UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF CONTROL SYSTEM FOR MAP 203 USING HUMAN MACHINE INTERFACE (HMI)

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

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DECLARATION

I hereby, declared this report entitled "Development of Control System for MAP 203 using Human Machine Interface (HMI) is the results of my own research except as cited in references.

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Date : ……………………..………………………………….

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) (Hons.). The member of the supervisory is as follow:

……………………………………….

(MR. SHAMSUL FAKHAR BIN ABD GANI)

ABSTRAK

SMC MAP 200 adalah satu set siri latihan untuk sistem pengendalian yang dibangunkan oleh SMC International Training. Siri ini terdiri daripada 7 stesen berbeza. Setiap stesen mempunyai kaedah sendiri untuk mengendalikan produk yang menggambarkan sistem pengendalian sebenar di dalam industri. Stesen MAP 203 adalah peranti menegak yang boleh berpusing lengkap dengan penggenggam dalaman yang menggerakkan objek dari satu kedudukan kepada kedudukan yang lain. Stesen ini terdiri daripada beberapa teknologi perindustrian seperti pneumatik, "Programmable Logic Controller" (PLC) dan pengesan. Projek ini akan membangunkan sistem kawalan baru untuk MAP 203 menggunakan Pengantara Muka Mesin dan Manusia ataupun "Human Machine Interface" (HMI) yang boleh mengurangkan penglibatan manusia dalam mengendalikan jentera industri yang besar. Sistem kawalan asas akan dibangunkan dengan menggunakan CX - Programmer berdasarkan bagaimana stesen ini beroperasi. Manakala HMI pula akan dibangunkan menggunakan NB - Designer untuk mewujudkan Pengantara Muka Grafik Pengguna, "Graphical User Interface" (GUI). Kedua-dua sistem kawalan akan diintegrasikan ke dalam stesen MAP 203.

ABSTRACT

SMC MAP 200 is a set of training series for handling systems developed by SMC International Training. These series consist of 7 different and independent stations. Each station has its own method of handling the products that mimics the actual industrial handling systems. The MAP 203 station is a vertical revolving device with internal gripper that moves an object from one position to another. This station consists of several industrial technologies such as pneumatics, programmable logic controllers (PLC) and sensors. This project will develop new control system for MAP 203 station using Human Machine Interface (HMI) that can reduce human involvement in handling large industrial machineries. A proper control system will be developed by using CX – Programmer based on how the station operates. The HMI will be developed using NB – Designer to create the Graphical User Interface (GUI) of the station. Both of the control system will be integrated on the MAP 203 station.

DEDICATION

To my beloved mom and my late father.

Habibah Binti Taharin

Md Zain Bin Zainuddin

This is for both of you.

ACKNOWLEDGEMENT

Alhamdulillah, praise to Allah SWT, who gave me the strength to complete this project throughout my final year as a bachelor degree student. Thank you, Allah.

I would like to thank to my mom, Habibah Binti Taharin, who always give me her full support towards me in everything that I involved in. I would never repay everything that you've done to me, mom. Not to forget my family members, thank you so much.

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Also, thousands of thanks to my classmates for their useful views, tips, and comments that they gave. Thank you, guys.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURES

MAP	Multiple Application Platform
GUI	Graphical User Interface
PLC	Programmable Logic Controller
NO	Normally Opened
NC	Normally Closed
HMI	Human Machine Interface
NEMA	National Electrical Manufacturing Association
GM	General Motors
TTL	Transistor Transistor Logic
CPU	Central Processing Unit
GRAFCET	Graphe de Commande Etape – Transition
SFC	Sequence Function Chart
LED	Light Emitting Diode
IR	Internal Relays
SCADA	Supervisory Control and Data Acquisition

CHAPTER 1

INTRODUCTION

1.1 Project Background

MAP series is a training kit produced by SMC International Training for study purposes. It was developed by SMC for handling training systems that consists of 7 different types of station. MAP 203 can move objects from one position to another using a rotating manipulator fitted with an inside gripper. This project will develop a new control method for this training kit other than manual push button and automatic input which is by using HMI system. HMI will provide user to control the whole system by using only the GUI from the computer.

