



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ROBOTIC ARM AND CONVEYOR CONTROLLER

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Electronic Engineering Technology (Industrial Electronics) with Hons.

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electronic Engineering Technology (Industrial Electronics) with Hons. The member of the supervisory is as follow:

.....

(Project Supervisor)

ABSTRAK

Projek ini adalah mereka bentuk lengan robot dan pengawal penghantar menggunakan MATLAB. Pengawal ini direka untuk mengawal lengan robot dan penghantar pergerakan sama ada ke kiri atau kanan atau bergerak atau berhenti dan ia juga boleh digunakan untuk mengawal proses mengangkat objek menggunakan lengan robot dengan bantuan perisian MATLAB. Projek ini juga menggunakan litar mikropengawal PIC 16F877A sebagai litar asas. Enam motor servo akan digunakan untuk membuat pergerakan dan mengangkat objek atau sebagai sendi robot. Dalam projek ini, mikropengawal PIC akan diprogramkan untuk mengawal motor servo. Projek ini menggunakan MATLAB sebagai pengawal dengan menggunakan antara muka pengguna grafik (GUI) untuk mengawal pergerakan robot ini. Perisian mikropengawal, Proteus Professional akan digunakan untuk menjalankan simulasi supaya ia tidak sentiasa terhad kepada simulasi dengan litar. Projek ini juga boleh digunakan dalam industri elektronik dan industri pembuatan.

ABSTRACT

This project is about designing a robot arm and conveyor controller using MATLAB. The controller is designed to be control the robotic arm and conveyor movement either to the left or right or run or stop and it also can be used to control the process of lifting object using a robot arm using MATLAB. This project also uses a PIC 16F877A microcontroller as the basic circuit. Six servo motors were used as an application extension to make movements and lifting an object or as robot joint. In this project, the PIC microcontroller will be programmed to control the servo motor. This project uses MATLAB as a controller using its graphical user interface (GUI) to control the movement of this robot. The microcontroller software, Proteus Professional will be used to run the simulation so that it's not always limited to the simulation by the circuit. The project is also can be used in the electronics industry and the manufacturing industry.

DEDICATION

This project and research work is dedicated to my beloved parents for their devoted caring throughout my life, my loving brother and sisters also my friends for their encouragement and love.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

DOF	-	Degree of Freedom
GUI	-	Graphical User Interface
IC	-	Integrated Circuit
I/O	-	Input / Output
PWM	-	Pulse Width Modulation
PIC	-	Programmable Integrated Circuit
PBP	-	PIC BASIC PRO
PROM	-	Programmable Read-Only Memory
RAM	-	Random Access Memory
ROM	-	Read-Only Memory
SCI	-	Serial Connection Interface
USART	-	Universal Synchronous Asynchronous Receiver Transmitter
USB	-	Universal Serial Bus

CHAPTER 1

INTRODUCTION

1.1 Robot

Robot is widely used in the industries. This is happen because the cost to operate a robot to do a certain work is much more less than the cost to pay human labour for the same task. On top of that, the robot can do a quick work with high accuracy that is can't be accomplished when using human labour once it is programmed. As we all know, the human labour is more versatile compared to robot because human aren't programmed to do one task only. They can switch their task easily with an order from their supervisor. Robot on the other hand is more specific to one task that is programmed to it. That is why robot has a very high accuracy to do same thing for long period of time. To change the robot job task, first it needs to be reprogrammed that is surely consume time. (Richard D. Klafter, Thomas A. Chmielewski, Michael Negin, 1989, 41).

Today's robot is like a catalyst to an industrial world. It will evolve. By looking at today's technology is can't be denied that today robot can evolve. The robot will become more human as time passes by. It may become more versatile and can switch job easily like human labor nowadays. Maybe it our time, personal computer is quite a technology that everyone has to have. In the future it is not possible that personal robot may be the technology that everyone has to have. To help them do chores and do shopping for them. (Richard D. Klafter, Thomas A. Chmielewski, Michael Negin, 1989, 41).

1.2 Robot Arm

The simplest robotic arm is the Cartesian robot or pick and place type. In this case the parts are moved from one location to a conveyor without caring how the part is going to be handled. However, these days robot is much more advance. It can be design and program to handle such fragile and sensitive object without any damage. It can be used to assemble little part in the electronic board or fit them into clamps and fixture. This is possible because of the high accuracy of the robotic arm.

