DESIGN & DEVELOPMENT OF PC-BASED SERVO MOTOR PICK AND PLACE ROBOT

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MAY 2009

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This Report is submitted in Partial Fulfillment of Requirements for The Degree of Bachelor in Electrical Engineering (Power Electronic and Drive)

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May 2009

"I hereby declare that I have read this report and in my opinion this report in term of content and quality requirement fulfils the purpose for the conferring of the Degree of Bachelor in Electrical Engineering."

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

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ACKNOWLEDGEMENT

First and foremost, I thank Allah the Almighty for blessing me to complete my Final Year Project. I would like to enlarge my appreciation to Prof Madya Mohd Ariff B Mat Hanafiah because of the kindness heart to accept me as one of the student under his supervision. Special thanks also dedicated to him for all comments, idea, and a guideline begin from the first day I start this project.

This appreciation also goes to my friend that always gives support, opinion, and advices for me to complete this report especially my friends under Prof Madya Mohd Ariff B Mat Hanafiah supervision.

To my beloved family, I would like to forward my obliged to them for their continuous support during my study period, their patience and benevolence. Lastly, I would like to thank to everyone who has contributed during my Final Year Project. Your kindness and cooperation in completion of my paper work is much appreciated.

THANK YOU.

ABSTRACT

PC-Based 4 axes robot arm control system is a project that use robot to help human to pick and place object using the computer software. A prototype of arm robot consists of simulating shoulder movement of a human arm were built to pick and place object from one point to another.

The microcontroller is used to execute a user program which is loaded in its program memory. The arm has three degree of freedom so it will be able to reach and pick object from any three dimensional point regarding its workspace. The motion of the robot arm is fully control by Visual Basic as interfacing tool.

Servo motors will be used as the actuator for the robot that is controlled by microcontroller. The project encompasses all design areas required to make a hand able to move and pick an object, including hardware design, analysis, controller circuit design and controller program. The controller circuit will use PIC16F877A microcontroller as 'the brain' of the robot.

ABSTRAK

Dalam laporan ini, Pembangunan Robot Motor Servo Angkat dan Letak Bersama Pengawal Mikro adalah dicadangkan. Sebuah robot yang akan berfungsi sebagai satu alat untuk mengangkat dan meletak sesebuah objek. Sebuah robot lengan kecil yang menyerupai pergerakan bahu manusia akan dibina untuk mengangkat dan meletak objek dari titik A ke titik B. Lengan tersebut mempunyai tiga darjah kebebasan agar robot tersebut dapat mencapai dan mengambil objek dari mana-mana titik tiga dimensi. Motor servo akan digunakan sebagai penggerak yang akan dikawal oleh pengawal mikro. Program Citec Scada akan menjadi pengantaramuka antara "software " dan "hardware". Projek ini mempunyai bahgian-bahagian rekabentuk yang diperlukan agar lengan tersebut dapat berfugsi untuk mengangkat objek, termasuk rekabentuk perkakasan, analisis, rekabentuk litar kawalan elektronik dan program pengawal. Litar pengawal tersebut akan menggunakan pengawal mikro PIC16F877A sebagai 'otak' kepada robot itu nanti.

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CHAPTER I

INTRODUCTION

Pick and place robot work cells are among the most popular material handling systems. It provides dependable solutions for production lines. Pick and place robot work cells perform tedious, repetitive tasks with ease, speed and accuracy. Nowadays robots play many important roles in industrial sector. More robots mean fewer workers needed by companies to run their production lines. So, engineers in the future need to take a step to learn as much as they can about robotics so they can add new skills and develop knowledge about robotics. This project can help in the understanding of basic knowledge about robotics.

PIC microcontrollers are popular with developers and hobbyists alike due to their low cost, wide availability, large user base, extensive collection of application notes, availability of low cost or free development tools, and serial programming (and re-programming with flash memory) capability. The name PIC initially referred to "Programmable Interface Controller", but shortly thereafter was renamed "Programmable Intelligent Computer".

Today they can be found in almost any complex electronic device - from portable music devices to washing machines and car. They are programmable, cheap, small, can handle abuse, require almost zero power, and there are so many varieties to suit every need. This is what makes them so useful for robotics - they are like tiny affordable computers that can be put right onto robot.

