



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**DEVELOPMENT OF AUTOMATED ASSEMBLY TRAINER
WITH HMI/SCADA SYSTEM**

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

by

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DECLARATION

I hereby, declared this report entitled “Development of Automated Assembly System with HMI/SCADA System” is the results of my own research except as cited in references.


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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 the Bachelor Degree of Engineering Technology (Industrial Automation & Robotics) (Hons.). The member of the supervisory is as follow:



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ABSTRACT

Assembly robots are controlled by computers, automated, programmable machines used in manufacturing and other industrial settings. These types of robots carry out desired tasks based on movement routes programmed in the computer. Usually, these robots appeared as a robotic arm mechanism or a set of arms mechanism that perform functions such as welding, cutting, picking, or materials placement along an assembly line. The manufacturing environments involve repetitive tasks, hazardous materials, or unsafe conditions, which are the ideal environments for the assembly robots. In addition, to create the mechanism for a robot, the primary criteria that must be followed for the assembly or other manufacturing robots is using three or more axes on which the robot articulates. Using this three axes, the industrial robots have the ability to manipulate any number of materials and perform any number of movements required to assemble products. These criteria also allow the assembly robots to articulate, not only along a straight line, but through space anywhere within the reach of the end-effector of the robotic arm. The main concept is about designing and developing the robotic arm mechanism with two degrees of freedom for picking and assembling process of small components using pneumatic system that act as an automated assembly trainer with the conveyor process. This project is a basic development and modification of that type of mechanism where the development project will involve a Programmable Logic Control (PLC), a Human Machine Interface (HMI), hardware and software integration as well as system troubleshooting. The robot arm mechanism will rotate 180 degrees (clockwise) and -180 degrees (counter clockwise) to pick the component on the conveyor then, assemble the component to its base on the other conveyor before returning to its initial position.

DEDICATIONS

Special dedicated to my beloved parent Mamat Bin Talib and Norzalena Binti Mohamad, also to my sibling who have encourage, guided and supported me throughout my study.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

On-going research on robotics happened in order to improve productivity in the manufacturing automation. With the recent advances in the areas of vision sensors, robots have become a major element of the industrial world. They have been beneficial in replacing humans not only in the production lines for simple tasks but the robots are more efficient, can handle heavy and light materials, works in unsafe conditions and perform a repetitive task. In the last several years, more efforts have been put on the integration of multiple sensors for assembling process in the robotic systems. The goal is to make the robot more adaptive, flexible and to enable them for the assembling tasks. Thus, the robot's ability and productivity can be improved to eliminate human errors and make the work more precise. The main objective of this project is to develop an arm robot mechanism which could be used to assemble small components, to replace humans in the production line and do repetitive tasks. The mechanism is designed with a base rotation and wrist motion with a functional gripper to pick and assemble small components.

1.1 Background

A robot is a machine designed to execute one or more tasks repeatedly at a constant speed, with precision and without errors. There are many different types of robots all over the world that are capable of performing a wide variety of tasks, such

as material handling, spot welding, arc welding assembly, dispensing, material removal, coating and inspection. Because of that, they are widely used in the general industries including foundry, metal fabrication, plastics, consumer electronics, food and beverage, machine tools, solar, pharmaceuticals and chemicals. For example, a robot that functions to pick a component on a moving conveyor and then place the component to its base also required a high amount of repetitive motion and precision.

1.2 Problem Statement

The problem statements for this project including an automated system for small parts assembly applications requiring a high number of repetition motion that is beyond human ability. Then, the efficiency is insufficient due to human errors and the student was not well exposed to the movement and mechanism of an actual robot arm.

1.3 Problem Objectives

The aim of this project is to achieve several goals throughout the completion of the work. It is desired to reach the goals within the given time. The objectives of the project include:

- a) To design and construct a PLC based on how a robot arm mechanism function and operate.
- b) To develop a control and monitoring system using a Human Machine Interface (HMI).
- c) To develop a system prototype as an educational training tool for academic institutions.

