PICK AND PLACE SYSTEM USING CONTROLLED ROBOTIC ARM

MOHD HELMI BIN SUID

MAY 2007

"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, Instruments And Automation)."

Signature : ....

Supervisor's Name : Mohd Ariff Bin Mat Hanafiah

Date : 7/5/2007

PICK AND PLACESYSTEM USING CONTROLLED ROBOTIC ARM

MOHD HELMI BIN SUID

This Report Is Submitted In Partial Fulfillments of Requirements for the Degree of Bachelor in Electrical Engineering (Control, Instrumentation and Automation)

Fakulti Kejuruteraan Elektrik
Universiti Teknikal Kebangsaan Malaysia

May 2007

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

Signature :..

Name : Mohd Helmi Bin Suid

Date : 7/05/2007

ACKNOWLEDGEMENTS

Alhamdulillah, praise be to Allah s.w.t and sustainer of world, most gracious, most merciful God.

Praise be to Allah s.w.t for enabling me to present this 'Pick and Place System Using Controlled Robotic Arm' progress report for my "Projek Sarjana Muda 2".

I would like to thank En. Mohd Ariff B. Mat Hanafiah as my supervisor for his invaluable help, support and ideas to me through achieving my "Projek Sarjana Muda 2" objective. His countless contributions in this project will remind forever in my heart.

Finally, I would like to honor my parent for supporting me stead fastly and their advice through my project progress.

ABSTRACTS

Nowadays in this modern technology era, human use robots to help them and make their job easier. In fact usage of robot system can give human more and more advantage in completing the job even in the extraordinary and dangerous place. Robots are used in the auto, medical and manufacturing industries etc. Building and programming a robot is a combination of mechanics, electronics and problem solving.

This robotic arm prototype system is a mechanical robot arm with 4 individual servo motor. It consists of two major elements; a mechanical arm (hardware development) and PIC microcontroller system (software development) that will function as a brain to control all sequences of the pick and place system. The mechanical arm has a jointed-spherical geometry with 3 degree of freedom in the arm and wrist. The three axes of motion include rotation at the waist for positioning the hand; then flex rotation motion in the wrist for orientation of the gripper.

This prototype can be controlled by the PIC microcontroller software which is using C language as command program. The microcontroller is used to execute the program which is loaded to its program memory. All the robotic arm prototype motion is controlled under command program. So, the motion of 3 axes robot will be change accordingly to the program that was install to the PIC 16F877A. The robotic arm will follow the command from PIC 16F877A programming system to pick an object and place it at the other position.

ABSTRAK

Dalam teknologi moden pada hari ini, robot kebanyakannya diguna untuk membantu manusia dan membuat sesuatu kerja menjadi mudah. Malahan penggunaan sistem robot boleh memberi banyak kelebihan kepada manusia dalam menyelesaikan sesuatu kerja walaupun dalam persekitaran yang luar biasa dan berbahaya. Robot sering digunakan dalam industri automasi, perkilangan dan bidang perubatan. Membina dan memprogram sesebuah robot adalah suatu kombinasi antara mekanikal, electrical dan penyelesaian masalah.

Prototaip sistem lengan robot adalah sebuah lengan robot mekanikal yang menggunakan 3 servo motor. Ia terdiri daripada 2 elemen utama iaitu lengan robot mekanikal dan juga sistem PIC microcontroller yang akan berfungsi sebagai otak bagi mengawal keseluruhan operasi sistem 'Pick & Place'. Lengan robot mekanikal mempunyai '3 degree of freedom' pada untuk bahagian lengan dan pergelangan lengan. 3 paksi pergerakan tersebut termasuklah putaran pada bahagian pinggang, untuk posisi tangan robot; bengkokkan dan putaran pada bahagian pergelangan lengan untuk orentasi elemen pencengkam 'gripper'.

Prototaip lengan robot ini boleh dikawal dengan perisian PIC microcontroller. Microcontroller yang mana ianya menggunakan bahasa C sebagai program arahan. Microcontroller digunakan untuk melaksanakan kesemua program yang telah dimuatkan dalam program memorinya. Keseluruhan pergerakan prototaip lengan robot ini dikawal oleh program arahan. Jadi, pergerakan lengan robot akan berubah mengikut arahan yang telah dimuat di dalam cip PIC 16F877A. Lengan robot ini akan mengikut arahan dari program PIC 16F877A untuk menjalankan operasi bagi mengambil sesuatu objek dan meletakannya pada posisi yang lain.

Contents

List of Figures

List of Tables

List of Equations

List of Appendices

List of Abbreviations

PWM	Pulse Width Modulation
PIC	Peripheral Interface Controller
DC	Direct Current
DOF	Degree Of Freedom
I/O	Input / Output
IC	Integrated Circuit

CHAPTER I

INTRODUCTION

1.0 Introduction

Functionally, a robot is a physical agent which is capable of executing motion for the achievement of tasks. A robot's degree of autonomy depends on its ability to perform the ordered sequence of perception, decision-making and action. A robot is a programmable, multi-functional manipulator designed to move material, parts or specialized devices through variable programmed motions for the performances of a variety of tasks.