Servo motors are extremely useful in robotics. The motors are small, have built in control circuitry, and are extremely powerful for their size. A standard servo such as the Cytron C40S has 7.00 kg/cm of torque in the speed of 0.16 every 60 degrees, which is pretty strong for its size. It also draws power proportional to the mechanical load. A lightly loaded servo, therefore, doesn't consume much energy. Their precision positioning makes them ideal for robot arms and legs rack and pinion steering, and sensor scanners to name a few. Since servos are fully self contained, the velocity and angle control loops are very easy to implement.

This report briefly explains about designing a pick and place robot which interfacing with personal computer (PC) that can pick certain size and form of objects. A gripper was designed to grip the chosen object. Servo motors were used as the actuators for the robot mainly because of their size, easy to control and ease to be implemented onto robot chassis. PIC microcontroller will control the servo motors by generating square wave pulse width (PWM) to the servos. The pulse will depend on the program that burned into the microcontroller.

1.1 Project Objectives

The objectives of this project are as follows:-

i. To design and build a prototype of pick and place robot that can pick up an object and move it from one point to another.
ii. To make program for microcontroller using certain software.
iii. To use microcontroller to control the movement of servo motors.
iv. To do analysis about the pick and place robot's performance, reliability and others.
v. To provide industrial application to control hardware and software using Visual Basic program.

1.2 Scope of Work

For this project, the scopes of work are to study and investigate the process of:

1) Designing a prototype of picks and place robot.
2) Building controller circuit for the pick and place robot.
3) Using 'c' language for command
4) Controlling the movement of the robot.
5) Using Visual Basic as computer interface
6) Constructing a robot structure which has permanent base and is not mobile.

1.3 Problem Statement

In industrial environment, robots are the machine that can assist human in their job. Robot also can set to work continuously in a long duration. In the factories robot arm can used to pick and place work piece in the range of their workplace. User use robot arm in the factory to pick some work piece from one line system to another line system to continue the process of the product. If the object is heavy or in big quantity, it gives problems to the workers to move the work piece. By using human energy also, the company will spend high cost to pay the worker's salary. The alternative to solve the example problem is by using the robot arm system. User just make a program and interface the program using the control circuit interface card or microcontroller and connect it from computer to the robot with parallel or serial connection.

1.4 Report Structure

Chapter 1 gives brief overall explanation regarding the implementation and analysis involved in developing the prototype of pick and place robot structure and the PC interfacing.

The next chapter discussed about the literature review. This chapter divided into five parts that are the introduction, fact and finding, project methodology, project requirements and project schedule and milestones. This chapter includes a related case with the e-learning applied in this project.

Chapter 3 discussed about theoretical background. This chapter introduced the theory involved for the implementation of robot arm.

Chapter 4 described the results of overall robot implementation including all parts; hardware and software. The results contained all analysis regarding the subject.

The next activity is analysis according to result. This will be discussed and analysis the errors in the project.

The last chapter is conclusion that contains explanation and description of weaknesses and strengths, propositions for improvement and project contribution. This chapter also includes the recommendation to future upgrade for improvement

CHAPTER 2

LITERATURE REVIEW

2.1 Previous Research

2.1.1 Graphical User Interface Development for PC-Based Control of SCARA Robotic Arm

This project has been done by Darryl Wai from Canterbury University, Christchurch, New Zealand for Final Year Project. The task undertaken in this work is a development of computer interface of a Selective Compliance Robotic Arm (SCARA). The hardware used was manufactured by Feedback Instruments and the interface had been developed for the robot.

The student altered a present robot which used to interface with BASICA program to interface with Visual Basic 6.0. Microsoft BASICA is a simple disk-based BASIC written by Microsoft for PC-DOS. BASICA requires the use of master, as the program was distributed in source code form. Also, the interface of this program was developed around a text driven menu interface. Due to these characteristics, this type of interface is considered to be conventional by current programming standards.

Microsoft programming package, Visual Basic 6.0 was employed to develop a new interface. However, analysis from this project, the student focused only on the interfacing structure other areas such as controlling the servo. The purposed of the actuators does not addressed in the report.

Figure 2.1.1(a) shows the interfacing surface created by the student using the Visual Basic 6.0. The structure is more to position each axes of the robot including the gripper. The positions have been declared by the student. For SCARA robot axis, the position of the robot inputs were in millimeter (mm) meanwhile the gripper input was in angle.

