SOLAR POWERED ELECTRIC BOAT

NORAZLAN BIN ISHAK

MAY 2009

”I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Control, Instrumentation and Automation)”

Signature : ……

Supervisor’s Name : EN. KYAIRUL AZMI BIN BAHARIN

Date : 13 MAY 2009

SOLAR POWERED ELECTRIC BOAT

NORAZLAN BIN ISHAK

This Report Is Submitted In Partial Fulfillment Of Requirements For
The Degree of Bachelor In Electrical Engineering
(Control, Instrumentation and Automation)

Fakulti Kejuruteraan Elektrik
Universiti Teknikal Malaysia Melaka

May 2009

"I hereby declared that this report is a result of my own work except for the excerpts that have been cited clearly in the references."

Signature : ……..

Student : NORAZLAN BIN ISHAK

Date : 13 MAY 2009

To my beloved

Mother, Hjh Hasmah Binti Jahidin;

Brother, Nordin Bin Ishak

Brother, Norissham Bin Ishak

Sister, Norismaliza Binti Ishak

Sister, Norismawati Binti Ishak

Sister, Norismalaily Binti Ishak

Sister, Norismalina Binti Ishak

Sister, Norismalaila Binti Ishak

ACKNOWLEDGEMENT

Alhamdulillah, praise to be Allah S.W.T for the guidance and blessing bestowed upon me, for without it I would not have been able to come this far.

I would like to convey my thousands of appreciation upon *University Teknikal Malaysia Melaka* especially to my faculty for giving me the chance to do my Final Year Project II here. My deepest gratitude to Mr. Kyairul Azmi Bin Baharin, who was my Supervisor for all the advice an assist toward the progress of this project, understanding, well guidance and help though out this project. Without his valuable suggestion and encouragement, this project would not have been successful. My handful thanks to the staffs, of Universiti Teknikal Malaysia Melaka (UTeM), for helping me in many ways. Thank you so much for your help and cooperation during my Final Year Project II period.

A special thank to my beloved family especially my parent who encouraged me in final year here and gives me lots of inspiration. Thank you so much for your kind understanding and moral support given during this time being. Hopefully Allah S.W.T blesses both of you. Not to forget, a warm gratitude to all my friends especially Fahrulrazi, Khaldon and Amirul for their brilliant ideas and a lot of encouragement, throughout the duration of this project.

Lastly, my heartfelt appreciation goes to all, who have directly or indirectly helped me to make this project a success.

ABSTRACT

This project is about the design and development of a solar boat that is powered by an electric motor which gets its supply from photovoltaic (PV) panels and utilizes solar energy. The PV panels must be mounted and installed on the boat without compromising riding comfortability. This provides a cost-effective way for leisure or moving around relatively short distances. To design the solar powered electric boat, the system is using solar panel, rechargeable battery and electric motor. A solar collector is connected to the rechargeable battery for collecting solar energy and converting such energy to electrical power that is delivered to the rechargeable battery for recharging thereof. A rechargeable battery is connected to an electric motor for providing electrical power to drive the motor. Besides that, this solar boat is developed to minimize and economize the electricity uses for its electric motor and maximizes the usefulness of solar energy in our life without wasting it and then extends the system for commercial market. For the conclusion, the solar powered electric boat that obtains its supply from photovoltaic panels wills functional using solar energy.

