WALKING ROBOT

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26 APRIL 2008

"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 FARIZ BIN ALI

Date : 7 MAY 2008

DEVELOPMENT OF A WALKING ROBOT

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Faculty of Electrical Engineering

Universiti Teknikal Malaysia Melaka

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

Signature : ……...
Name : TAN POH TOO
Date : 7 MAY 2008

Untuk ayah dan ibu tersayang

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ABSTRAK

Projek yang dibuat ini adalah untuk mereka dan membina robot berjalan. Projek ini memerlukan pengetahuan dalam mikro pengawal PIC untuk menjayakannya. Tujuan utama projek ini adalah untuk membina sebuah robot berjalan yang mempunyai keupayaan untuk berjalan ke hadapan, ke belakang, membelok kiri dan membelok ke kiri. Robot berjalan dalam projek ini menggunakan empat kaki untuk bergerak dengan menggunakan dua DC motor sahaja. Kaki hadapan dan kaki belakang digabungkan untuk membolehkan pergerakan serentak apabila motor yang berputar menggerakkan kaki hadapan robot. Dalam projek ini, mikro pengawal PIC digunakan sebagai sistem kawalan untuk mengawal robot ini dengan aturcara yang dituliskan dan disimpan dalam PIC. PIC 16F877A akan digunakan sebagai mikro pengawal. Satu aturcara akan ditulis untuk menentukan pergerakan robot ini dimana aturcara ini akan menentukan isyarat keluaran PIC kepada pemacu motor yang bertindak sebagai perantaraan PIC dengan motor. Motor akan berputar berdasarkan isyarat keluaran dari PIC tersebut dan robot akan berjalan apabila motor berputar.

ABSTRACT

This project is to design and develop a walking robot. This project required the knowledge in microcontroller to complete it successfully. The main aim for this project is to build a robot that can walk forward, backward, turn left and turn right. The walking robot built will be a four legged robot with only two DC motors. The front and back legs will be joint together so that the movement will be synchronized when the motors rotation move the front legs of the robot. In this project, PIC microcontroller will be used as a control system to control this robot with the program wrote and saved in PIC. PIC 16F877A will be used as the microcontroller. One program will be written to decide the movement of the robot where as this program will state the output signal of PIC which will be sent to motor driver which act as an interface between PIC and motor. Motors will rotate based on the output signal from PIC and the robot will walk as the motors rotate.

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CHAPTER 1

INTRODUCTION

A robot is a mechanical or virtual, artificial agent. It is usually an electromechanical system, which, by its appearance or movements, conveys a sense that it has intent or agency of its own [6]. Not all of the machine can be identify as robot because robot have several of properties which is either has been artificially created, can sense its environments, can manipulate or interact with things in its environment, has some degree of intelligence, or ability to make choices based on the environment, or automatic control / preprogrammed sequence, programmable, can move with one or more axes of rotation or translation, can make dexterous coordinated movements, appears to have intent or agency or is in some degree metallic.

In the past, mobile robot were controlled by heavy, large, and expensive computer system that could not be carried and had to be linked via cable or wireless devices. However, nowaday we can build small mobile robots with numerous actuators and sensors that are controlled by inexpensive, small, and light embedded computer systems that are carried on-board the robot. A Mobile Robot is an automatic machine that is capable of movement in a given environment and are not fixed to one physical location. Mobile robot mainly use several type of device to move, which is legged, wheeled or tracks. In contrast, industrial robots usually consist of a jointed arm (multi-linked manipulator) and gripper assembly (or end effector) that is attached to a fixed surface. Mobile robots are the focus of a great deal of current research and almost every major university has one or more labs that focus on mobile robot research. Mobile robots are also found in industry, military, security environments and also space exploration. They also appear as consumer

products, for entertainment or to perform certain tasks like vacuum cleaning or mowing.

Walking robots are often slower than driving robots, but they have the important advantage that they navigate over terrain, while driving robots require a more or less flat surface. The more legs a walking robot have, the easier to balance. Legged robots usually require two or more motors depend on the degrees of freedom (DOF) per leg of the robot. Walking robots can be define with [7]:

- All legs must operate in a cyclical fashion.
- No wheels or rotary wheel-like appendages will be permitted for locomotion.
- The ground contact point on the foot can not revolve around some origin that is located on the leg or hip.
- The entire weight of the robot must be completely supported by the robot's legs.
- All legs must be actively used to move the robot.
- All passive legs/appendages that are used to assist in balancing the robot, or locomotion, must separate (lift/hop/move) off the ground at some point during each walk cycle.
- If the robot falls over, external appendages/arms can be used to help the robot get back on its feet.

In this project, the walking robot will be using a PIC 16F877A microcontroller as a control system for this robot. While to control DC motor with PIC, motor driver is required to change the low current control signal to high current control signal to drive the DC motor.

1.1 Objectives of the Project

The aim in this project that need to be achieved:

1. Build a four legged robot using PIC 16F877A microcontroller as the control system.

2. The robot able to walk forward, backward, turns left and right.

3. When the legs of the robot lift up, the remaining legs of the robot must be able to walk and hold the weight of the robot.

