UNIVERSITI TEKNIKAL MALAYSIA MELAKA

# Design and Development Path Finding Robot Using Line Tracking

Thesis submitted in accordance with the partial requirements of the
Universiti Teknikal Malaysia Melaka for the
Bachelor of Manufacturing Engineering (Robotics and Automation)

By

**Azizi Bin Kamarudin**

Faculty of Manufacturing Engineering

April 2007

**APPROVAL**

This thesis submitted to the senate of UTeM and has been accepted as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotics& Automation). The members of the supervisory committee are as follow:

.................................................

(Mr. AzrulAzwan Bin Abd Rahman)

Main Supervisor

.................................................

(Mr.Ruzaidi Bin Abd. Rahman)

Co-Supervisor

**DECLARATION**

I hereby, declare this thesis entitled "Design & Development Path Finding Robot Using Line Tracking" is the result of my own research except as cited in the references.

| | | |
|---|---|---|
| Signature | : | ............................................ |
| Author's Name | : | AZIZI BIN KAMARUDIN |
| Date | : | 12/05/2007 |

ABSTRACT

A mobile robot is a robot that moves from one place to another place. The definition of an autonomous is capability of movement in a given environment in where it can perform desired tasks without human guidance. Many kinds of robots are autonomous to some degree. Different robots can be autonomous in different ways. The most common class of mobile robots is wheeled robots. A second class of mobile robots includes legged robots while a third smaller class includes aerial robots, usually referred to as unmanned aerial vehicles. Mobile robots can be found in industry, military and security environments, and appear as consumer products. A path finding robot is one type of the mobile robot where the movement is based on the line tracking. The main parts of the robots are sensor, motor and controller. The electronic parts and programming are important aspects for a robot. In this project, the dc servo motor is used to drive the robot movement and the infrared sensor is used as a guide for the movement of the robot .The PIC 16F877A microcontroller is used as robot controller. The path finding robot is able to follow the line on the surface but sometimes it's strayed from the line.

# DEDICATION

For my beloved mother and father also to my family that always give me support

## ACKNOWLEDGEMENTS

Grateful thanks are due to the following:
My project supervisor Mr. AzrulAzwan B. Abd Rahman for his kind criticism, advices and guidance and also to my Head of Departments of Robotics & Automation, Mr. Shariman B. Abdullah also to Mr Arfauz B. Abd Rahman for their moral support and ideas to me. Last but not least to technicians for their cooperation.
The contributions from these people are greatly appreciated.

**TABLE OF CONTENTS**

## LIST OF FIGURES

# LIST OF TABLES

## LIST OF ABBREVIATIONS

| | | |
|---|---|---|
| DC | - | Direct current |
| CCD | - | Charge-coupled device |
| CID | - | Charge-injection device |
| RTD's | - | Resistance Temperature Device |
| PLC | - | Programmable logic controller |
| MCU | - | Micro-controller unit |
| IC | - | Integrated circuit |
| CPU | - | Computer processing unit |
| PWM | - | Pulse width modulation |
| CCD | - | Charge-injection devices |
| LEDs | - | Light-emitting diode |
| IC | - | Integrated circuit |
| CPU | - | Computer processing unit |
| ROBOCON | - | Robotic contest |
| RAM | - | Read Access Memory |
| ROM | - | Read Only Memory |
| EEPROM | - | Electrical Erasable Programmable Read Only Memory |
| PIC | - | Peripheral Intelligent Controller |

# CHAPTER 1

## INTRODUCTION

The word robot originated from the Czech word 'robota', which means 'slave labour'. The term robotics was coined by Isaac Asimov in his short science fiction in 1940s, in which he defined robotics as a study of robots. A robot is a re-programmable multifunctional manipulator designed to move material, parts, tools, or specialized devices through variable programmed motions for performance of a variety of tasks (Snyder, 1985).