ABSTRAK

Projek ini adalah bertujuan untuk menghasilkan dan merekabentuk sebuah bot yang menggunakan kuasa solar bagi menggerakkan motor elektriknya. Bekalan kuasa untuk menggerakkan motor elektrik diperolehi daripada *photovoltaic (PV) panel*. Pemasangan panel PV pada bot dilakukan ditempat yang sesuai supaya ia tidak mengganggu keselesaan penumpang bot. Untuk menghasilkan dan merekabentuk sebuah bot yang menggunakan kuasa solar, ia memerlukan peralatan-peralatan seperti panel solar, bateri yang boleh dicas dan motor elektrik. Panel solar memerangkap tenaga cahaya dari matahari dan menukarkan tenaga tersebut kepada tenaga elektrik seterusnya tenaga tersebut disimpan di dalam bateri. Bateri disambungkan pada motor elektrik untuk membekalkan tenaga elektrik apabila diperlukan bagi menggerakkan motor. Bot yang menggunakan kuasa solar ini dihasilkan bertujuan untuk meminimumkan dan menjimatkan penggunaan tenaga elektrik bagi menggerakkan motor elektriknya serta memaksimumkan penggunaan tenaga solar dalam kehidupan harian kita. Ia juga bertujuan untuk memanfaatkan tenaga solar dan memperkembangkan penggunaannya kepada pasaran yang lebih meluas. Sebagai kesimpulannya, bot yang menggunakan kuasa solar ini dapat direalisasikan dengan jayanya.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

NUM	TITLE	PAGE

CHAPTER I

INTRODUCTION

1.1 Solar Powered Electric Boat Definition

While most boats on the water today are powered by diesel engines, sail power and gasoline engines, it is perfectly feasible to power boats by electricity too. Electric boats were very popular from the 1880s until the 1920s, when the internal combustion engine took dominance. Since the energy crises of the 1970s, interest in this quiet and potentially renewable marine energy source has been increasing steadily again, especially as solar cells became available, for the first time making possible motorboats with an infinite range like sailboats. The first practical solar boat was probably constructed in 1975 in England.

Solar electric boat is powered by an electric motor which gets its supply from photovoltaic (PV) panels and utilizes solar energy. The photovoltaic panels mounted and installed on the boat without compromising riding comfortability. This provides a cost-effective way for leisure or moving around relatively short distances. To design the solar powered electric boat, the system is using solar panel, converter, rechargeable battery and electric motor. Solar electric boat can minimize and economical the electricity uses for its electric motor. It is also can maximizes the usefulness of solar energy in our life without wasting it and then extends the system for commercial market.

1.2 Problem Statement

This project is designed and developed because there are a lot of problem with the ordinary boat that use electric power which gets its supply from the generator. For example, the ordinary boat uses diesel fuel to run the generator of the boat, and then supply electric power to run the electric motor. The increasing impact of fuel price in the global market is one of the factors that motivate people now to try and find the use of new alternative energy to substitute the usefulness of fuel. The solar electric boat is one of the alternative energy that can possibly solve this problem. This solar electric motor that is powered by an electric motor which gets its supply from photovoltaic (PV) panels has economical fuel and electric uses added to its electric motor usefulness. So, to keep this solar boat more popular and broaden its scope for commercial uses, the quality of the solar boat must be increased.

As we know, the solar electric boat cannot be use at night because there is no sunlight to produce energy. However, this problem can be solved by using rechargeable batteries that can supply current to the electric motor of the solar boat at night. Besides that, the solar electric boat also has an electric motor to move it's easily and efficiently on water. So, the selection of electric motor must be exact and applicable to the solar electric boat. The aspects that must be stressed to choose an applicable electric motor are the types of motor either AC motor or DC motor and the horsepower of motor to move the solar electric boat. A lot of calculation must be done for the electric motor in order to determine the required horsepower to support the weight, size and burden and then move the solar boat easily and efficiently. Lastly, we must consider whether the use of either generator or solar energy is more cost-effective for the boat.

1.3 Project Objectives

The main objective for this project is to design and develop a solar boat that is powered by an electric motor which gets its supply from photovoltaic (PV) panels and partially uses solar energy. Besides that, the objective is to develop a solar powered electric boat that can minimize and economical the electricity uses for its electric motor and maximizes the usefulness of solar energy in our life economically and efficiently, and then extends the system for commercial market. Another objective is to study the relationship between electric propulsion and solar energy and wiring connection between solar panel, converter, rechargeable battery and electric motor in developing a solar boat. The last objective is to study the characteristics of solar energy to produce alternative renewable energy and make analysis about the appropriate method to use the solar energy as an alternative source of energy.

