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DESIGN AND IMPLEMENTATION OF AN AUTOMATED WORK-PIECE LOADER INDEXER TABLE STATION USING SENSOR AND PROGRAMMABLE LOGIC CONTROLLER (PLC)

DORA JAU

This Report Is Submitted In Partial Fulfillment Of Requirements For The Degree of Bachelor In Electrical Engineering (Industry Power)

Fakulti Kejuruteraan Elektrik
Kolej Universiti Teknikal Kebangsaan Malaysia

April 2006

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"Saya akui laporan ini adalah hasil kerja saya sendiri kecuali ringkasan dan petikan yang tiap-tiap satunya saya jelaskan sumbernya."

Tandatangan : .....

Nama : DORA JAU

Tarikh : 04/05/2006

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Dedicated to my parents, and beloved sisters and brothers; Stewart, Alice, Grace and Albert.

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To all my friends who ever helping me and giving me support and advices, I am very appreciate. Thank you very much.

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ABSTRACT

Industries mostly make use of the technology in order to produce quality products in huge amount in one period time with minimum cost. Therefore Automated Work-piece Loader Indexer Table Station, the Programmable Logic Controller (PLC) and sensors are use to control the whole system with higher efficiency with minimum cost. In this Indexer Table project has four stations with four different processes or activities. It is consisting both software and hardware with PLC programming. Automated Loader Indexer Table Station using sensors and PLC mainly, and have a few equipments which are stepper motor, cylinders, Arm-robot, DC Motor, valves and Stepper controller. Each of these equipments has its own functions in which to produce desire response or output. PLC is used to control the whole system and also to make modification and maintenance to this Automated Loader Indexer Table Station system. The sensors are used to sense and give input to the system. The cylinders, Arm-robot and DC Motor are purposely for doing the process at each station. The stepper is used to rotate the table.

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ABSTRAK

Perundustrian banyak menggunakan teknologi ini untuk menghasilkan produk yang berkualiti dan produktiviti yang tinggi dengan kos yang minimum. Oleh itu *Automated Work-piece Loader Indexer Table Station*, menggunakan PLC dan pengesan (*sensor*) untuk mengawal seluruh sistem dengan lebih efisen dan kos yang minimum. Projek *Indexer Table* ini mempunyai empat stasen yang melakukan aktivi yang berbeza. Ia melibatkan kedua-dua program PLC dan juga perkakasan. Automated Loader Indexer Table Station ini juga menggunakan pengesan (sensor) dan PLC sebangai peralatan utama di samping peralatan lain seperti silider, Motor DC, Stepper, Arm-robot, valve dan juga pengawal Stepper. Setiap peralatan ini mempunyai kegunaan yang berbeza bagi melakukan setiap proses yang terlibat. PLC adalah untuk mengawal, mengubahsuai serta memperbaiki sistem. Silider, Arm-robot dan Motor DC adalah untuk melakukan proses pada setiap stesen. Manakala Stepper pula adalah untuk memutarkan meja.

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LIST OF SYMBOLS

PLC	-	Programmable Logic Controller
CPU	-	Central Processor Unit
KUTKM	-	Kolej Universiti Teknikal Kebangsaan Malaysia
sec	-	seconds (time)
mm	-	length unit
Hz	-	frequency unit
Kg	-	mass unit
LD	-	Ladder Diagram
FDB	-	Function Block Diagram
ST	-	Structure Text
SFC	-	Sequential Function Chart
N.m	-	Newton meter
FKE	-	Fakulti Kejuruteraan Elektrik
OMRON	-	PLC manufacturer (brand)
CQM1H	-	PLC model
I/O	-	Input/Output
f	-	frequency symbol
t	-	time symbol
m	-	weight symbol
V	-	voltage
DC	-	Direct Current

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CHAPTER 1

INTRODUCTION

1.1 Introduction

This project actually is all about the control system, where is applied to the Loader Indexer Table Station. Loader Indexer Table Station is commonly used in many applications in the manufacturing sector, such as the precision process and so on.

Automation system is applied to this project, so that every process will be done automatically using the sensors or detector and the Programmable Logic Controller (PLC) beside other auxiliary equipment or component.

This Loader Indexer Table Station have four stations which doing the different process of each stations. It is used to produce the product continuously and work independently without any further control by the operator.

There are two major tasks in this project. It is designing and implementing task which really require critical thinking. Both of the task is very important and has to be done successfully with proper progress.

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1.2 Problem Statement

Any new project have several problems has to break through, all along the project's progress. These problems can generate ideas to come out with desire result at the end of the progress. In other hand, it can bring good and useful suggestion to the project. There ware several problems that I have state in this project, which is listed below:

(a) Designing the manufacturing process of the project system.
(b) Selecting the suitable actuator to rotate the table.
(c) Selecting the actuator driver or controller.
(d) Writing the Ladder Diagram for programming purpose.
(e) Developing the hardware; assemble the hardware components and materials.
(f) Hardware simulation.