1.4 Project Scope

To make a clearer visualization and fulfil the requirement of this project objectives, the scope of the project has been performed. In general, the goal of this project is to design a mechanism to assemble small components that use a Human Machine Interface (HMI) and Programmable Logic Controller (PLC) as the main controller to drive the motor according to the inputs and outputs and to control the full operation of the mechanism. In order to detect a moving object on the conveyor, an adjustable infrared sensor will be used. The end effector is to perform the pick and assemble process and the controlled 90-degrees rotation clockwise and anti-clockwise will use a power window (high torque dc gear motor). Then, the conveyor will be operated by a dc gear motor and the joint for the robot arm will use a double acting pneumatic cylinder which is controlled by a 5/2-way solenoid valve.

1.5 Summary

Chapter one describes the introduction of the project, background, problem statement, project objectives, purposes and limitation of this project. In addition, it shows details of the problems or goals to be achieved and how the project will be conducted. Chapter two will provide a description on the literature review of the robot design, the mechanism needed to perform the tasks and the electrical components within the robot. Then, chapter three will illustrate the methods to be followed or the work associated with this project in details.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter will discuss mainly on references and project idea gathered from various sources, such as journals, articles, case reports, websites, books and previous research projects. Each reviewed sources has been selected by identifying ideas that are relevant to the research project.

The main focus in this chapter is on how the mechanism for the pick and assembly operated with a different kind of methods applied, the characteristic of the pick and assembly mechanism and the suitable controller and sensor used for the robot to perform different kind of tasks given.

2.1 Journals

Among the journals I reviewed, these are several journals that are most likely related to my project.

2.1.1 Simulation of Pick and Place Robotics System Using Solidwork Softmotion by Rosidah Sam, Kamarul Arrifin and Norlida Buniyamin

This paper presents the design of a pick and place robotics system mechanism using the Solidwork Softmotion software which is used to design a Cartesian robot and an articulated industrial robotic arm with different types of end effector for different types of task. The design of the robotic arm mechanism using the Solidwork 3D CAD software can shorten the robot development time duration, improve the speed and upgrade the quality of the robot design. The Solidwork 3D CAD software was divided to four sections which is the manual drawing module, part module, assembly module and drawing module. Through all these modules, a user can design their own articulated robot arm part and assembly, and then presented to demonstrate the pick and place robotics system mechanism.

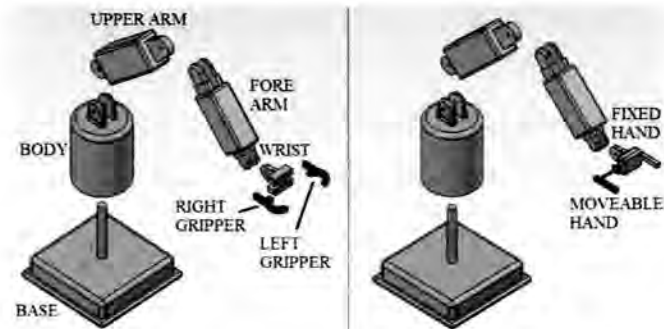


Figure 2.1: Component of Robot 1 and 2

Figure 2.1 shows the component design for Robot 1 and 2 which consists of the base, body, upper arm, fore arm, wrist and end effector. The end effector for Robot 1 is a gripper while Robot 2 used a moveable hand as an end effector.

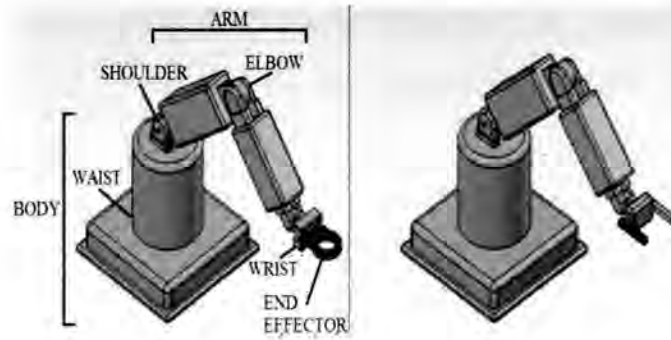


Figure 2.2: Assembly of Robot 1 and 2

Figure 2.2 shows the complete assembled component design for Robot 1 and Robot 2 using mate function in the Solidwork software with different types of end effector.

