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SELF-SUSTAINING SOLAR POWERED ROBOT

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"I here by declare that this thesis is the result of my own effort expect as clearly stated its references"

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Dedicated to my family, lectures and to all my friends

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ABSTRACT

This project was proposed to solve the problems of limited power source of mobile robots. Their work range is limited and requires constant monitoring and assistance from humans for these robots to operate for prolonged period. Some robots are always plugged into an outlet making the robot's work range limited to the length of the cored. Others use battery packs which need to be replaced or charged periodically. Application like Mobile Rovers are the best examples since Malaysia has recently taken a liking in space exploration. An application much closer to home is the tsunami detector on the open ocean where human cannot be around all the time. This project uses PIC Microcontroller as the brain, sensors as the eyes and ears and motors as the manipulators.

ABSTRAK

Projek ini dicadangkan untuk menyelesaikan kekangan sumber tenaga terhad yang ditimbulkan oleh robot bergerak. Lingkungan kerja robot berkenaan adalah terhad dan memerlukan pengawasan berterusan daripada manusia untuk robot beropearsi untuk jangka masa yang panjang. Sesetengah robot terbatas oleh panjang kabel yang selalu berada pada palam tenaga. Manakala ada pulak yang menggunakan bateri yang pelu dia tukar secara berkala. Aplikasi robot adalah seperti *Mobile Rover* adalah contoh terbaik memandangkan Malaysia telah menunjukan minat dalam penjelajahan angkasa lepas sejak kebelakangan ini. Selain itu, pengesan tsunami laut dalam juga boleh dijadikan aplikasi kerana manusia tidak mampu selalu berada di persekitaran yang sedemikian. Projek ini mengunakan PIC Pengawal Mikro sebagai otak, sensor sebagai mata dan telinga dan motor sebagai kaki dan tangan.

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CHAPTER I

PROJECT INTRODUCTION

1.1 INTRODUCTION

It is very hard to precisely define the term robot as it has various definitions from various points of view. Many are concern of the physical of a robot while others are concern of the programmable of the robot.

The British Robot Association (BRA) defines robots as:

> "A programmable device with minimum of four degrees of freedom designed to both manipulate and transport parts, tools or specialized manufacturing implements through variable programmed motion for the performance of the specific manufacturing task" [1].

The Robotic Institute of America defines robots as:

> "Programmable multifunction manipulator designed to move material, parts, tools or specialized device through variable programmed motion for performance of a variety of task"[2].

Based on the definition, it occurs to that a robot must be an automated machine that is able to adapt to the changing information of the real world.

1.1.1 Self-Sustaining Robots

Robots with an apparently infinite energy source, while still maintaining mobility, they could separate themselves from outside assistance to become self-sustaining entities. A self-sustaining robot would be useful in many situations. It could be used in extreme environments that would not allow for easy maintenance to be performed. For example, a battery powered robot that enters into an environment not fit for humans can only use half its energy inside before it must return to the "safe" environment. Then, human interaction must be done to replenish its power supply. This severely limits the usefulness of the robot. A self-sustaining robot would be able to use all of its power supply and also be able to replenish it unassisted. This will allow the robot to completely separate itself from necessary assistance giving it the opportunity to perform its task in places not possible with the other types of robots.

1.1.2 Solar robots

1.1.2.1 Hyperion

Hyperion is two meters long and two meters wide with a panel of silicon solar cells of 3.5 square meters. It can be configured for polar or equatorial operation. In Polar Regions it carries its solar array near vertically to catch the low-angle sunlight; when operating closer to the equator its panel lays flat on a level deck to capture the sunlight overhead. Hyperion is fabricated of lightweight aluminum tubing and has four wheels on two axles. On the front axle an A-frame stands 1.5 meters high to support the stereo cameras and laser scanner at a proper height to see the surrounding terrain. All of Hyperion's computers, electronics and batteries are enclosed in a single body mounted between the axles.

1.1.2.2 Sojourner

Sojourner is a small, six-wheel robotic vehicle built here at the Jet Propulsion Laboratory. She weighs in at a sleek 11.5kg (25lbs) and is about the size of a milk crate. Sojourner will land on Mars aboard the Pathfinder Spacecraft, but will quickly strike out on her own to traverse the Martian terrain, perform science and technology experiments, and transmit images and data back to the Lander spacecraft. The Lander will then relay the information back to the scientists and engineers waiting on Earth. Although Sojourner needs only about four days to complete her primary mission, she is designed to survive the cold Martian nights (which dip down to a chilly -120C) for many months

1.2 PROBLEM STATEMENT

Robots are more and more becoming the solution to accomplishing difficult or mundane tasks. Though they prove to be useful and versatile for many situations, robots tend to be restricted by their energy source. Some robots, such as those common in factories require being plugged into an outlet at all times. More mobile alternative uses batteries but have a drawback since batteries must be removed for charging or replacement. A last group of robots are solar powered. These are not limited to outlets or maintenance issue of batteries but rather are confined by the fact that they must be in direct sun light at all times. These typical robots are bound by their energy source. Thus limiting their work range and require constant monitoring and assistance from humans for these robots to operate for prolonged period. For example, some robots are always plugged into an outlet making the robot's work range limited to the length of the cord. Others use battery packs which need to be replaced or charged periodically.