1.3 Introduction of project

This final project is about designing a robotic arm and conveyor controller using MATLAB. The robot will move, grab an object and place it on the conveyor. The project focuses on MATLAB software that will be used to control the robotic arm and the conveyor. To control the movement of the robotic arm, 3 servo motor will be used as a joint. For this particular case, the PIC microcontroller that is used to control the servo motor is programmed. This project used MATLAB software as a base to control the robotic arm and the conveyor.

1.4 Objective Project

PSM is a subject that requires student to develop a project based on what they learn for about 3 years at UTeM. The main objective of this project is to develop a controller that can control robotic arm and a conveyor using MATLAB software. The system will be developed using MATLAB software and PIC microcontroller based circuit.

1.5 Problem Statement

Nowadays robotic controller is lack of function. Sometimes the robot needed to do extra function other than pick and place item. Robotic Arm also can't recognize item that they grip. With the help of MATLAB, this is possible. The MATLAB software is very powerful software that can do many functions such as image processing. The common robotic controller is using console. The MATLAB GUI offers a better control because the GUI can be design to make the interface user friendly. It also can be very flexible because it can be used in any device that can support MATLAB GUI.

1.6 Scope of Project

The scope of this project includes develop a controller circuit using PIC16F877A to control the robotic arm and conveyor. Servo motor is used for robotic arm's joint is controlled using MATLAB. MATLAB software is used to control the PIC microcontroller circuit that is connected to robotic arm using RS232 Serial Cable. This project was started with designing a PIC Microcontroller Circuit to control the servo motor and conveyor. The circuit will be designed and put to test to see whether the circuit is running smoothly.

The next stage is deciding what type of robotic arm that will be used for this system. The robotic arm will have 6 joint to be able to move and pick item and place it on the conveyor.

The last stage is implementing the design that is including connecting the PIC microcontroller circuit to the MATLAB GUI using RS232 Serial Cable. The implementation is basically connecting and program both PIC and MATLAB so that it can work together. This project is basically creating new possibilities in the basic robotic arm scope of work.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The research conducted on previous theses, journals, articles, research papers and other sources will be presented in this chapter. The main idea of literature review is to obtain enough relevant information and knowledge on similar projects done by others. A few projects done previously by students and researchers will be discussed here.

2.2 Previous Project

For the past years, many have attempted to design, create and construct robotic arms using different approaches. Many have tried to create a robotic arm controller using other software and it's GUI. Many types of robotic arm design can be seen. The projects have its own pros and cons. Stated below is some of the projects which are closely related to the concept of a robotic arm and its controller.

2.2.1 Robotic Arm

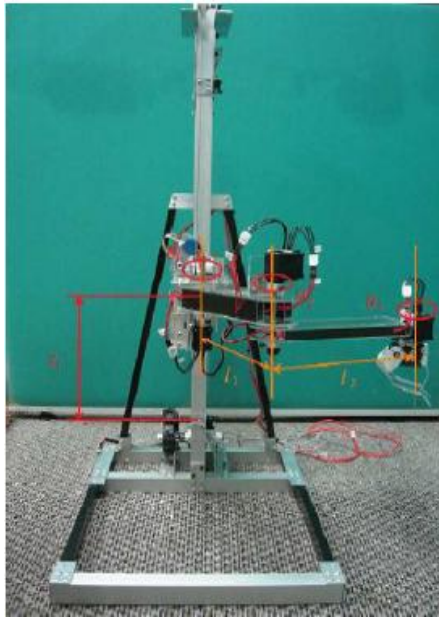


Figure 2.1: Robotic arm

This project was created in 2010 by an undergraduate student from UTM. The objective of the project is to build four degrees of freedom (4DOF) robot arm with Self Compliant Automatic Robot Assembly (SCARA) geometry to perform the motion of pick-and-place for the purposes of education and research. A graphical User Interface (GUI) is also included in this project in order to provide the interaction between the robotic arm and the user (Yong Shen Goh, 2010, 1-2).

This robot arm has a horizontal reach of 37cm and vertical reach of 40cm with horizontal displacement of 0° to 180° . The joint sensor is provided for each robotic arm joint in order to monitor the position and displacement of each joint and gain angular displacement feedback from each joint. To allow the user to control the movement of the robotic arm for picking and placing motion of the robot is the main objective of this GUI in this project. As a simple explanation, the GUI allow the user to put the object in the desired location within its range and the robot arm will then move to the corresponding location after the execution instruction has been send. This robot arm can also perform the motion of picking and placing through the GUI manually. (Yong Shen Goh, 2010, 1-2).