The word robot is used to refer to a wide range of machines, the common feature of which is that they are all capable of movement and can be used to perform physical tasks. Robots take on many different forms, ranging from humanoid, which mimic the human form and way of moving, to industrial, whose appearance is dictated by the function they are to perform. Robots can be grouped generally as mobile robots (autonomous robots), manipulator robots (industrial robots) and self reconfigurable robots, which can conform themselves to the task at hand. Robots may be controlled directly by a human, such as remotely-controlled bomb-disposal robots, robotic arms, or shuttles, or may act according to their own decision making ability, provided by artificial intelligence. However, the majority of robots fall in-between these extremes, being controlled by pre-programmed computers. Such robots may include feedback loops such that they can interact with their environment, but do not display actual intelligence.

Mobile robots are autonomous machines that are capable of movement in a given environment in which can perform desired tasks in unstructured environments without continuous human guidance. Many kinds of robots are autonomous to some degree. Different robots can be autonomous in different ways. The most common class of mobile robots is wheeled robots. A second class of mobile robots includes legged robots while a third smaller class includes aerial robots, usually referred to as unmanned aerial vehicles. Mobile robots are also found in industry, military and security environments, and appear as consumer products. A path finding robot is one of the mobile robot where the robot is moving base on the line tracking. The main parts of the robots are sensor, motor and controller. The line can be in white or black line tape on the floor. The sensor will detect the line on the floor and send signals to controller to be process. After that it send signals to motor to rotate and the robot is moving base on the signal given.

## 1.1 Problems Statement

Currently the syllabus for course in Robotics & Automation is lack of exposure in electronics, electrical and programming due to that, students had a problem regarding to design and develop the control system for a robot. The electronics, electrical and programming are the important aspects to design a robot. This are the things that been highlighted to improve the syllabus for course in Robotics & Automation.

## 1.2 Objectives

To develop the electronic hardware and write a program of path finding robot using line tracking.

## 1.3 Scope of Project

The scope of the project is to design and develop a path finding robot using a line tracking.

## 1.4 Project Overview

To ensure that the project is finish within the time, a schedule is made and divided into PSM 1 and PSM 2.In PSM 1 consists of research information and references about 'Path Finding Robot using Line Tracking', research about current design & technology used to design & develop 'Path Finding Robot using Line Tracking', make a literature review, make a conceptual design, selections of electronic and electrical parts for the robot, research about programming language to program the robot. Whereas in PSM 2 consists of study about programming language to program the robot, test the program, material selections and manufacture the robot base, assemble the electronic parts to the robot base and finally test the functional of the robot.

## 1.5 PROJECT SCHEDULE

Below is the project schedule starts on July 2006 (PSM 1) and end on April 2007 (PSM 2).

| Project Activities | 2006 (PSM 1) | | | | | | 2007 (PSM 2) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | July | August | September | October | November | December | January | February | March | April |
| Research about current design & technology used to design & develop 'Path Finding Robot using Line Tracking' | | | | | | | | | | |
| Literature Review | | | | | | | | | | |
| Conceptual design | | | | | | | | | | |
| Selection of the electronic and electrical components | | | | | | | | | | |
| Research about programming language to program the robot | | | | | | | | | | |
| Develop the electronics circuits for the robot | | | | | | | | | | |
| Write & testing the robot programming | | | | | | | | | | |
| Material selections and manufacture the robot base | | | | | | | | | | |
| Assemble the electronic parts to the robot base | | | | | | | | | | |
| Test the functional of the robot & trouble-shooting | | | | | | | | | | |

# CHAPTER 2

## LITERATURE REVIEW

### 2.1 Introduction to Robots

A robot is an electro-mechanical device that can perform autonomous or pre-programmed tasks. A robot may act under the direct control of a human such as the robotic arm of the space shuttle or autonomously under the control of a programmed computer. Robots are growing in complexity and their use in industry is becoming more widespread. The main use of robots has so far been in the automation of mass production industries, where the same, definable tasks must be performed repeatedly in exactly the same fashion. Car production is the primary example of the employment of large and complex robots for producing products. Robots are used in that process for the painting, welding and assembly of the cars. Robots are good for such tasks because the tasks can be accurately defined and must be performed the same every time, with little need for feedback to control the exact process being performed. Industrial Robots can be manufactured in a wide range of sizes and so can handle much larger tasks than a human could.