1.3 Objectives

This project will be done successfully when the objectives of the project are state clearly. That will be the guide line to develop this project from state to state. The aims for this project are:

(a) To design the Automated Work-piece Loader Indexer Table Station;
(b) To study and use the technology of the PLC;
(c) To design the manufacturing process of each station;
(d) To design the Ladder Diagram program of the project;
(e) To build the hardware of the Indexer Table Station;
(f) To run the indexer table station system successfully;

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1.4 Project Scopes

This project is actually based on the control system that use for the automated system. PLC is a control device or method to use to control and monitor the whole system. The sensors are also implant to the system as detector devices to do the limitation and detection process; control the input data. So, the PLC program must be build as a command to control the whole system that related in this project. The ladder diagram must be constructing. The function of the PLC has to be studied and understand in order to develop a perfect command and function well. Every path of the PLC has to be learned.

Beside that this project comes with the hardware as well. At the end of this project, the hardware must be completed and ready for hardware simulation. The Indexer Table itself has to build and do the implementation of the project specifications.

Not even that, this project also dealing with the electrical motor, where it uses to rotate the Indexer Table Station. The step angle, toque, rotation speed (rpm) has to be control and calculate in order to get the desire step angle with optimum accuracy. The motor have to be drive by a driver or controller and control the rotation speed and step angle of the motor.

Designing is a must to produce and develop this Automated Loader Indexer Table Station. There a several type of software that are use to design all of the system and material that will be use. The software that must have is AutoCAD and others.

The sensor or switch also plays the important role in this project. The characteristic and the function of this sensor have to be studied and learn. It will be place in the system as the detector, limiting, sense and as the input signal for the PLC to give command to other path of the system.

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1.5 Project Methodology

Automated Loader Indexer Table Station has four main methods to complete this project with desire output. These methodologies are:

(a) Literature research

This is done by doing the research through some media to get the information and useful input to get some view of this Automated Loader Indexer Table Station. This research helps a lot to understand more about this project and created able to build the system for this project.

The research is done through reading the books, journals, articles, notes and other sources else. These types of information sources, able learn a lot about the automation system, control system and also the process system, including the manufacturing system. Then applied these information and input to develop this project and also as a guidelines to solve several problems that existed.

In order to understand the function of the equipments that are use in this project, reading and learning from the data sheets and the manuals of the equipments is needed. So that, able to know and understand the fundamental of each equipment and helps to make decision to choose the suitable equipment that suitable be implement in this project.

Beside that, need to surf the internet to get some information to increase the knowledge and skill to develop this project perfectly. From the internet, there are a lot of the articles, manuals, data sheets, journals, and other information to reed. Internet gives the world wide range information and it is easier for me looking for anything that related to indexer table station project.

Through this literature research, can conclude that there are abilities to develop this project and gain more knowledge and skill as well. It helps a lot in viewing the general ideas and even gives input to design this project until development stage.

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(b) Hardware Development

The second methodology for this project is hardware development. Hardware development required several stage of development progress. Through this methodology, need to commit with one step to other steps to get the good result.

Firstly, need to design the table with certain value of diameter, width and the material of the table. Beside that, it needs to design the work piece or part too, which is including the material will be use and all the parameters. After that, the table is ready to build.

Then only come to the motor's selection stage. Have to list up all the motor that can be use to rotate the table with its criteria, such as the advantages and disadvantages of the motor, and also the application of the motor. After that, need to make the decision to choose the suitable motor type that will be used. This stage required the torque calculate and other required parameter in selecting the motor.

After choosing the motor, the next step is to decide whether the motor need the drive or not. If yes, again come to selection stage; to select the suitable controller or drive to drive the selected motor. The driver must suitable and able to drive that motor.

Selecting the pre-actuators and actuators come after the selection of the controller. Due to the system requirement that has been designed, then able to choose the pre-actuator and the actuator that will be used to develop this project. This stage is important when dealing with the movement mechanisms where its need some suitable equipment or actuator. The actuators need the pre-actuator to drive the actuators.

To control the whole system, it needs a special controller such as PLC. Then need to make sure all the related I/O boards that will be used are available in the PLC panel. Beside that it needs a set of computer to create a PLC program to control the system.

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The next step is choosing the suitable sensors which will be implemented to the system. Again has to list up the sensors and switches with its' functions and also the criteria. Sensors selection is depend on the applications, material detection and also the function where its will be used.

The final step is to assemble all the hardware on one base and wiring the project. This step takes long time to assemble every thing and do the correct wiring. After that, the trouble shooting take place after assemble all the hardware equipments.

(c) Software development

This methodology required to design the hardware using the suitable software such as AutoCAD and the SolidWork software. Need to study on how to use this software and design the table and also the work-piece.

Beside that, the PLC software is used to program and control the project system. It also needs to study the command of the PLC and write the program one by one of the process till it's completed. This program writing stage takes longer time to finish it. Its need several command and must to be understand more about it, and able to use it. The program is written according the desire output and mechanism that have been designed before in the hardware development progress.

The PLC program is written using the CX-Programmer in Ladder Diagram method.

(d) Others

Others methodology, is attending a suitable class and laboratory session. This is important in order to learn the PLC and also the automation system where required high skill to develop it. It helps a lot on how to use and where to the PLC commands when writing the program.

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