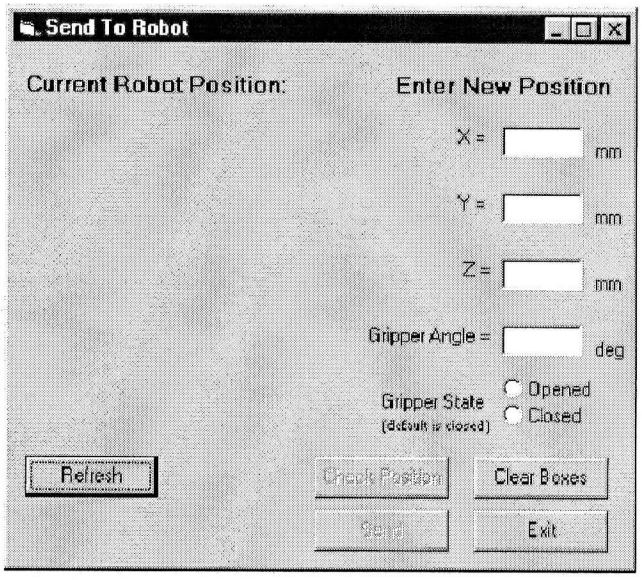

Figure 2.1.1(a): interfacing structure

2.1.2 Visual Programming for Robot Control

This Project has been done by Philip T. Cox and Trevor J. Smedley They propose a robot programming system consisting of two parts; a definition module with which to describe the structure, function and visual representation of a specific robot (LEGO car), and a programming module that uses this description to enable programming by direct manipulation.

Accordingly, this project has proposed a robot programming system consisting of two modules; a Hardware Definition Module (HDM) and a software Definition Module (SDM). HDM consists of a set of editors for specifying the structure and function of a robot and its environment, while SDM uses the model built by HDM to enable the programmer to build control programs by directly manipulating a visual. The disadvantage for this project is they use no hardware and only imaginary and animation. Whereas, for this project it will discover three importants parts, animation, hardware and software and this is better than Philip T.Cox's and Trevor J. Smedley's project.

2.1.3 Stair Climbing Robot (Smart Little Climber)

The third source is a thesis done by Roshiela binti Darus from (KUiTTHO) Kolej Universiti Teknologi Tun Hussein Onn. She has created a wheeled robot that can climb stairs using a PIC16F877 microcontroller. In this project, she used MPLAB IDE to program the robot. The robot used 4 DC motor, 2 servo motor, 2 limit switches, inductive proximity sensor and IC L293D circuit driver.

The student referred to the project because of it has some similarities. The main idea is to control the robot using a microcontroller which is also acts as the brain and the control system to the robot. The most important is the robot must be able to move by itself and performing certain tasks without any human assistance.

To build the PC-Based 3 Axes Robot Arm Control System, the student use PIC 16F 873 as the microcontroller. So to learn more about the PIC, the student referred to the third reference. In this project, PIC 16F877 has been used to control the robot. Even though it used different type of microcontroller as comparing to this project, the student still can refer to the circuit especially on how to do the connection and what components that should be used in this project.

2.1.4 PC-based 4 axes robot arm system.

This project has been done by Muhammad Faizal bin Zainal Abidin from Universit Teknikal Malaysia Melaka (UTeM). The student proposed an arm robot with 4 degree of freedom (DOF), computer interface by using Visual Basic 6.0. The microcontroller is used to execute the program and the motion of the robot is under supervision of computer program.

This project alike the previous project unless of microcontroller usage. This project show the inter relationship between the arm robot and personal computer. It is the good revolution of robotic system that can use PC-Based system to control the robot arm. The robot arm system can control by GUI (Graphical User Interface) to make the communication from the computer to robot arm easier. By using this PC-Based system, the robot arm system can move and the pulse of the servo motor can be set to any suitable degree to locate the arm robot to a desired position. Robot arm is a robot which able to do any job as human arms and make our lives easier, safe and more enjoyable.