Today, the robot is gaining more popularity in industrial sector such as in the manufacturing industry. Tasks or process which can typically be accomplished by using robots include:

- Welding:
  This is the process of joining two work-pieces together by applying molten weld metal.
- Cutting:
  This is the process of applying thermal or mechanical energy to cut a work-piece into a specific shape. Position and velocity is important in this process.

- Assembly:

  This is the process of either adding components to form a single entity, or affixing components to a base unit (e.g. to place components on a printed circuit board). Position is important in this process.
- Material handling:

  This is the process of either packaging parts into a compartment (box) or loading/unloading parts to/from another station. Position is an important parameter in this process.

The robot arm prototype that will construct in order to perform pick and place system is pertain as a material handling robot.

1.1 Problem Statements

In most real industries, robots are the machine that can be used to help human doing their job. Base on many factors, it is increasingly necessary for a robot to be able to reduce human job that was manually and repeatedly done such as in the manufacturing industries. Especially to handle complicated and dexterous tasks skillfully in automated manufacturing area, we often need robotic system which is capable of controlling the process.

In the industrial sector, robot arm can be used to pick some object and place it at the other side in the range of their axes. For example the robot arm is widely used in the factory to pick the object from one line to the other line system to continue the process. By using this robotic method, company can reduce cost to pay the labors salary. So, one approach to satisfy the industrial demands is to identically designed, fabricated and develop a robotic arm prototype.

The wide use of robots in the manufacturing industry will certainly have positive impact, as well:

i. Productivity:

It is impossible to achieve a high production yield using human labor because the biological system cannot deliver continuous physical effort without rest. There is no doubt that automation with robots will increase productivity.

ii. Quality of Products:

Humans are not capable of making things with a consistent degree of accuracy. For example, our vision does not make metric measurements when performing tasks. And, without accurate visual guidance, we cannot perform motions with any reasonable degree of accuracy or replication. Robots can not only execute accurate motions repeatedly, but are immune to the emotional states which affect human's performance.

iii. Quality of Humans Life:

The use of robots can free humans from doing dirty, dangerous and difficult job.

1.2 Project Objectives

Automation systems are found in all major local factories and the industrial robot is part of many of these systems. The technicians, engineers and managers working in automated plants must have an understanding of automation concepts including basic robotic principles.

The construction, programming and operation of the pick and place system is identical to most industrial robots, so a complete understanding of this system will prepare student to work on the industrial robots and automation systems that used in modern factories. Besides, the objectives of this project are:

i. To study and learn the robotic arm prototype construction and it's design.
ii. To design and develop a fully automated system that is used to apply pick and place system using robotic arm prototype.
iii. To investigate and design the command program that can be used as a controller for the robotic arm system.

iv. To combine the robotic arm prototype with the developed robot command program and testing in real time.

1.3 Project Scope

The basic pick and place system using controlled robotic arm includes the following elements; a mechanical arm, PIC microcontroller, end-of-arm tooling (gripper) and external power source.

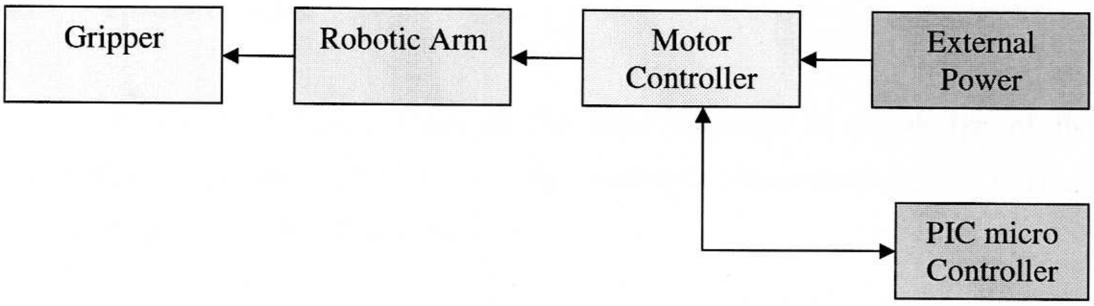

Figure 1.1: A genealogy of project scope

As a result of this project, the robotic arm prototype will be produced and it can be controlled by using PIC program in order to perform pick and place process.

CHAPTER II

LITERATURE REVIEW

2.0 Theory of robot

In this theory, it discusses some of the issue involved in the design of the manipulator. In general, methods of design and even the evaluation of a finished design are partially subjective topics.

The elements of a robot system fall roughly into four categories:

1) The manipulator
2) The end-effectors or end-of-arm tooling
3) External sensors and effectors, such as vision systems and part feeders
4) The controller

In developing a manipulator design, it will start by examining the factors likely to have the greatest overall effect on the design and then consider more detailed questions. Ultimately, however, designing a manipulator is an iterative process. More often than not, problems that arise in the solving of a design detail will force rethinking previous higher level design decisions.