1.4 Scope of Project

The scope of this project is to design and develop a solar boat that is powered by an electric motor which gets its supply from photovoltaic (PV) panels and partially uses solar energy. This project will focuses on how to design and develop circuit for solar electric boat and how to choose the suitable motor for this project, which can improve the speed of boat for more efficient to support the boat weight, size and burden and then move the solar boat easily on water. The focuses of this project also is to design and develop the hardware of boat for more safe and applicable to used on water. This solar boat is proposed for recreation activities used. It is also applicable for one or two person.

Because of the **high-cost** to develop an actual size of ordinary boat, the size of the boat will be **scale-down to (1: 16)**. I will use the remote control boat as my main equipment. The prototype dimensions of the boat is about length (0.81 meter) x width (0.27 meter) x height (0.19 meter). The unladen weight about 1 kg (2.2 lbs) and the load

that can be support is about 1.5 kg (3.3 lbs). Below are the full characteristics and specifications of the solar powered electric boat project:

Theory Specification

Actual size specification of solar electric boat:

Boat dimensions	: 3.66 meter – 4.88 meter (12ft- 16ft)
Unladen weight	: 27kg – 59kg (60 lbs – 130 lbs)
Load	: 114kg – 273kg (250 lbs - 600 lbs)
Battery weight	: 27kg – 55kg (60 lbs– 120 lbs)
Motor type	: Trolling motor (outboard/submersible)
Motor horsepower	: 373 W - 746 W
Speed	: 0.45 m/s – 1.34 m/s
Range	: 3 – 4 hours, depending on speed and current/wind

1. Essentially this type of craft is the one and two man powered boat.
2. Small enough to be carried to the water's edge, but large and strong enough to support a trolling motor, one 12 volt battery and the picnic hamper.

Calculation Specification

Scale-down size ⟶ (Actual size : Project size) = (1: 16)

Scale-down size specification of solar electric boat prototype (1: 16):

Boat dimensions	: 0.61 meter – 0.81 meter
Unladen weight	: 1.7kg – 3.7kg
Load	: 7.1kg – 17kg
Battery weight	: 1.7kg – 3.4kg
Motor horsepower	: 23.3 W – 46.6 W
Speed	: 0.45 m/s – 1.34 m/s
Range	: (11 minutes – 15 minutes), depending on speed and current/wind

Prototype specification of solar electric boat

Boat dimensions	: Length (0.81 meter) x Width (0.27 meter) x Height (0.19 meter)
Unladen weight	: 2.2 kg (With solar panel and solar panel base)
Load	: 0.3 kg
Battery weight	: 0.2 kg
Motor type	: DC Motor (High speed 540 racing motor with cooling system)
Motor horsepower	: 36 W
Speed	: 0.56 m/s – 1.11 m/s
Range	: (10 -12) minutes, depending on speed and current/wind

1.5 Expected Results

By the end of this project, the expected results that can be obtained are the solar powered electric boat that is supply from photovoltaic panel will be function by using solar energy. The wiring connection between solar panel, converter, rechargeable battery and electric motor are functioning as we need. Then, the electric motor will support the weight, size and burden of the solar electric boat. Besides that, the rechargeable battery will supply current at night to the solar boat when there is no sunlight. The photovoltaic panel is mounted and installed on the boat without compromising riding comfortability. Lastly, the solar boat has a cost-effective way for leisure or moving around relatively short distances.

1.6 Thesis Outline

This thesis is divided into 7 chapters. The first chapter is the introduction of the project, followed by Chapter 2 for literature review. Chapter 3 will covers about the methodology of project. Chapter 4 will describe about the project design, while Chapter 5 shows the analysis and discussion of project. Chapter 6 will cover the conclusion and

suggestion, while Chapter 7 will shows the references of project. Lastly is Chapter 8 that will cover the appendices.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

This chapter will be stressed on the literature review of related system. The main purpose of this chapter is to analyze, identify and make conclusion based on the research. A literature review means a collecting related data, analyzed business process, identify underlying patterns and create the conclusion. Another description of the literature review is a systematic, explicit and reproducible method to identifying, evaluating and synthesizing the existing body of completed and recorded work produced by researcher, scholars and practitioners.

