SIX – LEGS WALKING ROBOT

LIM SIEW LAY

This report is submitted in partial fulfillment of the requirements for the award of Bachelor of Electronic Engineering (Telecommunication Electronics) With Honours

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UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : Six-Legs Walking Robot

Sesi Pengajian : 2007/2008

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Signature : .....

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Date : 9th May 2008

Dedicated to my beloved parents.

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ABSTRACT

The six-legs walking robot can walk on 6 legs. This robot uses the infrared sensor to explore the environment and avoid from obstacles. It has the ability to turn and reverse, walk on rough ground and avoid obstacles. All the robot's functions are controlled by a Microchip PIC 16F84A microcontroller. The objective of this project is to solve the instability problem using tripod gait as control algorithm. Besides, infrared sensor is also used to overcome the obstacles problem. Insectronic in history face the problem of stability in walking movement. When a walking robot traverses ground that not smooth, several control problems may arise from it. The problems include navigation where the robot must choose a route that will get it to a specified location. The second problem is with path selection that the robot must choose the detail of route to minimize the problem of slope roughness and obstacles avoidance if a specified location is given. The third problem is with terrain adaptation and obstacle crossing. With the completion of this project, the robot equips by the three servos and a main controller board has the ability to walk forward and backward, walk on rough ground and reacts to its environment. The robot will also possess obstacles-avoidance capabilities to the front and on both sides of its head that necessary for survival by an infrared sensor board.

ABSTRAK

Robot berenam kaki boleh bejalan dengan enam kakinya. Robot ini menggunakan pengesan inframerah. Untuk menjelajah persekitaran dan mengelak daripada sebarang halangan. Robot ini mempunyai keupayaan membelok, berundur, berjalan atas tanah dan boleh mengelak halangan. Semua fungsi robot ini dikawal oleh microchip PIC 16F84A microcontroller. Sebelum ini, Insectronic menghadapi masalah masalah kestabilan dalam pergerakan. Beberapa masalah pengawalan akan muncul apabila robot berjalan atas tanah yang tidak rata. Masalah ini termasuk pemilihan perjalanan yang sesuai untuk sampai ke lokasi tertentu. Masalah yang kedua ialah pemilihan laluan dimana robot mesti memilih perjalanan yang boleh mengurangkan masalah kekasaran lereng dan pengelakkan halangan jika butiran dan lokasi tertentu dibagi. Masalah yang ketiga ialah penyesuaian terhadap permukaan tanah dan melalui halangan. Objektif projek ini adalah untuk menyelesaikan masalah ketidakstabilan semasa menggunakan "tripod gait" sebagai kawalan algoritma. Selain itu, pengesan inframerah digunakan untuk mengatasi masalah halangan. Dengan lengkapnya projek ini, maka robot ini akan dilengkapi dengan tiga servo dan satu papan pengawal utama yang mempunyai keupayaan untuk berjalan ke depan dan ke belakang. Selain itu, robot ini juga boleh berjalan atas tanah yang tidak rata dan menunjukkan reaksi terhadap persekitaran. Robot ini juga dilengkapi dengan keupayaan mengelak halangan dari depan dan kedua-dua belah kepala yang diperlukan untuk hidup oleh satu papan pengesan inframerah.

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BASIC	-	Beginner's All-purpose Symbolic Instruction Code
CPU	-	Central Processing Unit
DC	-	Direct Current
EEPROM	-	Electrically Erasable Programmable Read Only Memory
Hex	-	Hexadecimal
Hz	-	Hertz
ICSP	-	In-Circuit Serial Programming
I/O	-	Input Output
LED	-	Light Emitting Diode
PIC	-	Programmable Integrated Circuit
RC	-	Radio Control
R/C	-	Geared Direct Current
RISC	-	Reduced Instruction Set Computer
RAM	-	Random Access Memory

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CHAPTER I

INTRODUCTION

1.1 Introduction

This chapter will discuss the brief of robot and walking robot. Besides, objective, problem statement, scope of work, methodology and report structure of this project also will be covered in this chapter.

1.1.1 Robot

In 1920, Czechoslovakian playwright Karel Capek had introduces the word robot in the play R.U.R. (*Rossum's Universal Robots*), that 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 Walking Robot

Basically, robots can be classified into two categories that are fixed robot and mobile robot. Fixed robot is a robot mount on fixed surface and the working materials are brought to the workspace. For mobile robot, it moves from one space to another unstructured environment to a desired target. Mobile robots may further categorize into wheeled, tracked or legged robot. Most of the mobile robots are applied in difficult task and dangerous environment such as bomb defusing. Besides, it also used in manufacturing area and agriculture related activity such 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 application, 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 Objectives

The objectives of this project are:

i. to solve the instability face by walking robot before using tripod gait as control algorithm.

ii. to design and develop the six-legs walking robot that able to turn and reverse, walk on rough ground and avoid obstacles.

1.3 Problem Statement

Insectronic in history face the problem of stability in walking movement. When a walking robot traverses ground that not smooth, several control problems may arise from it. The problems include navigation where the robot must choose a route that will get it to a specified location. The second problem is with path selection that the robot must choose the detail of route to minimize the problem of slope roughness and obstacles avoidance if a specified location is given. The third problem is with terrain adaptation and obstacle crossing.

1.4 Scopes of Work

The scopes of work of this project are:

i. servo motors to achieve walking gaits of the robot's leg by mounting the legs to the servos and chassis.

ii. an infrared sensor board that acts as the robot's sense of sight by avoiding itself from the obstacles.

iii. a PIC16F84A microcontroller on main controller board which serves as the robot's "brain" by controlling and managing all functions, sensors and reflexes of the robot.

iv. PicBasic Pro as programming language.

