Omni-directional Hexapod Walking Robot

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

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Dedicated to my beloved family especially my parents

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ABSTRAK

Robot yang berjalan memerlukan mobiliti yang tinggi dalam aplikasinya. Biasanya ia digunakan untuk beroperasi dalam persekitaran yang permukaan yang tidak rata seperti di permukaan bulan. Robot yang berkaki adalah diutamakan kerana ia berupaya untuk berjalan ke sebarangan arah. Dari segi tugas pelayaran, perbezaan utama wujud di antara robot yang beroda dengan berkaki adalah robot yang berkaki dapat menjalankan tugasnya dengan lebih baik dari segi mobiliti. Oleh itu, robot yang berkaki harus direka berdasarkan konsep "Omni-directional" dengan aspek mobility. Berdasarkan struktur yang rumit direkabentuk, beberapa teknik tertentu dicadangkan untuk kawalan pelayaran. Dalam projek ini, prototaip robot yang berkaki enam dikaji dan dilakasanakan dengan cara berjalannya. Microcontroller digunakan sebagai "otak" robot yang berfungsi untuk mengawal setiap pergerakan robot. Manakala, ultrasonic sensor ditambahkan untuk mengesan halangan semasa robot itu manjalakan tugasnya.

ABSTRACT

The walking robot requires high manipulability and mobility in most of its applications, which normally operate in complex environments such as outdoor rough terrain or uneven floors such as steps. It is essential for a legged robot to walk in omni direction. From the expected navigation task, differences existing between wheeled and legged robots are legged robots can be performed better in terms of mobility. Thus, the legged robot should be designed taking this omni-directional mobility aspect into account. Based on the complicated structure designed, some specific techniques are proposed for navigation control, sensing and map usage, path planning, body movement, and gait generation. In this project, the gait pattern of omni-directional hexapod walking robot will be studied and developed. The structure of the robot consists of six limbs with 3 DOF each. The microcontroller will be used to implement the walking gait to control the movement of the robot. To enhance the mobility of the robot, sensor will be added to detect the obstacle and has ability to avoid it.

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CHAPTER I

INTRODUCTION

1.1 INTRODUCTION

This chapter will discuss on the term robots, and the application of robot. The objectives of project and the briefing about a walking robot of this project also will be discussed.

1.1.1 What is robot?

In 1920, Czechoslovakian playwright Karel Capek had introduces the word robot in the play R.U.R. (*Rossum's Universal Robots),* which the word comes from Czech *robota*, which means tedious labor.

For decades, man has been fascinated with the idea of creating a machine in his own image. And while the dream existed, such a machine did not. Today, robots are no longer a science-fiction fantasy; they have become an accepted part of our daily lives, as steel collar workers, farmers, and even medical assistants. Robots are putting together automobiles, assembling delicate electronic parts, handling nuclear material, exploring the surface of other planets, and assisting surgeons in complex surgery.

They are replacing humans in mundane, precise or dangerous jobs with accuracy and an expediency level that even human beings cannot duplicate. It also may be used to perform tasks that are too dangerous or difficult for humans to implement directly (e.g. nuclear waste clean up) or may be used to automate repetitive tasks that can be performed more cheaply by a robot than by the employment of a human like automobile production.

1.1.2 The Application of Robot

Robot is an electro-mechanical device that can perform autonomous or preprogrammed tasks. A robot may act under the direct control of a human or autonomously under the control of a programmed computer. Specifically, robot can be used to describe an intelligent mechanical device in the form of a human. Table1.1 shows several applications that today's robot can perform.

Table 1.1: Table of the robot's application

Field	Jobs
Industry	1. When doing a job, robots can do many things faster than humans. 2. Robots do not need to be paid, eat, drink, or go to the bathroom like people. 3. Can do repetitive work that is absolutely boring to people and they will not stop, slow down, or fall to sleep like a human.
Security systems	1. Individual stationary sensors have limited ranges and applications. 2. Watchdogs or humans can lose their level of alertness during a shift or can easily be injured by an intruder. 3. Autonomous robot systems are tools that combine the precision of sensors with the mobility and intelligence of humans. 4. Robotic site security sentries are able to work long hours at a consistently high level of precision and vigilance.

Medicine	1. A human would not be able to make a whole exactly one 100th of a inch wide and long when operating. 2. When making medicines, robots can do the job much faster and more accurately and delicate than a human. 3. Some doctors and engineers are developing prosthetic (bionic) limbs by using robotic mechanisms.
Exploration	1. For people are interested in places that are sometimes full of danger, like outer space, or the deep ocean. 2. But when reach a limit that they cannot go there themselves, they make robots that can go there. 3. The robots are able to carry cameras and other instruments so that they can collect information and send it back to their human operators. 4. The continuing development of autonomous robot technologies furthers our ability to explore the universe.

