ROBOT WORM

HO FU YEAP

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

Faculty of Electronic and Computer Engineering
Universiti Teknikal Malaysia Melaka

MAY 2008

UNIVERSTI TEKNIKAL MALAYSIA MELAKA
FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : ROBOT WORM

Sesi Pengajian : 2007 / 2008

Saya HO FU YEAP mengaku membenarkan Laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (√) :

☐ **SULIT*** (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)

☐ **TERHAD*** (Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

☑ **TIDAK TERHAD**

Disahkan oleh:

(TANDATANGAN PENULIS)

Alamat Tetap: 5813, PANTAI BELIMBING,

DURIAN TUNGGAL,,

76100 MELAKA.

Tarikh: 08 MAY 2008

(COP DAN TANDATANGAN PENYELIA)

FAUZIYAH BT SALEHUDDIN
Pensyarah
Fakulti Kej Elektronik dan Kej Komputer (FKEKK),
Universiti Teknikal Malaysia Melaka (UTeM),
Karung Berkunci 1200
Ayer Keroh, 75450 Melaka

Tarikh: 8/5/2008

"I hereby declare that this report is the result of my own work except for quotes as cited in the references."

Signature : ....

Author : HO FU YEAP

Date : 08 MAY 2008

"I hereby declare that I have read this report and in my opinion this report is sufficient in terms of the scope and quality for the award of Bachelor of Electronic Engineering (Industrial Electronics) With Honours."

Signature	:	....
Supervisor's Name	:	PN. FAUZIYAH BT. SALEHUDDIN
Date	:	08 MAY 2008

Dedicated to my beloved family especially my parents, my siblings, girlfriend, supervisor, and also all my friends.

ACKNOWLEDGEMENT

First and foremost, I would like to thanks God for blessing me physical and mental strengths to perform my final year project up to completion.

First of all, I would like to express my utmost gratitude and sincere thanks to my supervisor, Mdm. Fauziyah Bt. Salehuddin for her support, encouragement and also guidance. Her kindness and patience are truly appreciated.

Apart from that, I would like to express my special thanks and gratitude to the technicians of PSM's laboratory for their helping in the components obtaining.

In addition to that, I am also grateful to all my friends who help and guide me in searching for important and relevant notes, books and other resources.

Finally, I would like to thanks to my parents for their moral support and caring all the ways in my life and I can count on them whenever I am feeling need.

ABSTRACT

The robot worms that will be built and programmed consist of six segments and a head, with each segment being powered by a DC servo. The segments alternate in orientation so that the first segment in a horizontal motion and the next segment move in a vertical motion. This sequence repeats itself for all six segments and the head. This gives the worm enough flexibility to move its body in a number of different ways in order to achieve locomotion, in much the same way as a biological worm. The robot is controlled by a Microchip PIC 16F84 microcontroller. The microcontroller is used to sequence the movement of each of the worm's body sections via servos. The microcontroller also monitors an infrared sensor so that the worm will avoid obstacles as it explores. At the end of this project, the robotic worm is expected to be able to use its segments alternate in orientation so that the first segment moves in a horizontal motion to move forward and the next segments moves in a vertical motion to change direction left or right. This gives the robotic worm enough flexibility to move its body in a number of different ways in order to achieve locomotion. The robotic worm will avoid obstacles as it explores using the infrared sensor.

ABSTRAK

Robot ulat yang akan dibina dan diprogramkan mengandungi enam bahagian badan dan satu kepala., setiap bahagian badan digerakan dengan menggunakan satu motor servo. Ia akan bergerak dengan mengerakkan bahagian badan pertama secara mengufuk dan bahagian seterusnya secara mendatar. Pergerakkan ini akan sentiasa berulang-ulang untuk setiap bahagian badan dan kepalanya untuk menghasilkan pergerakkan ulat yang lancar seperti dengan ulat yang sebenar. Robot ini akan dikawal dengan menggunakan mickrochip PIC 16F84A pengawal mikror. Pengawal mikro ini digunakan untuk memantau pergerakan setiap bahagian badan robot ulat dengan menggunakan motor servo. Pengawal mikro juga digunakan untuk memantau pengesan infra merah supaya ia dapat mengelak dari halangan apabila ia beroperasi. Di akhir project ini, robot ulat yang dihasilkan dijangka akan bergerak dengan lancar dan akan mengelak halangan yang dihadapi.