1.2 Scope of the Project

A program will be written with MikroC with the movement of the walking robot being programmed. A variety of motion of the robot will be design to achieve the objective of this project. The program will decide which output port of the microcontroller PIC 16F877A will be "ON" or "OFF". The output ports of the PIC 16F877A are connected to the motor driver which use to convert the low current signal from microcontroller to high current signal, and from there, it will drive the motor rotation based on the signal from microcontroller.

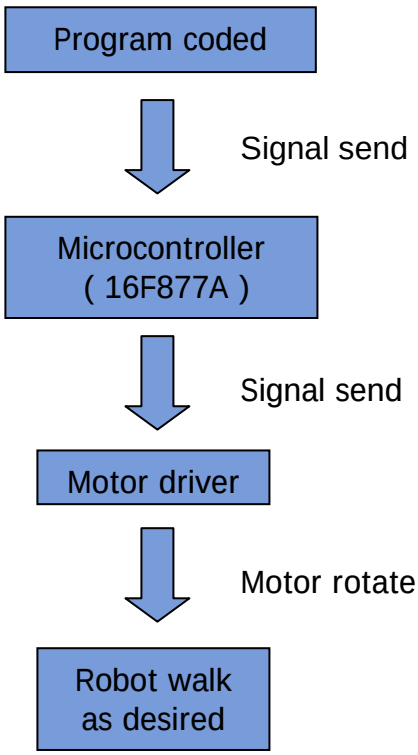

Figure 1.1: Flow chat of Walking Robot

For the hardware electronic parts, the controller board will be built using PIC 16F877A. While driver board will be built with L293B to control two dc motor using two set of H-bridge in the L293B chipset. Driver board and control board will be connected through port B and port C at PIC 16F877A and the input pins from the L293B.

While for mechanical hardware parts, aluminium will be used to construct the robot's structure including robot base, legs, joint and others related parts.

1.3 Problem Statement

Wheeled robot can only be use in smooth surface, while in terrain, its difficult for the wheeled robot to navigate through.

1.4 Project Planning Schedule (Gantt Chart)

Table 1.1: Gantt chart

PERANCANGAN PROJEK *PROJECT PLANNING*													
Senaraikan aktiviti-aktiviti utama bagi projek yang dicadangkan. Nyatakan jangka masa yang diperlukan bagi setiap aktiviti. *List major activities involved in the proposed project. Indicate duration of each activity to the related month(s).*													
Aktiviti Projek *Project's Activities*	**2007**								**2008**				
	J	J	A	S	O	N	D	J	F	M	A	M	J
1. PROPASAL		X											
2. LITERATURE REVIEW(programming and 6 legged robot)		X	X	X									
3. HARDWARE CONSTRUCTION			X	X	X	X	X	X					
4. PROGRAMMING				X	X	X	X	X					
5. PRESENTATION PSM 1					X								
6. SUBMIT PROGRESS REPORT FOR PSM1					X								
7. THESIS AND FINAL PRESENTATION								X	X	X	X		

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Ever since robots have been invented, people have been very interested in them. Robotic technology has made many things possible, including space and deep sea exploration, dangerous military and police missions, new types of entertainment, and new toys that talk and respond like real creatures. Robotic have been a subject of philosophical and a source of literary inspiration for hundreds of years. It is only since this century that robots have emerged out of fiction and turn philosophy into the real world. Today robots are common-place, for instance, fixed-location robotics arms now tirelessly perform precise repetitive tasks for industry. However, robots still have significant limitations. Specifically, most industrial robots require the parts they operate on to be precisely aligned and mobile robots that move around in an environment are still largely confined to academic research laboratories.

Today, we use robots in many ways to help us to make our life easier. One of the advantages of robots is in exploration. People are interested in places such as outer space or the deep ocean where sometimes it's full of danger. Sometimes, such places are risky for human being to reach therefore they make and sent robots that are able to reach there. The robots are able to carry cameras and other instruments so that they can collect information needed and transmit it back to human. Robots help humans a lot in industry too. Robots can do many things faster than humans and this is an advantage for production. Robots do not need to be paid, eat, drink, or go to the bathroom like people. They can do repetitive work that is absolutely boring to people and they will not stop, slow down, or fall to sleep like a human. While in medical,

sometimes when operating, doctors have to use a robot instead. A human would not be able to make a hole exactly of an inch wide and long. When making medicines, robots can do the job much faster and more accurately than a human can. Also, a robot can be more delicate than a human. Some doctors and engineers are also developing prosthetic (bionic) limbs that use robotic mechanisms. Dr. David Gow, of the Prosthetics Research and Development Team at Princess Margaret Rose Orthopaedic Hospital, made the first bionic arm called the Edinburgh Modular Arm System (EMAS) in 1998 [1]. For military and police, Police need certain types of robots for bomb-disposal and for bringing video cameras and microphones into dangerous areas, where a human policeman might get hurt or killed. The military also uses robots for locating and destroying mines on land and in water, entering enemy bases to gather information, and spying on enemy troops. Robots nowadays are being invented for the purpose of entertainment and as a toy too.

