DESIGN & IMPLEMENTATION OF PICK & PLACE AND STORAGE SYSTEMS APPLICATION USING FANUC ROBOT & ELECTRO-PNEUMATIC SYSTEMS

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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, Instrumentation & Automation)

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Thesis submitted in accordance with the partial requirements of the
Universiti Teknikal Malaysia Melaka for the
Bachelor of Electrical Engineering
(Control, Instrumentation & Automation)

Faculty of Electrical Engineering
Universiti Teknikal Malaysia Melaka

MAY 2007

DECLARATION

I hereby, declare this thesis entitled "Design & Implementation of Pick & Place and Storage System Application Using Fanuc Robot & Electro-Pneumatic Systems " is the result of my own research and design except as cited in the references.

Signature : _____

Name : MOHD NIZAM BIN ABU SEMAN

Date : MAY 2007

DEDICATION

For my beloved mother, Wan Zainab Bte Che Mat and father,
Abu Seman Bin Mohamad Saad.

ACKNOWLEDGEMENTS

Alhamdullilah, firstly I am grateful to almighty Allah S.W.T because at last I have finished my Bachelor Degree Project 2 (PSM 2) and my report without any problem. It is difficult to finish this Bachelor Degree Project 2 (PSM 2) report without the help.

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Thank you.

ABSTRACT

This project is about the design and implementation of a pick & place application and storage system. It comprises of integration between industrial robotic, programmable logic controller (PLC) and electro-pneumatics system. This combination will produce a perfect automation system. The functions of the system are for loading, pick & place, sorting and storing metal and non-metal work-piece. It is divided into several stations, which are the FANUC LR Mate 200iB Robot used to sort the work-piece and the loading process, which is applied using electro-pneumatics system. These stations are controlled using programmable logic controller (PLC) as a master controller for the system and R-J3iB controller for the FANUC robot as a slave.

ABSTRAK

Projek ini adalah mengenai merekabentuk dan pelaksanaan bagi aplikasi ambil & letak (*pick & place*) dan sistem penyimpanan (*storage system*). Ia terdiri daripada integrasi antara robot industri, pengawal logik aturcara (PLC) dan sistem elektro-pneumatik. Kombinasi ini akan menghasilkan satu sistem automasi yang sempurna dan lengkap. Fungsi sistem ini adalah untuk memuat *(loading)*, ambil & letak (*pick & place*) serta mengasing bahan kerja logam dan bukan logam. Ia adalah terbahagi kepada beberapa stesen, di mana robot FANUC LR Mate 200iB digunakan untuk mengasing bahan kerja dan proses memuat diaplikasikan menggunakan sistem elektro-pneumatik. Stesen-stesen ini adalah dikawal menggunakan pengawal logik aturcara (PLC) yang mana ia digunakan sebagai pengawal utama (*master*) untuk sistem ini dan pengawal R-J3iB bagi robot FANUC adalah hamba (*slave*).

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Projek ini adalah mengenai merekabentuk dan pelaksanaan bagi aplikasi ambil & letak (*pick & place*) dan sistem penyimpanan (*storage system*). Ia terdiri daripada integrasi antara robot industri, pengawal logik aturcara (PLC) dan sistem elektro-pneumatik. Kombinasi ini akan menghasilkan satu sistem automasi yang sempurna dan lengkap. Fungsi sistem ini adalah untuk memuat *(loading)*, ambil & letak (*pick & place*) serta mengasing bahan kerja logam dan bukan logam. Ia adalah terbahagi kepada beberapa stesen, di mana robot FANUC LR Mate 200iB digunakan untuk mengasing bahan kerja dan proses memuat diaplikasikan menggunakan sistem elektro-pneumatik. Stesen-stesen ini adalah dikawal menggunakan pengawal logik aturcara (PLC) yang mana ia digunakan sebagai pengawal utama (*master*) untuk sistem ini dan pengawal R-J3iB bagi robot FANUC adalah hamba (*slave*).

