there is sunlight. In the evenings and during cloudy conditions, the conversion process diminishes. It stops completely at dusk and resumes at dawn. Solar cells do not store electricity, but batteries can be used to store the energy.

One of the most fascinating aspects of solar cells is their ability to convert the most abundant and free form of energy into electricity, without moving parts or components and without producing any adverse forms of pollution that affect the ecology, as is associated with most known forms of nonrenewable energy production methods, such as fossil fuel, hydroelectric, or nuclear energy plants.

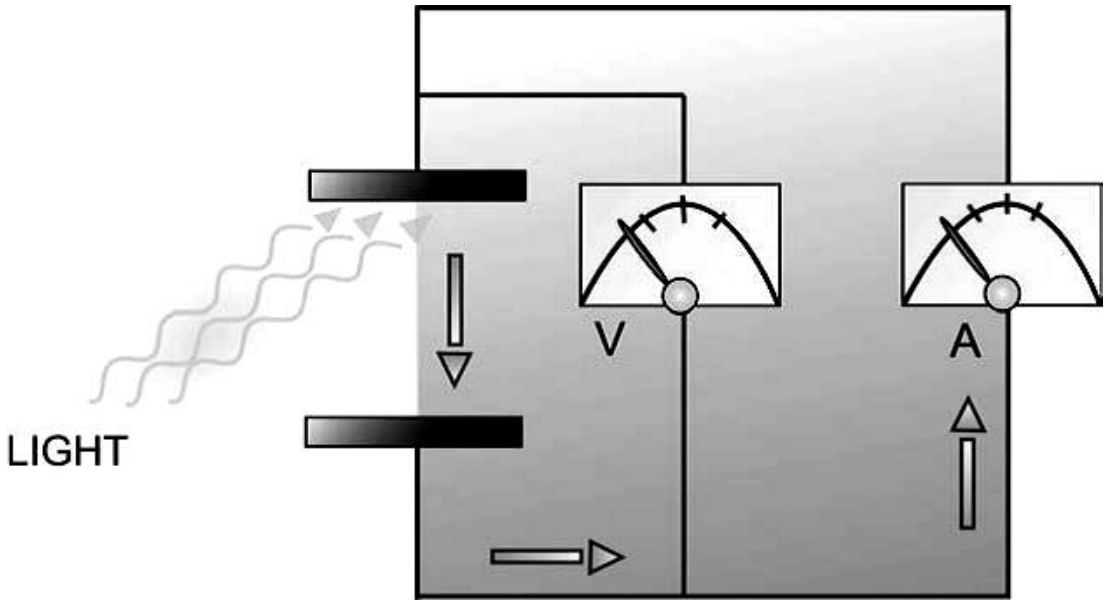

Figure 1.1: The photovoltaic effect experiment

(Source: Solar Power in Building Design, Gevorkian P., 2009)

The solar energy obtained from the photovoltaic panels is used to power up, per circuit flow, the mechanical components in the boat's circuit. The flow of the generated electricity in the circuit itself will move and work according to the flow:-

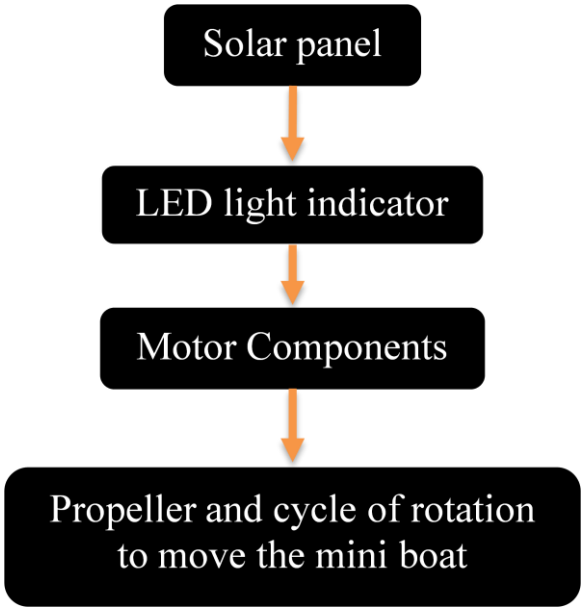

Figure 1.2: The electronic work flow of the circuit

The main body of the mini boat itself must be able to move through the water. The criteria that are needed to accomplish this are by adjusting the necessary specifications involving:-

- Low drag coefficient
- Aerodynamic properties of boat's body
- Stable, lightweight and durable

1.2 Objective

The objective of this project is to achieve these main points:-

- To design and obtain the best electronic circuit that goes well with the solar panels
- To design and fabricate the best design of a mini race boat.
- Able to integrate the use of solar energy (photovoltaic technology) with the mini boat.

1.3 Scope

The main target for this project to accomplish is to consider the following criterions:-

- To design a low cost, high efficiency mini boat that is suitable and applicable for installing a solar circuit
- Testing of various prototypes (boats and solar panels) through experimental procedures (measurement and simulations)

Thus, it is essential that in order to complete this project, the solar panel, its components, and the mini boat is necessary. Designing of mini solar race boat is done without using any battery or other source of power, except from solar itself, either direct power from sunlight or through an AC/DC convertor.

By using the concept of a low-power solar cell, sufficient electricity must be able to be generated by the photovoltaic panels to move the mini boat through its components. The boat itself must be stable to move at high speed in the water.