In order to develop a successful project, the current systems are identified. The system of conventional electric boat, solar system and its connection have been analyzed. Studies of these systems are significant to develop a valid, reliable and efficient upgrade project. The Literature Review part acts as a mean to discover which methodology should be chosen in developing this system.

2.2 On-Board Sensors

In the figure 2.1, all sensor connections to the on-board IMS are shown in simplified view. The lower part represents the energy chain, starting from the left with

the photovoltaic cells (PV-Generator) as energy source. A DC-DC-Converter adjusts the voltage of the cells, about 450 V, to the voltage of the battery pack, consisting of ten conventional car batteries. The batteries function as energy storage medium. A special photovoltaic cell gives reference values for irradiation and cell temperature. Energy user is the asynchronous 3-phase motor with attached propeller. A DC-AC-Converter provides the necessary adaptation of the battery voltage to the motor electronics [1]. Figure 2.1 shows a block diagram of energy chain and additional input to the IMS.

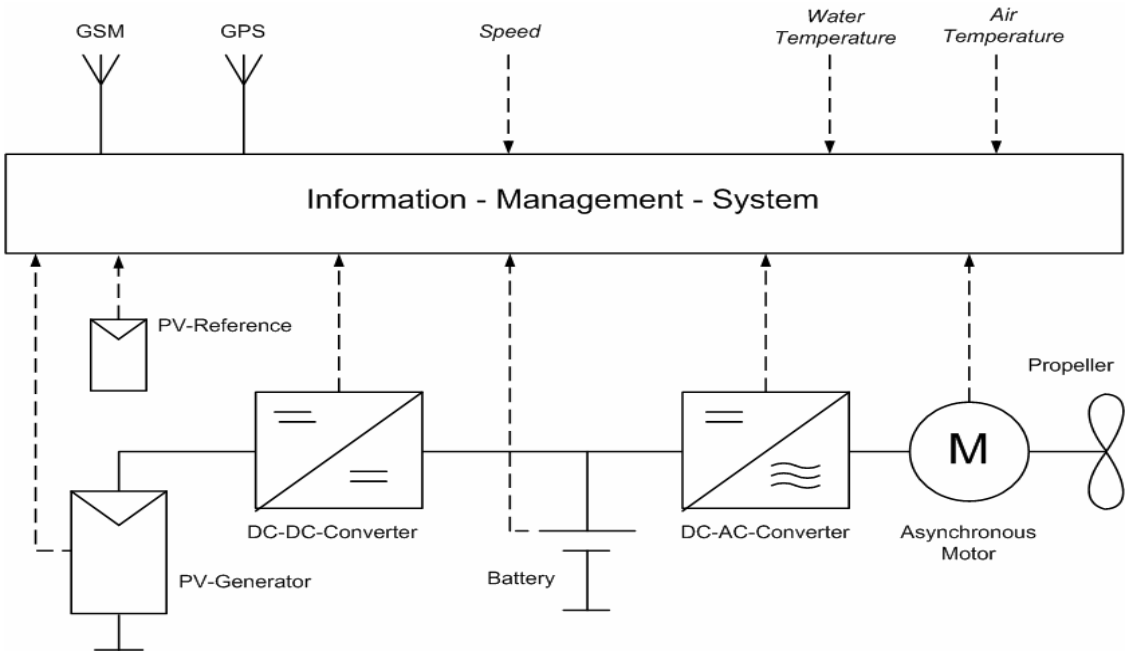

Figure 2.1: Block diagram of energy chain and additional Inputs to the IMS [1]

The upper part of Figure shows from the left the GSM antenna which provides connection to the server at the institute via internet. To prevent misuse by cell phones, only data transmission is allowed. GPS provides time and date as well as the location of the boat, from which speed above ground, course and distance to destination is extracted. Since the speed above ground is not very meaningful for moving water like e.g. a river or in a condition of wind drift, speed above water is given by a sum log, a speedometer typical in marine application. Water- and air-temperature sensors complete the upper part [1].