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LIST OF ABBREVIATIONS

PLC	-	Programmable Logic Controller
PC	-	Personal Computer
CPU	-	Central Processing Unit
RAM	-	Random Access Memory
ROM	-	Read Only Memory
DOL	-	Direct On Line
AC	-	Alternating Current
DC	-	Direct Current
I/O	-	Input/Output
IL	-	Instruction List
SFC	-	Sequential Function Chart
RCCB	-	Residual Current Circuit Breaker
MCB	-	Miniature Circuit Breaker
MIG	-	Metal Inert Gas
LED	-	Light-Emitting Diode
CAD	-	Computer Aided Design
LS	-	Limit Switch
FRL	-	Filter, Regulator & Lubricator
CIM	-	Computer Integrated Manufacturing
SCADA	-	Supervisory Control And Data Acquisition
CNC	-	Computer Numerical Control
G	-	Good
NG	-	Not Good

CHAPTER 1
INTRODUCTION

1.1 Introduction

Industrial automation is the use of robotic devices to complete manufacturing tasks. Currently, industrial automation is becoming increasingly important in the manufacturing process because computerized or robotic machines are capable of handling repetitive tasks quickly and efficiently. Machines used in industrial automation are also capable of completing any tasks that are not capable to workers. In this project, industrial robot is used to execute the material handling process. Therefore, it can become a prototype of integrated system, which comprises of industrial robot and programmable logic controller (PLC) in the manufacturing industry.

1.2 Project Overview

The project is to implement the hardware of pick & place application and storage system. The software application also is used in this project. The most important things in this project are the integration between FANUC LR Mate 200iB robot, programmable logic controller (PLC) and electro-pneumatics system. The NAiS FP1 PLC is used to control the whole sequences of the system. This project is divided into two sections, which are mechanical part and electrical part. The mechanical parts are consisting of mechanical drawing, measuring, welding and fabrication process. The electrical parts are consisting of electrical drawing, electrical wiring and programming.

1.3 Problem Statements

This system is designed as a training kit for the automation and mechatronic students. There are several reasons why this system is designed. The faculty's laboratory just has only a few training kit for the storage system, so this system can be used as a prototype of the storage system in industrial area. The FANUC Robot training kit at the laboratory is too simple. It has no integration with other external devices such as indicator, conveyor, sensors etc. That why the training kit is looked insipid. Therefore, this system is designed to be integrated with others system that will make the FANUC Robot training kit more sophisticated. In the industry especially in automotive industry, most of the system at the factory is using the integrated system between programmable logic controller (PLC) and industrial robotics. Thus, this system can be used as an introduction to students about the integrated system between PLC and industrial robot in the industry.

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1.4 Objectives of the Project

1. To make the system as a training kit machine
2. To implement the pick & place and the storage system
3. To implement the hardware installation, electrical wiring and mechanical mounting to control the sequences of the system
4. To be able to make programming for the PLC and Industrial Robot
5. To acquire experience in system design, electrical and mechanical drawing, wiring and troubleshooting

1.5 Project Scope

Generally, all projects have their own scope or limitation as a guideline. The project scope for implementation this project is:

i. Design and develop the complete automated system that is used to apply the pick & place and storage system in term of hardware and software development.

ii. The hardware development & implementation consists of the mechanical structure, FANUC LR Mate 200iB robot, electro-pneumatics system, PLC, sensor, etc. The PLC will be the main controller for the system.

iii. The programming or software development & implementation consists of FPWIN GR2 software for NAiS FP1 PLC and FANUC robot programming using teach pendant.

CHAPTER 2
LITERATURE REVIEW

This chapter is consisting of explained and review the past projects that have been done before. It is consist of the products in the market and training kit at the Robotic & Automation laboratory in Faculty of Electrical Engineering, UTeM. Beside that, this chapter is contained about the theory of components, equipments and programming languages that is used in the project.

2.1 First Review: FESTO Storing Station Training Kit

The Storing station training kit places work-pieces in and takes work-pieces out of storage. The station is equipped with three storage levels, with a level each for six red, six silver and six black work-pieces. The work-pieces are gripped using a pneumatic gripper. The linear movement is executed using a linear cylinder. The rotary movement is performed by an electrical servo drive with integrated controller. The stroke movement is executed using an electrical linear axis with separate controller. During placement into storage, a work-piece inserted in the Holder module is detected using the colour sensor. The work-piece is placed in the next free compartment in the corresponding storage level based on the colour. Upon removal from storage, the work-pieces are transported from the shelf compartments to the downstream station. The purposes of the training kit are to introduce the students about the sensor technology, mechanical system, pneumatics system, PLC, drive technology, etc. The sensor technology are consists of knowledge about application of colour sensor and limit switches. For the pneumatics system, it is consists of knowledge about pneumatic components, pneumatic grippers and pneumatic linear drives. Beside that, the students will be introduced about the configuration and parameterization of electrical drives,

application of drive controllers, adjustment of speed and acceleration profiles and the teaching of positions in the drive technology. The main controller for the training kit is a Siemens-S7 programmable logic controller (PLC) that only used 16 digital I/O, which are 8 for inputs and 8 for outputs. The operating pressure for the pneumatics system is 600 kPa (6 bar) and the supply voltage of the training kit is 24Vdc.