In fact, in the seventeenth century, mechanical designs were advanced enough, for people to make mechanical robots to perform some complex functions well. The main disadvantage of the "ancient robots" at that time was the low level programming and re-programming functions, because cams and gears were used for programming, and the programming and reprogramming were time consuming and expensive matters. Since the early twentieth century, design and research in robotics have accelerated with the developments of electronics, computer, and industrial automation in America, Japan, and Europe. In 1930s, American Pollard and Roseland developed an automatic spray-painting machine, which was re-programmable and resembled a modem industrial robot. In the Ilriddle 1950s, American George Devol, "the father of robot", developed the first programmable robot with a magnetic process controller .There are several reasons why robots are applied into industries area such as Quality improvement, Improvement of working environment, better cost effectiveness and Flexibility to change. Firstly is a quality improvement, a certain tasks robots can be superior to humans in terms of the quality of the work that is produced. This has been found to be the case where one or more of the following are required such as high positioning precision, high repeatability, no deviation due to fatigue and highly accurate inspection and measurement using sensors. Secondly is improvement of the working environment, In order to get the best long term performance from the work force it is important to make the working environment as conducive as possible to high quality, high output work. The human body if used incorrectly is susceptible to short term fatigue or long term injury or disability. Thirdly is cost effectiveness, cost effectiveness of robots is not always an easy calculation to perform. Most of the cost is up front in terms of the robot and tooling costs (Yoshitada, 1991). Often due to the lack of intelligence in robots the tooling costs are the most significant. In comparison to this performing the operations using humans the largest cost is in wages, where robots can operate continuously for 24 hours per day in order to get the best productivity from them.

### 2.1.1 Components of a robot manipulator

A robot manipulator system often consists of links, joints, actuators, sensors and controllers. The links are connected by joints to form an open kinematics chain. One end of the chain is attached to the robot base, and another end is equipped with a tool (hand, gripper, or end-effectors) to perform assembly operations or other tasks. The joints used to connect neighbouring links may be rotary or prismatic. The rotation of rotary joints and the sliding of prismatic joints allow the links to move in the robot work-space. Figure 2.0 shows the symbols of a rotary joint and a prismatic joint, respectively. Where z is the motion axis of a rotary joint or a prismatic joint, are two neighbouring links. The angle e of the rotary joint and the sliding distance d of the prismatic joint are called joint variables. In a robot system, the number of degrees-of-freedom is determined by the number of independent joint variables.

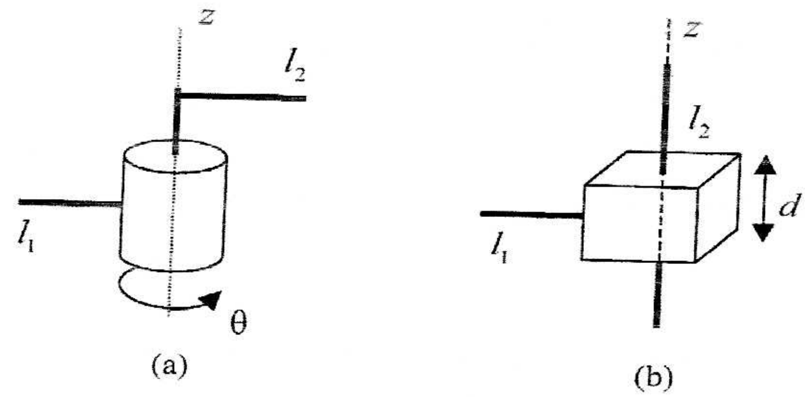


Figure 2.0: (a) Symbol of rotary joint. (b) Symbol of a prismatic joint

Although robot links often have deformations from their nominal positions when forces are impressed on them, for convenience, we assume that all links are rigid bodies, e.g., the links have no deformation when forces are acting on them.