2.1.2 Automatic Planning of Pick and Place Operation in Presence of Uncertainties by I. Mason, R. Alami and P. Violero

This paper describes an implementation system that plans automatically “Pick and Place” tasks. This system comes from the consideration of the different steps needed to complete the “Pick and Place” tasks. The researchers described modules which included in their system and showed how the controller involves to manage the interaction and the mechanism of the system. The system is able to automatically produce the sequence for the end effector actions that suitable to perform a Pick and Place task with the initial and final position of the robot also for the object. The characteristic of the local motion become the limitation of the system. The major advantage of the system is the flexibility that provided for different types programming control strategies. More work seeks to improve the system in order to achieve the target of this project includes the integration of the system, development of local motion planner and the investigation on various control strategies.

2.1.3 Multisensor Controlled of Robotic Tracking and Automatic Pick and Place by Ilhan Konukseven, Bilgin Kaftanoglu and Tuna Balkan

This paper presents the robotic mechanism for recognizing and tracking an object which is selected from various unknown objects and randomly placed on a moving conveyor belt using sensors in the feedback loop. The robot tracks down the objects and placed them to the desired position. The used of vision, infrared and encoder sensors in the feedback loop is for identifying and locating the object coordinate and dynamically use the feedback information extracted from a vision sensor (visual feedback) to control the motion of a robot manipulator for object tracking, picking and placing.

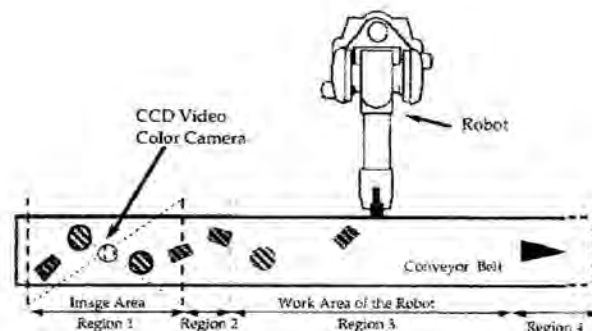


Figure 2.3: Image area and work area of the robot

Figure 2.3 explained the analysis of an end effector motion based on sensor outputs to make a robotic manipulator grasp an object on a moving conveyor belt where each frame of the sequence is segmented. The objects are placed randomly on the conveyor belt and the frame-object list is used to store the parameters of the object. The motion of the end-effector is controlled by an end-effector based on infrared proximity sensors and conveyor position encoder in order to predict the motion of moving target and determine desired trajectory point.

2.1.4 Development of Vision-Based Sensor of Smart Gripper for Industrial Applications by Hasimah Ali, Tei Chen Seng, Low Hoi, Mohamed Elshaikh

This paper aims to develop a vision based sensor of a smart gripper to automatically detect and recognize a various type of weight and shape of the object and then send the information to the robotic arm to perform the tasks given. This paper also discussed the design of an end effector which is a two finger gripper where one finger can move and the other one is fixed. The force sensor is used to control the force needed to pick and place the object with different weights without damaging it.

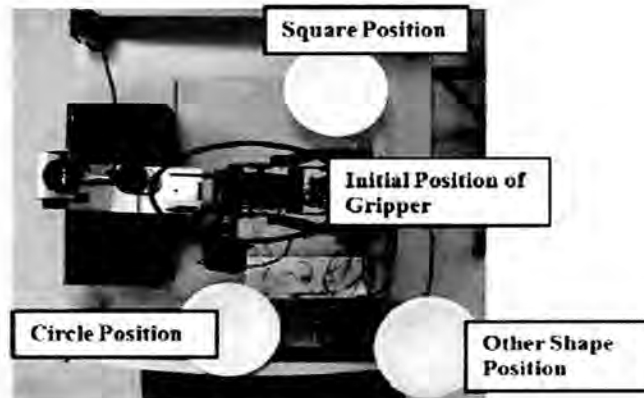


Figure 2.4: Positions of designated location of a classified object

Figure 2.4 shows the position of a robot arm mechanism designed to locate and detect various types of objects. The suitable position set up is important to classify the object based on the shape and send the information data for the gripping process.

