OMNI-DIRECTIONAL HEXAPOD VEHICAL
FOR UNEVEN ENVIRONMENT

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This report is submitted in partial fulfillment of the requirements for the award of Bachelor of Electronic Engineering (Computer Engineering) with honours

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Universiti Teknikal Malaysia Melaka

May 2011

UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek	:	**OMNI-DIRECTIONAL HEXAPOD VEHICAL FOR UNEVEN ENVIRONMENT**
Sesi Pengajian	:	**2010/2011**

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Dedicated to:

Mr Sani Irwan, my beloved family especially my parents and friends for giving me unconditional love and care.

ACKNOWLEDGEMENT

First of all, I would like to take this opportunity to express my most sincere gratitude to my project supervisor, Mr. Zul Atfyi Fauzan Bin Mohammed Napiah for accepting me as his project student and providing me excellent guidance, concern and informative support and editorial advice in preparation of this project. In fact, he gave me guidance when obstacles arise throughout this period of time. Once again, thanks to him for his tolerance and endeavors. Also not forgetting, my grateful thanks to Mr. Sani Irwan, my beloved family members for providing me love, support and patience and at last my friends who give me support and opinion to make my studies possible. Finally to all the people who involve directly or indirectly in my way along to accomplish this task.

ABSTRACT

The technology for building legged robot can be useful for human in investigation and exploration expedition to reduce any risk factor. Hence this project is concerned about the design and construction of a six legged walking robot that can move omnidirectionally. The use of legged hexapod robot has been gaining popularity among the robot inventor. Omni-directional means that it can move sideways, forwards, backwards, diagonally and rotation in uneven environment. The project involves of designing and fabrication of the robot's hardware and control circuitry. The design consists of a three Degrees of Freedom for each leg. These robots have 3 pairs of leg consist of 18 servos. The robot is controlled by a PIC16F877A microcontroller which acts as the brain of the robot.

ABSTRAK

Teknologi pembuatan robot berkaki enam ini boleh digunakan untuk mempermudahkan dan membantu manusia dalam bidang penyelidikan dan penerokaan. Ini kerana ia dapat mengurangkan risiko bahaya yang akan ditempuh semasa aktivi tersebut dijalankan. Penggunaan robot berkaki terutamanya berkaki enam yang berupa serangga semakin popular di kalangan pencipta robot. Memandangkan kelebihan robot berkaki yang begitu ketara berbanding robot beroda, adalah wajar usaha untuk membinanya. Projek ini berkaitan dengan rekaan dan pembinaan robot berkaki enam dan berkemampuan bergerak di kawasan tidak rata**.** Robot ini berkebolehan untuk berjalan ke semua arah termasuk hadapan, belakang, kanan, kiri, dan mengiring di atas permukaan tidak rata menggunakan keenam-enam kakinya. Projek ini merangkumi rekaan dan pembinaan robot dan juga litar-litar yang berkaitan. Rekaan robot ini merupakan robot berkaki enam yang mempunyai 3 Sudut darjah pada setiap kaki. Robot ini mempunyai 3 pasang kaki dan mempunyai 18 buah motor servo. Robot ini dikawal oleh mikro pengawal PIC16F877A yang mengawal corak robot berjalan dan juga bertindak sebagai otak.

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LIST OF ABBREVIATIONS

DOF	**-**	Degree Of Freedom
HEX	**-**	Hexadecimal
Hz	**-**	Hertz
PIC	**-**	Peripheral Interface Controller

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CHAPTER I

INTRODUCTION

1.1 Overview

This project is about designing a controller for an Omni-directional hexapod vehicle for uneven environment. This robot could act as a vehicle in moving through uneven terrain with stability and balance. Omni directional vehicle provide flexibility to move into isolated places with ease. PIC microcontroller is used as a brain to control the servos that manipulate the 6-legs of the vehicles. Servos are used because of the accuracy in determining the angle of the legs to provide stability in uneven environment.

Each leg is actuated by 3 servos which makes 18 servos in total. Omni-directional means that it can move sideways, forwards, diagonally and rotate. An array of sensors that is located below its body is used to follow a track but these sensors will be replaced by a computer vision system.

1.2 Objectives

Following are the objectives set in this project:

(a) To design, develop controller and also utilizing PIC microcontroller to control the movement of the Omni hexapod.

(b) Synchronize servo"s movement to perform walking capabilities in uneven environment.

1.3 Problem Statement

Most of the Omni hexapod that exists today only manages to move in the flat surface. The legged robot suits for work in such environment because it can select any landing point. This project will concentrate on movement on uneven environment and also provide stability and balance.