Actuators are devices that cause rotary joints to rotate about their motion axes, or drive prismatic joints to slide along their motion axes. Generally, there are three types of fundamental actuating systems used in robot systems: hydraulic actuating systems, pneumatic actuating systems, and electrical actuating systems. A hydraulic actuating system often has a small size and a very light weight.
However, it can develop very high forces and torques, and have a high speed of response. Due to the advantage of a high power-to-weight ratio, hydraulic actuating systems have been widely used in a class of robot systems that handle very heavy loads. The disadvantages of hydraulic actuating systems are that they are very expensive, and the oil leaking from hydraulic actuating systems may pollute the working environment. In addition, hydraulic actuating systems are difficult to control compared with other actuating systems (Holland, 1983).

Unlike a hydraulic actuating system, a pneumatic actuating system uses air as a working medium instead of oil. Although a pneumatic actuating system is cheap, clean, reliable with high power, and fire hazard-free, the main disadvantages are that the high-degree accuracy is difficult to achieve because of the elastic nature of compressed air, and a very big time-delay in operations due to a very slow air transmission (John,1989).

Electrical actuating systems, such as dc motors and stepper motors, are well known by engineers. Compared with hydraulic and pneumatic actuating systems, we can easily control electric motors to give fast response and high accuracy. However, electric motors are often very heavy, and gear systems are often needed to provide low torques, which may cause so-called back slash problem (John, 1989).

Sensors are devices that detect the information about robot manipulators' work and the interactions between robot manipulators and their environments. The detected information is conveyed to the robots' computers for processing, and then the computers issue control signals to direct the manipulators to their next operation. Good performance depends on accurate sensing, relevant processing, and precise control. The commonly used sensors in robot systems are position sensors, velocity sensors, force sensors, and vision sensors. Position sensors, such as optical encoders, can be seen nearly in all robot manipulator systems. Optical sensors are usually mounted on the motor shafts to measure the angular positions (McDonald, 1986).

Vision sensors are devices that collect visual information of objects and their surroundings, and then convert the collected visual information to the corresponding electronic signals for further processing and analysis. Although there are many vision sensors, such as photo-emissive devices, silicon sensors, photo-diodes, photo transistors, vidicon cameras, and solid-state cameras with charge-coupled devices (CCD) or charge-injection devices (CID), the most commonly used industrial robot vision sensors are vidicon cameras and CCD cameras (Castleman, 1996).Figure 2.1 shows an example using a vision sensor to detect the size, position, and orientation, information of an object. The detected information can then be analyzed by a computer to help the robot manipulator to understand some important features of the processed object. The computer may then make a decision for the next operation.

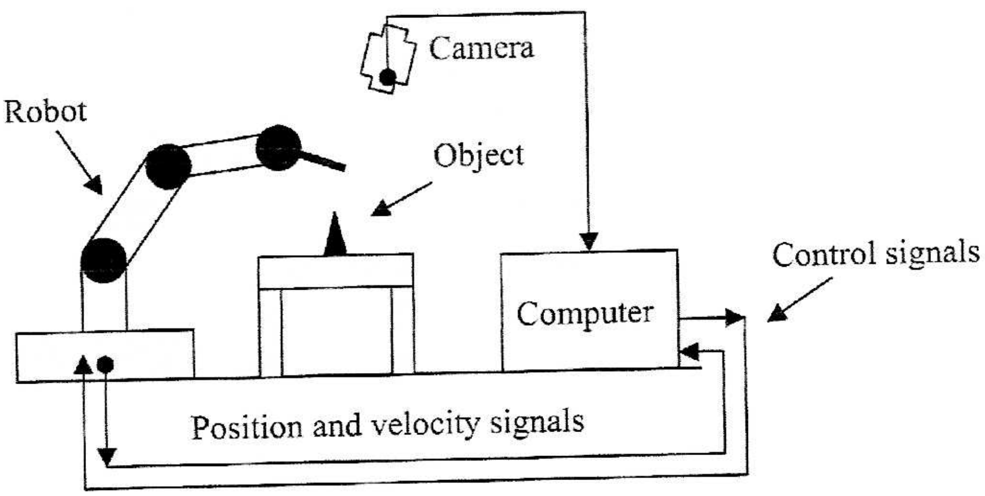


Figure 2.1: Robot system with a vision sensor