1.3 OBJECTIVE

The objective of this project is to study, design and develop a self sustaining mobile robot prototype that is able to operate unassisted for a long period of time. The robot is expected to accomplish this by monitoring its battery level during normal operations, seeks strong sunlight by means of using sensors, uses the sun as the power source for battery charging and stops at the light source and enter charging mode. The robot prototype should be light weigh to enable free motion and be able to move about by means of using motors.

1.4 OPERATING ENVIRONMENT

Work that constrains this robot operation will be,

- Self-sustaining – The robot should be able to operate without any assistance from the outside world.

- Light-seeking – The robot should be able to locate the strongest light source in the area and navigate toward it.

- Solar-Rechargeable – Once in a strong light source, the robot should enter a charging mode where it consumes very little power and stores the energy into rechargeable batteries.

- Light weight – The robot will have to be light enough that the motors can move it.

1.5 PROJECT ASSUMPTION

This projects main objective is light seeking where mobility is taken into account. This is achieved by building a light weighted robot. The secondary objectives include solar charging and battery monitoring capability however there are limitations to the kind of light wave lengths required. For instance, solar charging will require the robot be in direct sun light. Since there is no obstacle avoidance mechanism on this robot, the operation environment must be a flat and obstacle free area.

1.6 REPORT STRUCTURE

Chapter 1 will discuss the term robots and its diversity. The burning question, what are robots? This chapter will briefly review existing solar rovers. This chapter will also discuss the objectives of this project, the methods and steps used to complete this project and the assumptions of this project.

Chapter 2 will discuss the many types of devices and components that can be used to construct a robot. The literature review is very important in determining the best components. This chapter will explain about the devices and components that have been proposed to be used in this project. The main component is the solar cells that are fixed together to form a solar array. The motor type that is been used is DC motor.

Chapter 3 will discuss the methodology that were been used to complete this project. The steps that were taken during literature review, decisions on the robots physical structure. The circuit layout is also discussed.

Chapter 4 will discuss the hardware development. From the final selections of controllers and sensors, to make up of the robot to the circuit designs will be discussed. Software development is been discussed. The program flowchart depicts the flow of the supposed PIC coding. Then, the software that are involved in developing the program are discussed.

Chapter 5 will discuss about the analysis and findings from the project. The analysis of Cds sensor on voltage divider circuit is mainly discussed. Charge time by the solar charger is compared to conventional chargers.

Chapter 6 will discuss about the application of this project, the conclusions that can be drawn from this project and the recommendations for future improvement of this project will also be disclosed.

CHAPTER II

LITERATURE REVIEW

2.1 MICROCONTROLLER

Microcontrollers are central components found inside a surprising number of products these days. If a microwave oven has an LED or LCD display screen and a keypad, it definitely will contain a microcontroller. All modern automobiles contain at least one microcontroller, and some may have as many as six or seven of them. The engine is controlled by a microcontroller, as are the Advance Breaking System (ABS), the cruise control and etc. Any device that has a remote control almost certainly contains a microcontroller.

A microcontroller is a single-chip computer. All computers have several things in common:

- A central processing unit must exist
- The CPU loads the program from somewhere.
- The computer has some RAM where it can store variables.

- And the computer has some input and output devices to communicate with outside world

Microcontrollers are embedded inside some other device (often a consumer product) so that they can control the features or actions of the product. Therefore, it is named as an embedded controller. Microcontrollers are dedicated to one task and run one specific program. The program is stored in ROM and generally does not change. Microcontrollers are often low-power devices. A personal computer is almost always plugged into a wall socket and might consume 50 watts of electricity. A battery-operated microcontroller might consume 50 milli watts.

A microcontroller has a dedicated input device and often (but not always) has a small LED or LCD display for output. A microcontroller also takes input from the device it is controlling and controls the device by sending signals to different components in the device.

A microcontroller is often small and low cost. The components are chosen to minimize size and to be as inexpensive as possible. A microcontroller is often, but not always, rugged in some way.

2.1.1 Identifying suitable Microcontroller

After discussing the use of microcontrollers in the previous chapter, the selection of PIC microcontroller will be explained.