TABLE OF CONTENTS

LIST OF TABLE

LIST OF FIGURES

LIST OF ABBREVIATON

A/D	-	Analog to Digital
ADC	-	Analog to Digital Converter
CMOS	-	Complementary Metal Oxide Semiconductor
CPU	-	Central Processing Unit
DC	-	Direct Current
DOF	-	Degree Of Freedom
EPROM	-	Erasable Programmable Read Only Memory
EEPROM	-	Electrically Erasable Programmable Read Only Memory
GPS	-	Global Positioning System
IR	-	Infrared
IrDA	-	Infrared Data Association
I/O	-	Input / Output
LED	-	Light Emitting Diode
LW	-	Long Wave
LWIR	-	Long Wave Infrared
MCU	-	Micro Controller Unit
MW	-	Mid Wave
MWIR	-	Mid Wave Infrared
NIR	-	Near Infrared
NREC	-	National Robotics Engineering Center
OST	-	Oscillator Start up Timer
PC	-	Personal Computer
PCB	-	Printed Circuit Board
PIC	-	Programmable Integrated Circuit
POR	-	Power on Reset
PSM	-	Projek Sarjana Muda

PWM	-	Pulse-Width Modulation
PWRT	-	Power up Timer
R/C	-	Radio Control
RAM	-	Random Access Memory
SiO_2	-	Silica
SWIR	-	Short Wave Infrared
VLWIR	-	Very Long Wave Infrared
WDT	-	Watch Dog Timer

List of Appendixes

CHAPTER 1

INTRODUCTION

1.1 Introduction

A worm is an elongated, fat, soft-bodied invertebrate (an animal that lacks a backbone). Some species of worms are so different from- even unrelated to- each other that they have not been classified under a single group [15]. There are at least 20,000 kinds of worms. They are found almost all over the world. Worms are universal in distribution, occurring in marine, freshwater, and terrestrial habitats. Some worms that live in the ground help to condition the soil such as annelids and aschelminths. Many thrive as parasites of plants, for example aschelminths and animals, including humans, for example platyhelminths and aschelminths.

Several other worms may be free-living or non-parasitic. There are worms that live in freshwater, seawater, and even on the seashore. Ecologically, worms form an important link in the food chains in virtually all the ecosystems of the world. Worms usually have a cylindrical, flattened, or leaf-like body shape and are often without any true limbs or appendages. Instead, they may have bristles or fins that help them move. Many worms have sense organs that can detect environmental change. A few may even have light-sensing organs. Worms vary in size from less than 1 mm (0.04 inch) in certain aschelminths to more than 30 m (100 feet) in certain ribbon worms [15].

Worm species differ in their abilities to move about on their own. Many species have bodies with no major muscles, and cannot move on their own. They must be moved by forces or other animals in their environment. Many other species have bodies with major muscles and can move on their own; they are a type of muscular hydrostat. Many species of worms are decomposers; they break down dead plants and animals to return nutrients to the soil [15].

1.2 Objectives

The main goal of this project is to allow us to implementation and design a robotic worm in the hardware and also with the software. Beside that there are others objectives to be achieved in this project which are:

i. To implement a six segment worm robot this can move and avoid from obstacles.
ii. To design and construct a PCB circuit board which consist of the combination of hardware infrared and PIC Microcontroller to produce a system that has input and output signal.
iii. To understand the function of PIC Microcontroller as a controller processor.

1.3 Problem Statement

From the previous PSM robotic snake project, the movement of the robotic snake is all in horizontal motion in movement and obstacle avoidance. Movement in horizontal is very slow and ineffective. The idea come out is to improve the movement of the robotic snake with alternate in orientation so that the first segment moves in a horizontal motion and the next segments moves in a vertical motion. It will make the movement of the robot smoother and more effective.

1.4 Scope of Work

The robotic body will be constructed using aluminum plate. Two PCB board will be constructed is main controller board that consist of seven I/O port that control six servo motor each and one for receive signal from infrared sensor circuit board and controlled using a PIC Microcontroller 16F84A. And an infrared sensor circuit PCB board that will detect and send signal back to main controller board. BASIC PIC language will be used to program the PIC 16F84A in this project.

1.5 Report Structure

This thesis is a documentary delivering the idea generated concepts applied, activities done, and the preliminary final project product itself. It consists of five chapters. Following is a chapter-by-chapter description of information in this thesis.

Chapter 1 gives a basic introduction on how the idea of this project is generated. This chapter contains introduction, objective of the project, problem statement, scopes of works and report structure.

Chapter 2 is a literature review on theoretical concepts applied in this project. The history of evolution serpentine robot or snake-like robot is being discussed here. This chapter concludes with the brief explanation on how the Worm Robot work and gives a deeply explanation about what are microcontroller, servo motor and infrared sensor that being used for this project. As a results of that, the reasons of choose the specific microcontroller, servo motor and infrared sensor to use in the Worm Robot is clarify here.

Chapter 3 will discuss about the project methodology and introduces the construction of the project, which involves hardware development and software development. Basically, hardware development for the project concludes with circuit design, prototype or body design and PCB fabrication. Besides that, software development for the project will be discuss on what is programming language, written programming language to test the main controller board input and output port. After that, the robot operations are explained through the flow chart.

Chapter 4 will be covered all the result and analysis of the designing process, function ability and operation of the Worm robot. It will also include a discussion about the project. The chapter concludes with discussion on the analyzable of the software of Proteus, IrDA sensor, PIC programming, servo motor and results obtained for the main controller circuit.