1.4 Scope

In this project, PIC microcontroller is used to control 18 servos. The vehicle can move Omni-directionally in uneven environment. BASIC programming is used for the programming language.

1.5 Thesis Layout

Chapter 1 discuss on term of robot, objectives, scopes, and problem statement. This robot is about designing a controller for an Omni-directional hexapod vehicle for uneven terrain. PIC microcontroller is used as a brain to control the servos that manipulate the 6-leg of the vehicle. The important part which can give the accuracy in determining the angle of the leg to provide stability in uneven terrain called servo. Omni-directional means that it can move sideways, forwards, diagonally and rotate.

Chapter 2 consists about the hexapod walking robot, natural terrain, degrees of freedom and the explanation of servo, such as the operation and the component inside a servo. This chapter also gives the detail explanation of the basic microcontroller.

Chapter 3 is about the project methodology that divides in two parts, which are hardware development and software development. Besides that, this chapter will discuss about block diagram of the vehicle, PIC16F877A and the flows chart that shown the whole process. In software development the program that are used which are CodeDsigner Lite Compiler, Proteus and PICkit 2.

Chapter 4 will show all the analysis result and discussion from the hardware and software experiment.

Chapter 5 will be the conclusion and suggestion of the whole project and the problems during work progress that can be implemented in the future.

CHAPTER II

LITERATURE REVIEW

This chapter will discuss about the hexapod walking robot, natural terrain and degrees of freedom. Besides that, this chapter wills explain about servo, such as the operation, the component inside a servo, the concept degree of freedom and how to choose the suitable microcontroller.

2.1 Hexapod Walking Robot

A hexapod robot is a mechanical vehicle whose locomotion is based on three pair of legs. The term commonly refers to robots biologically inspired by Hexapod locomotion. Hexapod robots are considered to be more stable than bipedal robots because in most cases hexapods are statically stable. Therefore, they do not have to depend on real-time controllers for standing or walking. Nonetheless, it has been demonstrated that at high walking speeds, insects do depend on dynamic factors.

2.2 Leg Coordination

Leg coordination refers to the mechanism responsible for controlling leg step transitions (stance and swing); assuring that the body will not tumble. Most approaches try to replicate known insect gaits, e.g. tripod or tetra pod gaits. However, other approaches have been used to find stable gaits; for instance, by running genetic algorithms or optimizing walking energy cost function.

Insect gaits are usually obtained by two approaches: the centralized and the decentralized control architectures. Centralized controllers directly specify transitions of all legs, whereas in decentralized architectures, six nodes (legs) are connected in a parallel network; gaits arise by the interaction between neighboring legs.

2.3 Single Leg Controller

There is no boundary to the complexity of leg morphology. However, legs of those based on insect models usually range from two to six degrees of freedom. Leg segments are typically named after their biologically counterpart; which is similar for most species. From the body to the leg"s tip, segments are known as coxa, femur and tibia; typically the coxa-femur and the femur tibia joint are assumed to be a simple hinge joint. The body-coxa joint model ranges from one to three degrees of freedom, depending on the species and the thoracic segment that leg resides.

2.4 Natural Terrain

Natural terrain is geologically constructed. It is not artificially shaped, cleared, or leveled, but is a varying contour of mountains, hills, valleys and ravines. Particles of sand, soil, gravel and rock form the aggregate. These constituent materials have differing cohesive properties and those properties change as water content turns the ground from dust to mud.

In some places material is piled at its angle of repose, and in other places it is in smoother rolling hills, but rarely is natural terrain flat. Natural terrain is often densely populated with semi-discrete obstacles: geologic features and individual rocks, and vegetation such as trees, bushes, grasses and moss. By natural terrain which means the areas that have not been structured or constructed artificially: the forests, fields, mountains, shores and seabed. The surface of Mars, as seen in Figure 2.1, is an example of rough natural terrain.