2.1.5 Multiple Input/Outputs Programmable Logic Controller (PLC) Module for Educational Applications by Ibrahim Burhan, Ahmad Aftas Azman, Saharuddin Talib

This paper presents the newly designed, developed and fabrication of multiple I/O PLC modules that can assist the participants to accomplish the educational objective especially in enhancing the theoretical knowledge and hands-on skill aspect. The fabrication of PLC modules has been improved with the additional output components, cost effective, compact, and also a user friendly software to all the I/O devices which is embedded in one compact module. The available PLC Kit comes with the theoretical knowledge, cabling connection between input components and output components, PLC modules, ladder diagram design, programming execution, and problem solving.

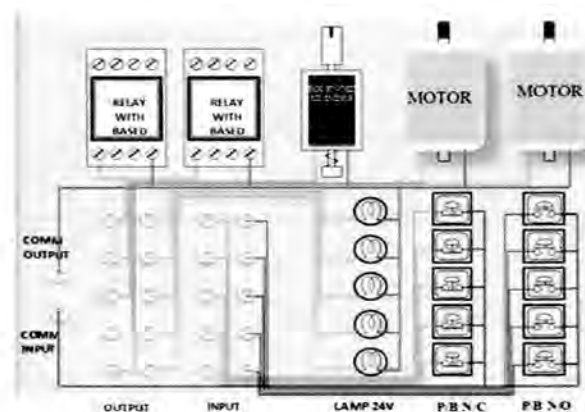


Figure 2.5: A schematic diagram for multiple I/O PLC modules

A schematic diagram as shown in Figure 2.5 represents the complete multiple I/O PLC modules wiring connection. The PLC module port, common input and output devices were connected to the common connection point of a +24VDC supply and for a complete circuit, the PLC module port also was connected with a -24VDC supply.

2.1.6 Development of Virtual Machine for Programmable Logic Controller (PLC) by Using STEPS™ Programming Method by Norashikin M. Thamrin, Mohd. Mukhlis Ismail

This paper presents the development of a PLC using STEPS programming method as a multiple tool suit to assist students learning in the class. It consists of a ladder diagram editor, a simulator and compiler. It also provides an interactive learning in class and also hand-on activities for laboratories. This software package is developed using Visual Basic programming language to create a virtual microcontroller environment in simulation process. This STEPS programming method means the way of simulation is carried out because all the instruction is guide step by step to develop the virtual microcontroller environment with the real microcontroller when performing the simulation.