2.3 IMS Mobile Station

Figure 2.2 shows the block diagram of the on-board IMS. It consists of Sensor Interface Modules (SIFs), which function to convert the sensor information into CAN protocol. Then, it consists of black box, which functions to store the actual data till it is sent to the main store. Besides that, it consists of auto pilot, which function to provide the connection to the internet respectively to the main server at the institute. Next, it also consist an on-board computer which processes the data and provides visual information via display. Lastly, it consist a CAN-Bus as communication medium within the IMS, with a protocol adapted to the specific needs [1]. Figure 2.2 shows a block diagram of on-board IMS.

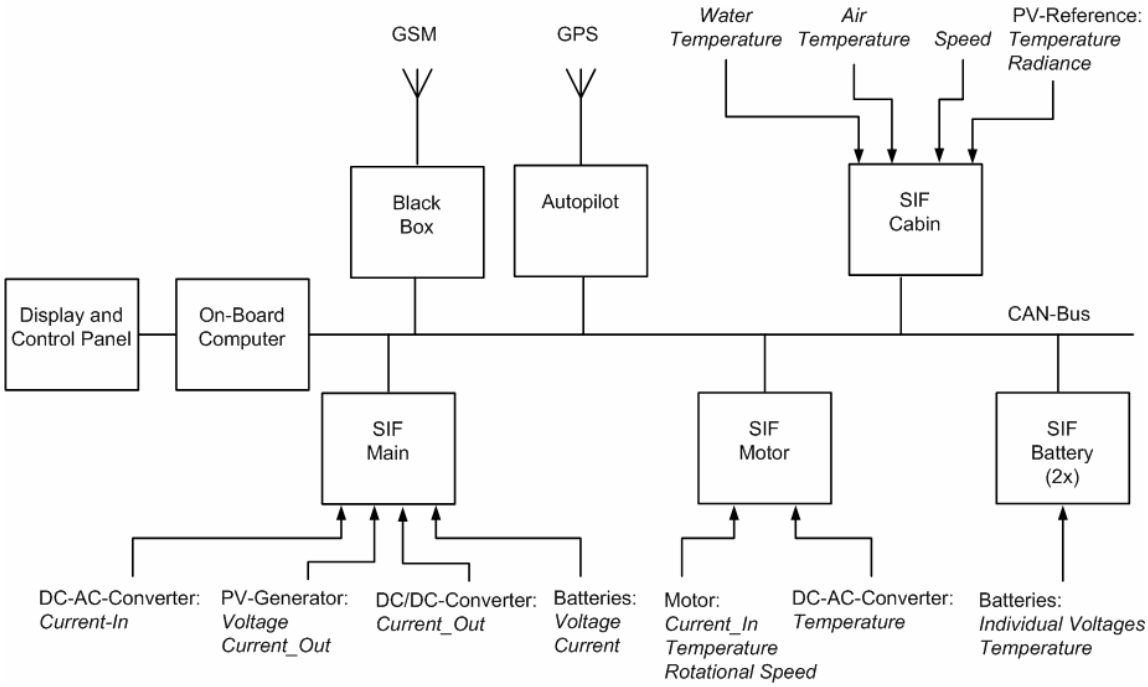

Figure 2.2: Block diagram of on-board IMS [1]

All SIFs consist of three functions. The first function is to adjust the voltage of the sensors to the input range of the analog-to-digital converter (ADC) of the microcontroller. Then, the second function is to convert the analog sensor signal into digital form. Lastly, the function is to send the data to the CAN-Bus with the appropriate protocol. The SIFs differ only in function one. It would theoretically be possible to use