1.4 Problem Statement

The solar cell energy which directly produced by the sun can be converted to electric energy by using solar cell. The power generated from these cells will be fully used to move a mini race boat, through the use of mechanical engineering technique. The performance will then and is evaluated in terms of speed. Also, bigger understanding is needed to develop a better product

Thus, the main problem statement for the project is:-

- The best design of the mini race boat that is able to move smoothly and fast on top of water is researched. Analysis and tests are done, to determine the best design
- The best and suitable solar electronic circuit to move motors and propellers, and in turn move the race boat is done. Options are aplenty, but searching for the best takes tests and calculations.
- The best and most suitable design of mini race boat that is able to be integrated with solar panels are much more difficult than simply designing a race boat or solar electronic circuit. Thus, compatible settings must be researched so it does not hinder the boat movements on water.

CHAPTER 2

LITERATURE REVIEW

2.1 Materials of Photovoltaic Panel

Most solar cells are constructed from semiconductor material, such as silicon (the fourteenth element in the Mendeleyev table of elements). Silicon is a semiconductor that has the combined properties of a conductor and an insulator.

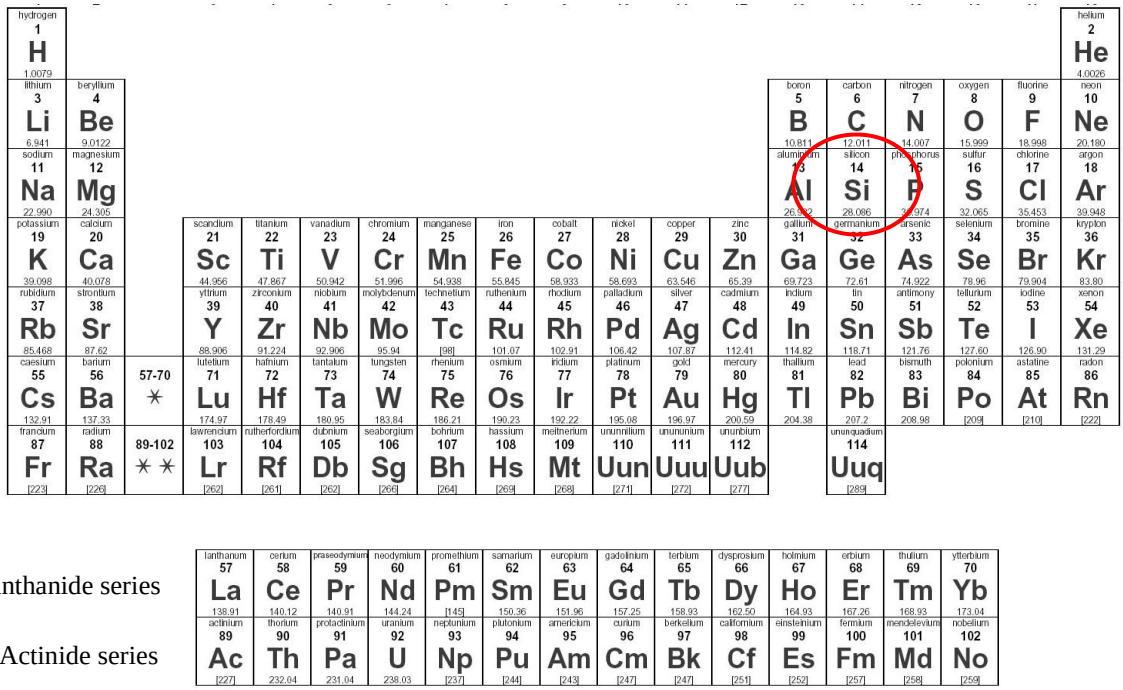

Figure 2.1: Periodic Table of Elements

(Source: The Physics of Solar Cells, Nelson J., 2003)

Metals (located generally from left and middle side of the Periodic Table of Elements) such as gold, copper, and iron are conductors; in which their properties have loosely bound electrons in the outer shell or orbit of their atomic configuration. These electrons can be detached from respective atomic configuration when subjected to an electric voltage or current. On the contrary, atoms of insulators (mostly from right side of Periodic Table), such as glass, carbon and other gasses, have a strong bond of electrons in the atomic configuration and does not allow the flow of electrons even under the high application of voltage or current. On the other hand, semiconductor materials such as silicon, that is the focus of this topic, bind electrons midway between that of metals and insulators. (Source: Solar Engineering of Thermal Processes, Duffie J.A., 2006)

In electronics, the semiconductor materials are constructed by combining the two adjacently doped wafer elements, which is constructed from silicon. Doping implies impregnation of silicon by positive and negative agents, such as phosphorus, P and boron, B. Phosphorus (15^{th} element) creates a free electron that produces N-type material, while boron (5^{th} element) have a shortage of an electron, which produces the P-type material. Impregnation or combination is accomplished by depositing the previously referenced doping material on the surface of silicon using a certain heating or chemical process. The N-type material has a propensity to lose electrons and gain holes, thus it acquires a positive charge while the P-type material has a propensity to lose holes and gain electrons, so it acquires a negative charge.

When N-type and P-type doped silicon wafers are fused together, they form a P-N junction. The negative charge on P-type material prevents electrons from crossing the junction, and the positive charge on the N-type material prevents holes from crossing the junction. A space created by the P and N, or PN, wafers creates a potential barrier across the junction. (Source: Solar Power in Building Design, Gevorkian P., 2009)