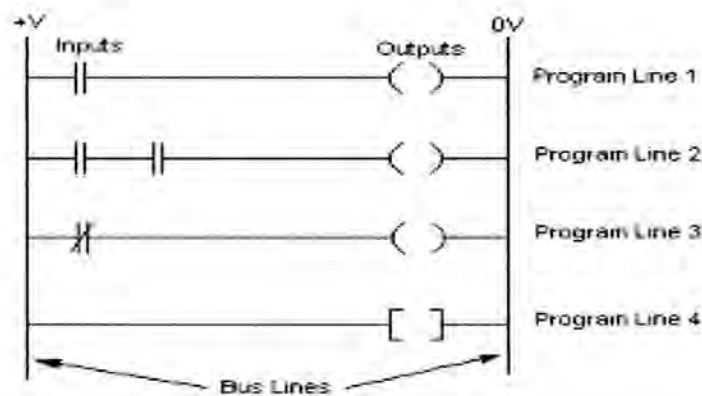


Figure 2.6: Ladder diagram

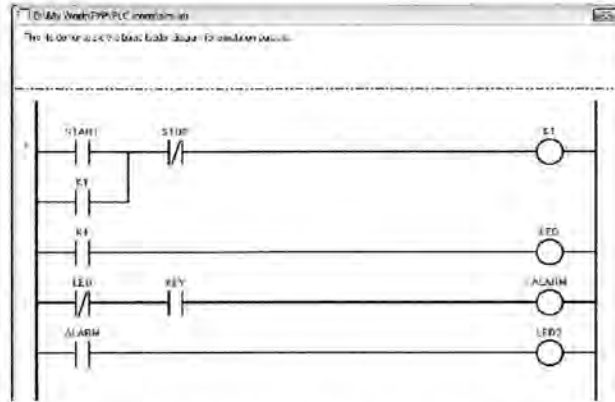


Figure 2.7: Ladder Diagram Editor

Figure 2.6 shows the ladder diagram constructed with a language programming designed by selecting elements such as contact, coil, timer or counter from the toolbar. The selected element then are placed on the rung by clicking the location where the element decided to be placed. Figure 2.7 presents the Ladder Diagram Editor where all the ladder diagram are designed and programmed.

2.1.7 Modelling and Control of a Joint Driven by Pneumatic Actuator
Nobutaka Tsujiuchi, Takayuki Koizumi, Hiroto Kan, Hiroyuki Takeda, Tatsuwo Kudawara, and Masanori Hirano

This research is focus on robots that has been used widely in the industries and have the ability to perform flexible tasks as people with features safety precaution in order not to injured people. Due to that problem, the researchers gain the idea to resolve the problem with the development of a robot hand that can be used as an artificial muscle-type pneumatic actuators which functioned like a human hand. Besides, a big compressor problem for the pneumatic actuator is replaced with a low-pressure, low volume pneumatic actuator to drive and enable the robot hand to perform flexibly and safely and to work with people. So, five-fingered robot hand with one degree of freedom using a pneumatic actuator with 1- link arm was constructed using PID control system as the main controller.

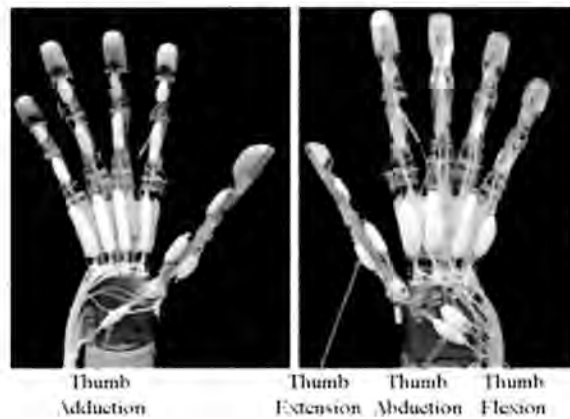


Figure 2.8: A Five-Fingered Robot Hand

Figure 2.8 shows the actuator attached on both side of the 1-link arm which is arranged one by one in a line.

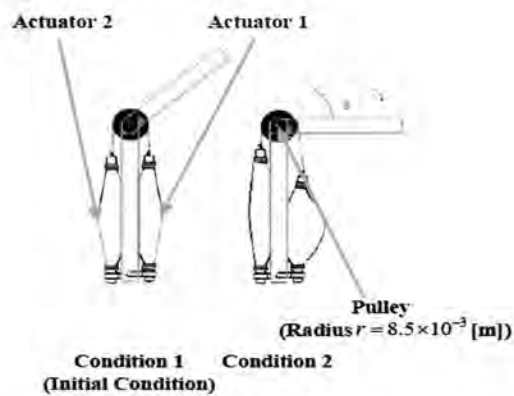


Figure 2.9: A Schematic of 1-Link Arm

Figure 2.9 shows the schematic of 1-link arm that has two actuators attached on both side of the link. The initial pressure for both actuators is the same value then when actuator 1 act as the flexion and actuator 2 act as the extension the pulley will move depending on the pressure supplied.