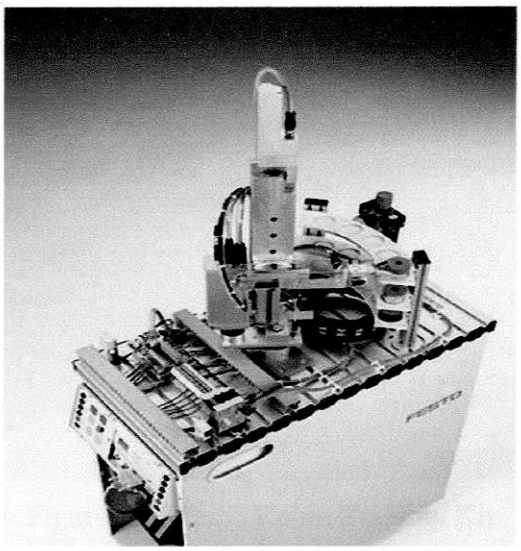

Figure 2.1: FESTO Storing Station Training Kit

2.2 Second Review: Rhino Robot Training Kit

The Rhino robot training kit is designed for the Faculty of Electrical Engineering, UTeM that is used for the robotic or automation subject. The purpose of the training kit is to introduce the students about the basic operation and system of industrial robot. It is consists of Rhino robot, conveyor, simple jigs, rotary indexing table, inductive proximity sensor, capacitive proximity sensor and work-pieces. The cylindrical metal aluminum is used for the work-pieces. This is because it is easier for the robot to grip the cylindrical work-piece compare to cube work-piece. Sensors are placed at the beginning and the end of the conveyor which is the inductive sensor is used to start the conveyor and capacitive proximity sensor is used to stop the conveyor after it sense the work-piece. The direct on line (DOL) connection is used as a motor starter for the AC motor of the conveyor by

using the contactor. The rotation Rotary indexing table is driven using the stepper motor. In order to make the robot grip the work-piece at the accurate point, simple jigs is used to fix work-piece. Rhino robot training kit also can be integrated to other external devices such as PLC, indicator, etc. This is because there is an I/O port at the robot controller. The sequences of the robot are created using teach pendant or Robotalk software. Supply voltage for the training kit is 240Vac.

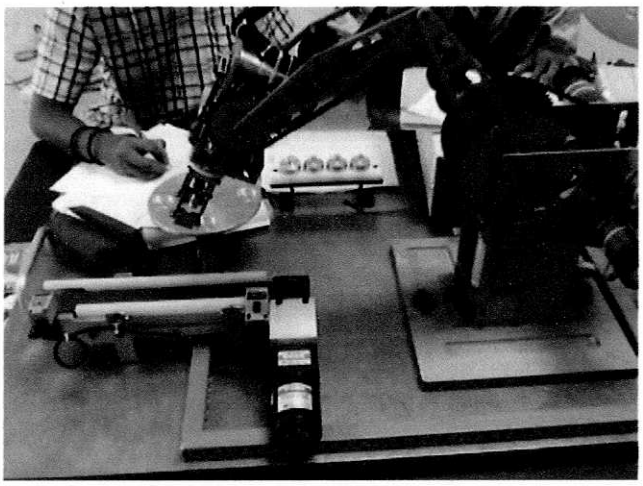

Figure 2.2: Rhino Robot Training Kit

2.3 Third Review: 4-Axis SCARA Robot Training Kit

SCARA robots are specifically designed for pegboard type assembly and are heavily used in the electronics industry. The robot is quite small and capable of operating very accurately and at high speed. It is used for assembly, palletisation and machine loading. The SCARA training kit is designed as a prototype and to introduce the students about the system and its application in the industry area. It is consists of SCARA Rhino robot, jigs, inductive proximity sensor, photo sensor, work-pieces and the goal boxes. The work-pieces shapes are cylindrical and have a hole at the center. There are different colors and materials of the work-pieces, which are black, white and metal color. The black work-pieces are made from metal aluminum and teflon, white work-pieces are made from teflon and the metal color work-pieces are made from aluminum. The jig is used to fix the work-piece from any movements. It will make the robot can grip the work-piece at the accurately. For the sensor application, inductive