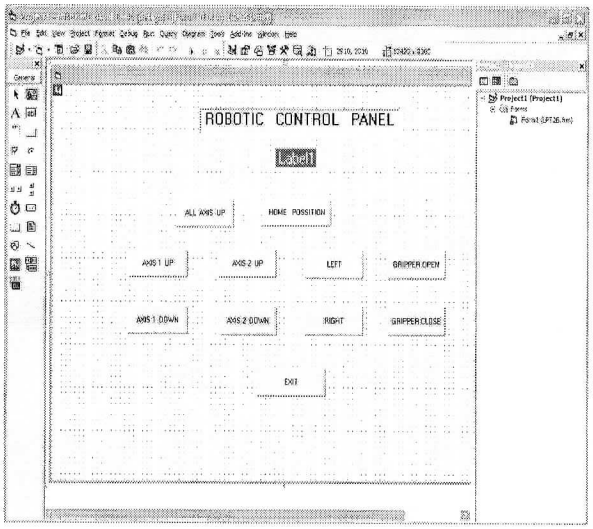

Figure 2.1.4(a): interface

2.1.5 Development of Servo Motor Pick and Place Robot.

This project has been done by Mohd Firdaus bin Rosli from Universit Teknikal Malaysia Melaka (UTeM). The student proposed an arm robot with two degree of freedom (DOF) as a tool for pick and place. As the actuators, he used 3 servo motors including for gripper. This robot controlled by human directly by using console (not interface with computer). Figure 2.1.5 (a) shows the result construction of the robot.

This project has some similarities with current implementing project. The robot was control by using microcontroller which acts as the brain of the robot. The selection of PIC 16F877 made this source as the main reference for me in order for code assembly.

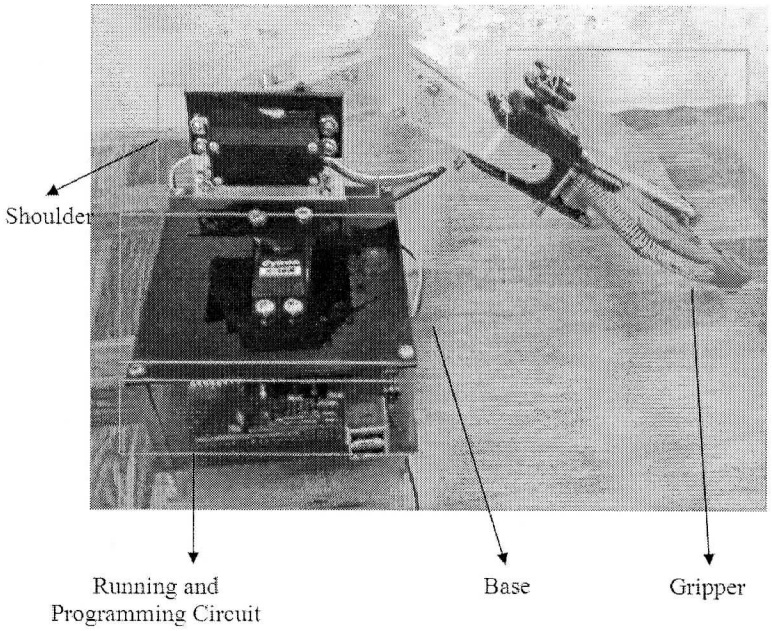

Figure 2.1.5 (a): robot hardware

2.2 Theoretical Background

2.2.1 Robot

The word robot comes from the Czech word *robota,* meaning slave-like labor. It was first used to describe fabricated workers in a fictional 1920s play by Czech author Karel Capek called *Rossum's Universal Robots.*

Most robots in the world are designed for heavy, repetitive manufacturing work and they handle tasks that are difficult, dangerous or boring to human beings. The word 'robotics' was first used in Runaround, a short story published in 1942, by Isaac Asimov (born Jan. 2, 1920, died Apr. 6, 1992). Asimov also proposed his four Laws of Robotics.

Law	Description
Law Zero	A robot may not injure humanity, or, through inaction, allow humanity to come to harm
Law One	A robot may not injure a human being, or, through inaction, allow a human being to come to harm, unless this would violate a higher order law.
Law Two	A robot must obey orders given it by human beings, except where such orders would conflict with a higher order law.
Law Three	A robot must protect its own existence as long as such protection does not conflict with a higher order law.

Table 2.2.1(a)

Robots are mechanical devices that can move by themselves, whose motion must be modeled, planned, sensed, actuated and controlled, and whose motion behavior can be influenced by programming. Robots are called "intelligent" if they succeed in moving in safe interaction with an unstructured environment, while itself achieving their specified tasks.