1.1.3 Walking Robot

Basically, robots can be classified in to two categories that are fixed robot and mobile robot. Fixed robot is a robot mounted on fixed surface and the working materials are brought to the work space. For mobile robot, it moves from one space to another unstructured environments to a desired target [1]. Mobile robots may further categorize into wheeled, tracked or legged robot. Most of the mobile robots is applied in difficult task and dangerous environment such as bomb defusing. Beside, it also used in manufacturing area and agriculture related activity uch as in placing the seeds in the soil and fruit harvesting.

A walking robot also classified as mobile robot. It had high manipulability and mobility in most of its applications, which normally operate in complex environments such as outdoor rough terrain or uneven floors such as steps. The control of a legged robot walking on difficult terrain demands the development of efficient and reliable algorithms to coordinate the movement of multiple legs according to a diversity of requirements.

1.2 OBJECTIVE

To develop the gait pattern of omni-directional hexapod walking robot that able walks in omni direction and avoid any obstacle.

1.3 SCOPES OF WORK

While doing the project, the scope of work plays a very important of role. So, it must be create properly. There must be a guideline, in which the student should attain to fulfill the requirement of the project. The scope of this project is listed as below:

1. To study the basic idea and the operation of omni-directional hexapod walking robot.
2. To identify the suitable type of PIC microcontroller for the project and design the microcontroller board.
3. To study the operation of ultrasonic sensor and its implementation of into obstacle detection module.
4. To develop the algorithm for walking gait pattern of the robot.

1.4 PROBLEM STATEMENTS

Nowadays, various kinds of robots have been developed. They are required to do work in human's stead, especially in dangerous environment for human, such as rescues, space or inner nuclear plant. The legged robot suits for work in such environment because it can select any landing point. But, for wheeled robot, it faces difficulties to control while perform in complex environments rough terrain or uneven actual environment and unable to recover from a situation in which it entered a non-navigable area (e.g., sand, mud, grass, rocky areas, and soft carpets).

Beside, it is hard for wheeled robot to go in omni directional. So, legged robot navigation can replace many implicit assumptions usually made for wheeled robots.[1]

1.5 REPORT STRUCTURE

This thesis is a document that delivers the idea generated, concepts applied, activities done and the final year project produced. It consists of five chapters. Following is an each chapter description in this thesis.

Chapter 1 is delivering term of robots, the application of robot. The objectives of project and a brief review of walking robot of will be discussed. It also contains objective, scopes of works, and problem statement of the project.

Chapter 2 is a literature review on theoretical concepts applied in this project. The chapter consist explanation about what is Omni-directional hexapod walking robot, different with other type of robot. Beside more explanation about the concept degree of freedom, gait pattern of omni-directional hexapod walking robot, how to choose the suitable microcontroller, sensor also will be discussed. And the different type of motor also discussed in this chapter. At the end, PIC 16F877A Microcontroller and Ultrasonic Sensor had decided to use. The choose reason of the hardware and the Gait pattern that had designed will be discuss in the following chapter.

Methodology is important parts of the whole project because it shows out ıow is the project's activity develop. So, it is divided in two parts, hardware levelopment and software development. In Chapter 3, it discuss on hardware levelopment, which involves the overview of microcontroller circuit. It also contains ;ome of the reason why the hardware had chosen and a list of typical tools and ıpproaches used in this project. For the software part, it discuss about the software levelopment of the project. Beside, the process in how to download source code into he PIC microcontroller through programmer board also discuss in this chapter.

In chapter 4, all the analysis result from the hardware and software xperiments is included in this chapter in the form of table, discussions, and mprovements done.

Chapter 5 is the last chapter that will be the summary of the whole project. The problems facing during work progress also will be discussed in this chapter. Beside it also concludes with some recommendations that can be implemented in future.

CHAPTER II

LITERATURE REVIEW

2.1 BACKGROUND STUDY

2.1.1 Hexapod walking robot

A walking robot had high manipulability and mobility in most of its applications, which can operate in complex environments such as outdoor rough terrain. In actual tasks, it is more essential for a legged working robot to walk in any direction smoothly while maintaining its stability. With an appropriate control of leg movements, a legged robot can climb steps, cross ditches, and walk on extremely rough terrain in which, due to ground irregularities, the use of wheels would not be feasible. As a counterpart, an important drawback of legged locomotion when compared with wheeled locomotion is the much higher complexity involved in its control, even in the case of completely flat ground.

The primary difference between legged and wheeled robots is the much greater capability to deal with uneven terrain.[3] Because of this, the natural niche for a legged robot is not the usual office like environments in which wheeled robots move, nor the smooth roads on which car-like vehicles run, but the irregular and unstructured terrain found in natural, not engineered environments. This change in