1.5 Report Structure

This thesis is a document that delivers the idea generated, concepts applied, activities done and the finial year project produced. It consists of five chapters which described as below.

Chapter 1 is delivering the history of robot. It also contains objective, problem statement, scope of work, methodology and report structure of this project also will be covered in this chapter.

In Chapter 2, it contains of the literature review about the theoretical and concept applied in the robot such as walking gait for hexapod robot. Reviews are done on the materials that are suitable to be used for this project. Microcontrollers, sensors, and servo motors are explained in this chapter.

Chapter 3 is introducing the development for the hardware and software of the project that includes the flow chart, functional block diagram and briefly description of the method used in the project.

For Chapters 4, the result of designing the hardware and software will be covered in this chapter. It also contains the analysis and discussion of the result.

Chapter 5 is the last chapter of the thesis which will be the conclusion of the PSM project and some recommendations that can be implemented in future.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

This chapter contains the literature review about the theoretical and concept applied in the robot such as walking gait for the robot. Reviews are done on the materials that used for this project which are microcontroller, sensor, and motor.

2.2 Walking Gaits

A robot's gait is the sequence of leg movements that uses to move from one place to another. Each leg movement is broken down into step cycles, where a cycle is complete when the leg configuration is in the same position as it was when the cycle was initiated. A walking gait is a repetitive pattern of foot placement causing a regular progression forwards and backwards. With six legs, there are many gaits, but the two most popular are the alternating tripod gait and the wave gait. Six legs allow the robot to have three legs on the ground at all times, making it a stable tripod.

A legged robot can be defined as a servomechanism with many degrees of freedom. The robot's legs are connected by movable joints and actuators of some sort to power the joints. Control of the actuator's movements, varying over time, will result in sustained stable motion of the machine in a specified direction. Sustained stable motion consists of several objectives, such as stability, maintaining body orientation, control of forward velocity, the ability to turn and reverse, walk in rough ground and avoid obstacles.

2.2.1 Stability

One of the main objectives with legged locomotion is to achieve stability. All legged animals and machines face the potentially dangerous problem of falling over. This is because any variations in the slope of the ground will cause unstable state. A six-legged robot is stable when at least three of its legs are touching the ground that forms a tripod.

During locomotion, the simplest form of stability is to pass without a break from one stable stage to another. Most walking machines pass through stages in the locomotion cycle which are not stable that make the machine fall temporarily. If the gait does not contain some phases which are stable, the machine will not be able to stop moving without falling over. Thus, the best way is to use six legs and move them in triplets, so that three legs always supported the robot.

2.2.2 Control Algorithm – Tripod Gait

With the alternating tripod gait, the legs are divided into two set of three legs. Each set is comprises of the front and rear legs on one side, along with the middle leg on the opposite side. A forward step for half cycle starts with one step of legs lifting and moving to a forward position. At the same time, the motors of the legs in contact with

the ground swing backwards the same amount, moving the body of the robot forward. The lifted legs are then lowered, completing the half cycle. The lifting and support sets are interchanged and the second half of the cycle is completed.

The simplified sequence diagram of an alternating tripod gait is shown in Figure 2.1 below. This is the fastest stable gait. During the step, the weight of the robot is only supported on three legs. If one fails to find firm footing, the robot will fall. The middle legs lift the body and used as a swivel, but they never actually, move in a forward or reverse direction.

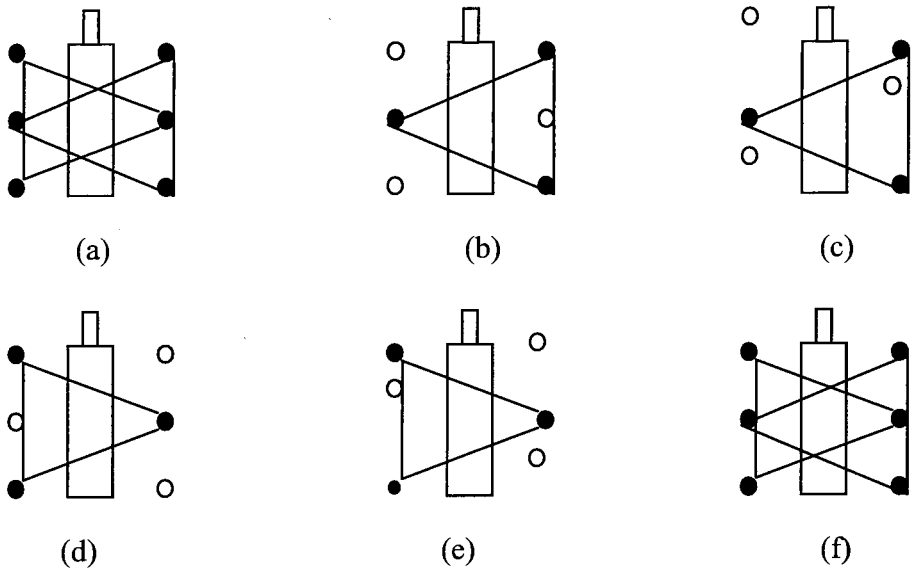

Figure 2.1: Simplified sequence diagram of an alternating tripod gait.

Figure 2.1 shown the simplified sequence diagram of an alternating tripod gait, where the sequence will descript as following:

1. Figure 2.1(a) shown the robot at rest condition, where all legs in contact with the ground.
2. Figure 2.1(b) shown three legs remain in contact with the ground and form a stable tripod to support the robot body.