Although this project look smart, but there are some improvements that can be done to the project in order to make it looked smarter. Firstly, it is suggested that the mechanical hardware need to provide a precise dimension of the mechanical hardware. This mechanical part is lack of accuracy because of the dimension and the structure is a handmade mechanical hardware. The use of handmade may reduce the cost, but this result in the lack of the accuracy. Second part to improve is the actuator of the robot. DC motor can be used as an actuator for this robot instead of servomotor since there are many academic researches on it. So, DC motor can replace the servomotors but for my project, the DC motor will be used to control the conveyor instead of the robotic arm.

Last but not least are the sensors. The accelerometer can be placed on the robot to provide additional information for each joint at the robotic arm. The camera or ultrasonic sensor can be placed to be an extra function to the robot as to detect and identified object. This will be the future development of my project. To be integrated with other function other than pick and place item that is robotic arm basic function.

2.2.2 Robotic Arm with Image Processing

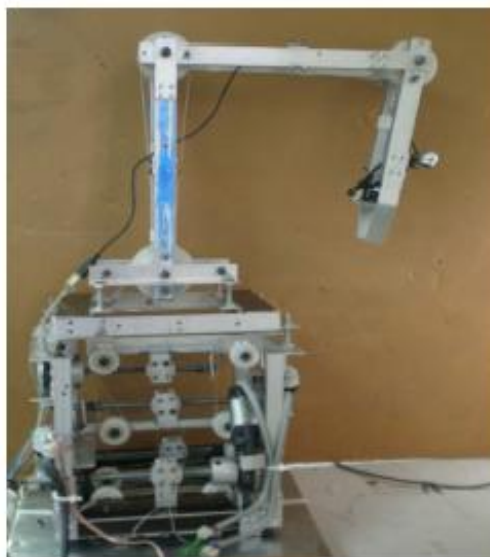


Figure 2.2: Robotic Arm with image Processing

Figure 2.2 shows that the Self Compliant Automatic Robot Assembly (SCARA) robotic arm that was conducted in 2009. The objective for this project is to build six degree of freedom (6DOF) of robot arm that can sufficiently emulate human arm movement. To aid the robotic arm when doing work to help humans do chores, an image processing function is added. Learn the object criteria is the main purpose of this robotic arm. The robotic arm will be using image processing function system and the data will be stored for future reference. (Men Wee Sam, 2009, 1-2).

The image processing system that gain image from the camera is used to extract data from the image of an object and its feature. This helps the robot to recognize the object. The robotic arm will also learn in real time, where it will recognize more and more objects and do classification based on object features. This aspect of function will be using artificial intelligence specifically neural network. The GUI that include several control panel is used to monitor the robotic arm status. The control panel will give and receive information from robotic arm and from there, the information will be analyze for improvement. (Men Wee Sam, 2009, 2-4).

However, there is some disadvantage on the hardware design. The use of string push pull mechanism proves to be clumsy and time consuming in construction. By using gear drive system or using commercially available advanced motor (digital servo, stepper) will be much of the improvement. But, this will potentially increases the cost of the project dramatically. Then, for further improvement is about the PCB board for the embedded microcontroller. The better PCB will actually improve the circuit stability and look more professional if the circuit is soldered using machine. Lastly, for the image processing technique, it must be more advanced. Current blob tracking implementation is still classified as simple task. The host application can be improved to add more functionality such as object recognition. (Men Wee Sam, 2009, 3-5).

The main function that is needed to make the future development of my project is the image processing function. This function will be using neural network as the base. It's like the robotic arm have its own brain to conduct certain task where

human is no longer needed like sort the group of item into different conveyor according to its type.

2.3 Robotic Arm

The robotic arm design is quite similar to this project reference. This robotic arm is quite simple. It is basically a robot to lift objects. More specifically, this is a robot arm with base, shoulder, elbow and wrist joints and end effector. This is where the servo motor will be placed.



Figure 2.3: Robotic arm

2.3.1 Robot Arm Kinematics

“Robot arm kinematics” deals with analytical study of the geometry of motion of a robot arm with respect to a fixed reference coordinate system without regard to the forces/moments that cause the motion. Thus kinematics deals with the analytical description of the spatial displacement of the robot as a function of time, in particular the relations between the joint-variable space and the position and orientation of the end-effectors that is also called gripper of a robot arm (R.K. Rajput. 2008, 32-40).