2.2 Background

Autonomous mobile robots are machines that are able to move around freely in a manner appropriate for their environment, with respect to some general goals. Control of the robot's movement in an environment is generally referred to as navigation. Among the earliest robots are Ctesibius of Alexandria's water clock, Grey Walter's "Elsie the tortoise" and Johns Hopkins "beast" [1]. The General Electric Walking Truck was a large (3,000 pounds) four legged robot that could walk up to four miles a hour. The walking truck was the first legged vehicle with a computer-brain, developed by Ralph Moser at General Electric Corp. in the 1960s [1].

2.3 AMOS-WD02

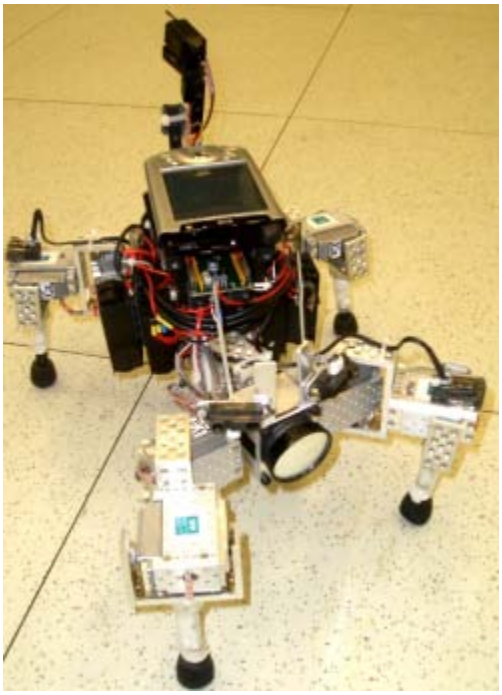

Figure 2.1: AMOS-WD02

AMOS-WD02 (Advanced MObility Sensor-driven Walking Device) is a simple platform for experiments with neural perception - action systems which were built referred to morphology of salamanders. This walking machine has 4 legs, each with 2 degrees of freedom, and one back joint. With IR-sensors and auditory sensors, it had different reactive behavior; such as obstacle avoidance and sound tropism [2].

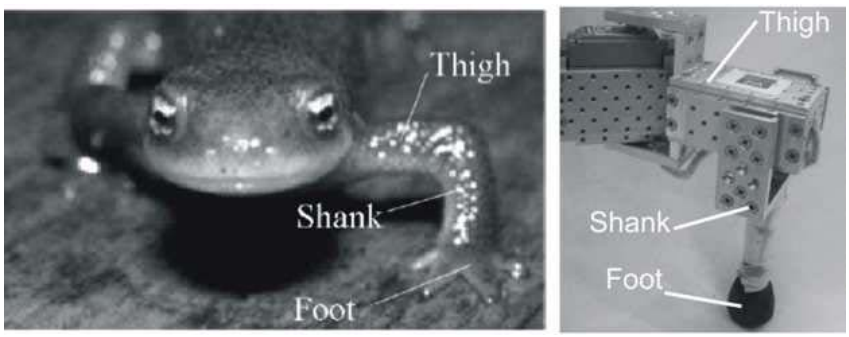

Figure 2.2: Basic principle of movement of a salamander leg [2]

AMOS-WD02 has three parts which is legs, body and sensors. For the leg parts, each leg has two joints (two degrees of freedom (DOF)) which are a minimum requirement to obtain the locomotion of a walking machine and which follow the basic principle of movement of a salamander leg. The upper joint of the legs, called thoracic joint, can move the leg forward and backward and the lower one, called basal joint, can move it up and down. While for body, it's inspired by vertebrate morphology of the salamander's trunk and its motion, the robot was constructed with a backbone joint which can rotate around a vertical axis. It facilitates a more flexible and faster motion [2].

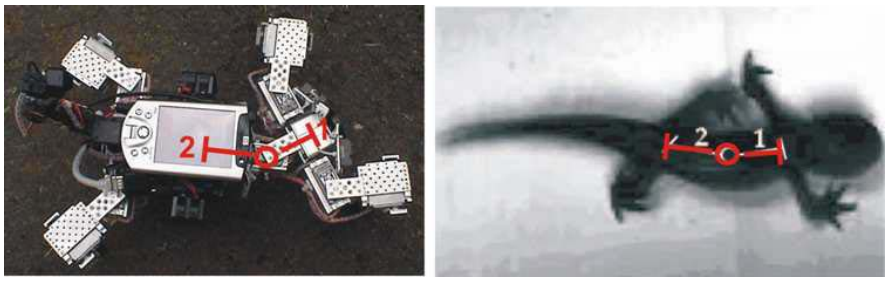

Figure 2.3: Backbone joint of AMOS-WD02

The backbone joint is also used to connect the trunk where two hind legs are attached with the head where two forelegs are installed. The AMOS-WD02 has two IR sensors (called antenna-like sensors), two auditory sensors and one wireless camera [2].

2.3.1 AMOS-WD02 Specification

Below is the specification for AMOS-WD02 [2]:

1. Mechanics

- Dimension without the tail (L x B x H): 28 x 30 x 14 cm