2.0.1 The Design on Task Requirement

Although robots are nominally universal programmable machines capable of performing a wide variety of tasks, economies and practicalities dictate those different manipulators be designed for particular type of tasks. For example, large robots capable of handling payloads of hundreds of pound do not generally have the capabilities to insert electronic components into circuit boards.

Base on the phenomenon, we shall see not only the size but the number of joints, the arrangement of the joints and the types of actuation; sensing and control will all vary greatly with the sort of task to be performed.

2.0.2 Number of Degrees Of Freedom

The number of degrees of freedom in manipulator should match the number required by the task. Not all tasks require a full six degree of freedom.

The most common such circumstance occurs when end-effectors has an axis of symmetry. In analyzing the symmetric-tool situation, it is sometimes helpful to imagine a fictitious joint whose axis lies along the axis of symmetry. In positioning any end-effectors to a specific pose, it need a total of six degree of freedom because one of these six is the fictitious joint, the actual manipulator need not have more than five degrees of freedom.

Some tasks are performed in domains that fundamentally have fewer than six degrees of freedom. Placement of object or component on circuit board provides a common example of this. Circuit board and palletizing generally are planar and contain parts of various heights. Positioning parts on a planar arm surface requires three degrees of freedom (x, y andθ); in order to lift and place the object, a fourth motion normal to the plane is added (z).

2.0.3 Workspace

In performing tasks, a manipulator has to reach a number of work pieces or fixtures. In some cases, these can be positioned as needed to suit the workspace of the manipulator. In other cases, a robot can be installed in a fixed environment with rigid workspace requirements. Workspace is also sometimes called *work volume* or *work envelope*.

The overall scale of the task sets the required workspace of the manipulator. In some situation, the details of the shape of workspace and the location of workspace singularities will be important considerations.

The intrusion of the manipulator itself in the workspace can sometimes be a factor. Depending on the kinematics design, operating a manipulator in a given application could require more or less space around the fixtures in order to avoid collisions.

2.0.4 Load capacity

The load capacity of manipulator depends upon the sizing of its structural members, power-transmission system and actuators. The load placed on actuators and drive system is a function of the configuration of the robot, the percentage of time supporting a load and dynamic loading due to inertial and velocity-related forces.

2.0.5 Speed

An obvious target or goal in design has been for faster and faster manipulators. High speed offers advantages in many applications when proposed robotic solution must compete on economic terms with hard automation or human workers. For some applications, however the process itself limits the speed rather than the manipulator such as welding and spray-painting applications.

An important distinction is that between the maximum end-effectors speed and overall cycle time for a particular task. For pick and place application, the manipulator must accelerate and decelerate to and from the pick and place locations within some positional accuracy bounds. Hence acceleration capability, not just peak speed is very important.

2.0.6 Repeatability and Accuracy

High repeatability and accuracy, although desirable in any manipulator design, are expensive to achieve. To a large extent, accuracy of a particular model of industrial robot depends upon the details of its manufacturer rather than on its design.

High accuracy is achieved by having good knowledge of the link and other parameters. Making it possible is accurate measurements careful attention to tolerances during processing.

2.1 SG5-UT (Ultra Torque) Robotic Arm

The SG5-UT, load balanced, robotic arm featuring all aluminum construction and the only fully expandable "smart grip" design components (detailed below). Feature for feature, the SG5 series presents the most powerful and sophisticated, all aluminum 5-axis robotic arm system available today.

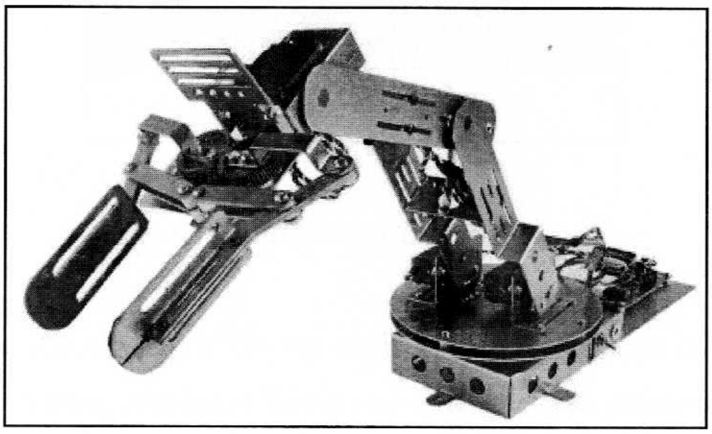

Figure 2.1: SG5-UT Robotic Arm

2.1.1 Key Features

All parts are precision CNC machined from .063 ga. 5052 brushed, sheet aluminum. The aluminum components are anodized to a smooth, scratch resistant, graphite