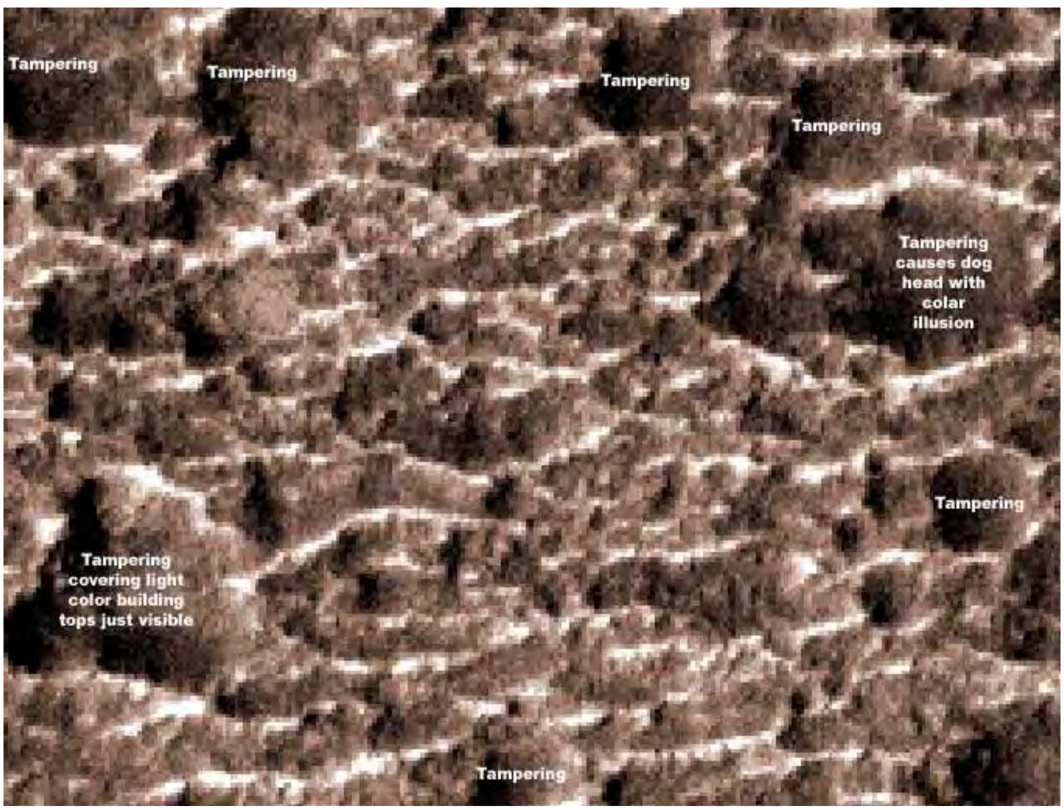

Figure 2.1: An example of rough Natural Terrain.

2.5 Different between Walking and Rolling

There are many ways in which walking and rolling differ. The conclusion made most apparent by these differences is that it makes sense to walk on rough terrain, but roll on hard, flat surfaces. By some estimates, more than half of the Earth is inaccessible to wheel mechanisms (including tracked mechanisms, which behave like wheels of large diameter).

2.6 Degrees of Freedom

Degree of freedom is a general term used in explaining dependence on parameters and implying the possibility of counting the number of those parameters. In mechanics, degrees of freedom (DOF) are the set of independent displacements that specify completely the displaced or deformed position of the body or system. This is a fundamental concept relating to systems of moving bodies in mechanical engineering, aeronautical engineering, robotics, structural engineering, etc.

In chemical engineering, degrees of freedom are used to determine if a material balance is possible for a given process. It takes into account the number of reactions, temperature, pressure, heat transfer, percent yield, mols entering/exiting and various other pieces of additional information.

A particle that moves in three dimensional spaces has three translational displacement components as DOFs, while a rigid body would have at most six DOFs including three rotations. Translation is the ability to move without rotating, while rotation is angular motion about some axis [1].

2.7 Servo Motor

Servo is a small device that incorporates with three wires DC motor, a gear train, a potentiometer, an integrated circuit and an output shaft bearing of the three wires that stick out from the motor casing, one is for power, one is for ground and one is a control input line. The shaft of the servo can be positioned to specific angular positions by sending a coded signal as long as the coded signal exists on the input line, the servo will maintain the angular position of the shaft. If the coded signal changes, then the angular position of the shaft changes.

A very common use of servos is in Radio Controlled models like cars, airplanes, robots and puppets. They are also used in powerful heavy-duty sail boats. Servos are rated for Speed and Torque. Normally there are two servos of the same kind, one geared towards speed (sacrificing torque) and the other towards torque (sacrificing speed). A good example of this are the HS-625MG servo and the HS-645MG servo [2].

Servos come in different sizes but use similar control schemes and are extremely useful in robotics. The motors are small and extremely powerful for their size. It also draws power proportional to the mechanical load. A lightly loaded servo does not consume much energy. Figure 2.2 below shows a servo motor.

Figure 2.2: Servo Motor.