Chapter 5 will be the conclusion of the PSM II project. This chapter concludes with some recommendations and applications that can be implemented in future.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Urban search and rescue, industrial inspections, and military intelligence have one need in common: small sized mobile robots that can travel across the rubble of a collapsed building squeeze through small crawl spaces to take measurements or perform visual inspections, and slither into the shelter of insurgents to gather intelligence. Some of these areas are not only difficult to reach, but could also present safety and health hazards to human inspectors. One species of mobile robots that promises to deliver such hyper mobility is the so called serpentine or snake robot. Serpentine robots typically comprise of three or more rigid segments that are connected by 2 or 3 degree of freedom (DOF) joints. The segments typically have powered wheels, tracks, or legs to propel the vehicle forward, while the joints may be powered or un-powered [5].

Desired capabilities for such a robot are the ability to traverse rugged terrain, such as concrete floors cluttered with debris, or unfinished floors such as those found on constructions sites, ability to fit through small openings, ability to climb up and over tall vertical steps, ability to travel inside and outside of horizontal, vertical, or diagonal pipes such as electric conduits or water pipes, ability to climb up and down stairs and ability to pass across wide gaps [5].

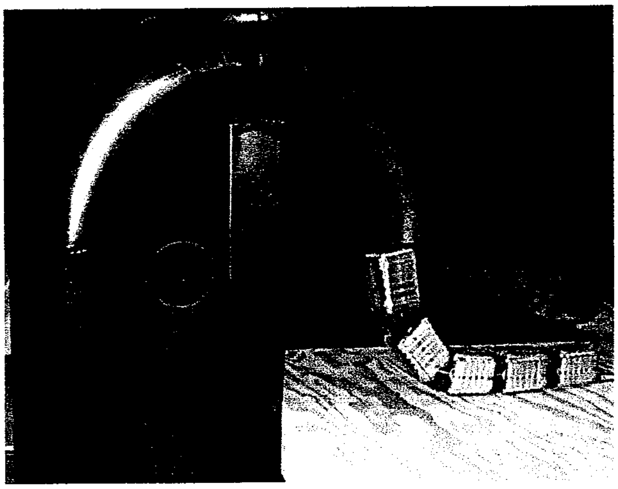

Figure 2.1: The Omni Tread Model OT 4 serpentine robot entering an 'Inverted J' ventilation duct at SwRI [5].

2.2 Serpentine Robot Evolution

Serpentine robots belong to the group of hyper redundant articulated mobile robots. This group can be further divided based on two characteristic features: the way the forward motion of the robot is generated and the activity of its joints. The first practical realization of a serpentine robot, called KR I, was introduced by Hirose and Morishima (1990) and later improved with version KR II (Hirose et al., 1991). This first serpentine robot was large and heavy, weighing in at 350 kg. The robot comprised of multiple vertical cylindrical segments on powered wheels (tracks in KR I) that give the mechanism a train like appearance. Vertical joint actuators allow a segment to lift its neighbors up, in order to negotiate steps or span gaps [8].

More recently, Klaassen and Paap (1999) at the GMD developed the Snake2 vehicle, which contains six active segments and a head. Each round segment has an array of 12 electrically driven wheels evenly spaced around its periphery. These wheels provide propulsion regardless of the vehicle's roll angle. Segments are interconnected by universal joints actuated by three additional electric motors through strings. Snake2 is an example of a robot that is inspired by the physiological structure of snakes where wheels replace tiny scales observed on the bodies of some real snakes. Snake2 is equipped with six infrared distance sensors, three torque sensors, one tilt sensor, two angle sensors in every segment, and a video camera in the head segment. Snake2 was specifically designed for the inspection of sewage pipes [8].

Another serpentine robot designed for sewer inspection was developed by Scholl et al. (2000) at the Forschungszentrum Informatik (FZI) in Germany. Its segments use only two wheels but the actuated 3 DOF joints allow full control over each segment spatial orientation. The robot is able to negotiate tight 90° angled pipes and climb over 55 cm high obstacles. One segment and its joint are about 20 cm long. The sensor suite of this robot is similar to that of Snake2. The development of sewer inspection robots is continued in the joint project MAKROplus (Streich & Adria, 2004) [8].

While wheeled serpentine robots can work well in smooth walled pipes, more rugged terrain requires tracked propulsion. To this effect Takayama and Hirose (2000) developed the Soruyu I crawler, which consists of three segments. Each segment is driven by a pair of tracks, which, in turn, are all powered simultaneously by a single motor, located in the center segment. Torque is provided to the two distal segments through a rotary shaft and universal joints. Each distal segment is connected to the center segment by a special 2 DOF joint mechanism, which is actuated by two lead screws driven by two electric motors. The robot can move forward and backward, and it can change the orientation of the two distal segments in yaw and pitch symmetrically to the center segment. One interesting feature is the ability of this robot to adapt to irregular terrain because of the elasticity of its joints. This elasticity is provided by springs and cannot be actively controlled [8].

A different concept using un-powered joints was introduced by Kimura and Hirose (2002) at the Tokyo Institute of Technology. That robot is also called Genbu is probably the only serpentine robot with un-powered joints. The stability of the robot and its high mobility on rough terrain are preserved by large diameter wheels (220 mm). The control system employs position and torque feedback sensors for the passive but rigid joints. Springs are used to protect the electric motors from impact, although the stiffness of the springs cannot be controlled during operation [8].