1.2 Problem Statement

Nowadays, the handling system in industries mostly uses manual operation instead of fully automated operation. This means the operator, human, must handle the machine operation by pushing the button. The button may be located near the machines in the factory. The operator of the machine may catch sleepy or careless when operating the machines. This may lead to hazardous accident when the process was not handled properly and carefully. Troubleshooting process of the manual operation may be difficult because there is no indication of which part is not working.

1.3 Objectives

The objectives of this project are:

a. Develop and design control system to run MAP 203 station.
b. Develop HMI system to be integrated with MAP 203.
c. Implement the designed control method to the MAP 203 station.

1.4 Work Scope

This project will develop the control system of MAP 203 by creating another control method which is the HMI system instead of the manual push button and fully automated system by using PLC. HMI system will provide user the ease of controlling the station without 'actually' be near to the station.

The work scopes of this project are:

a. To study the GRAFCET technique in order to upgrade the control system of MAP 203.
b. To create and design the ladder diagram using CX – Programmer for MAP 203.
c. Focus on how to develop the HMI system by using NB - Designer.
d. To study on how to implement the upgraded control system to the station.

CHAPTER 2

LITERATURE REVIEW

2.1 SMC MAP 203

The MAP – 200 handling system is a series produced by SMC International Training that consists of seven independent and different training systems. The series starts from MAP 201 till MAP 207. Each station differs from each other. It carries out simple assembly process by reproducing subsets of more complex processes found in industry.

MAP – 203 is a vertical revolving handling device with internal gripper. It moves object from one position to another by using its revolving handling device with an internal gripper. This station has a rotary pneumatic actuator and a pneumatic internal gripper at the end of a fixing arm.

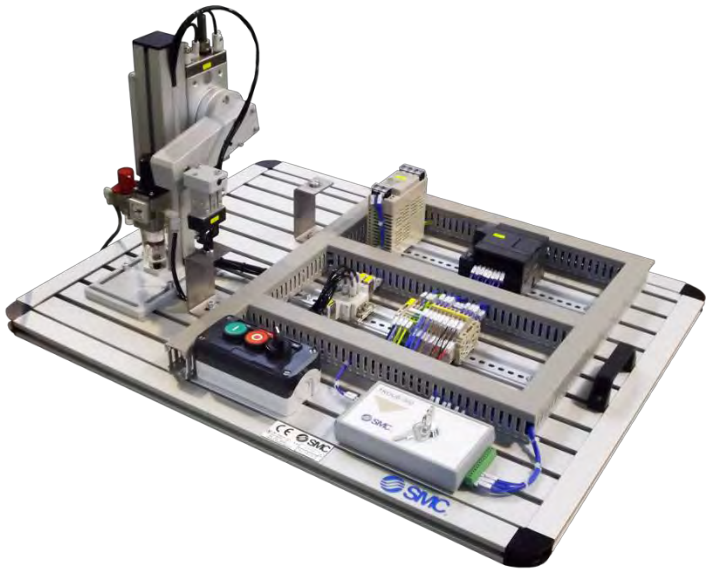

Figure 2.1(a) - The SMC MAP 203 station.

The station's pneumatic rotary actuator is a double rack and pinion type with maximum movement of 180º. The actuator also comes with speed controllers and 0º, 90º and 180º position switch and controlled by a closed 5/3 solenoid valve. The fixing arm uses a pneumatic grippers with two parallel – opening jaws and is controlled by a single 5/2 solenoid valve. This station has 3 auto switches using reed type switch to detect the movement of the rotary actuator.

Figure 2.1 (b) - The double rack and pinion type actuator.

2.2 Programmable Logic Controller (PLC)

Programmable Logic Controller (PLC) is a microprocessor – based device that can be used to control movements of industrial systems such as electric motors, conveyors and robots [1]. PLC also defined as a specialized electronic device based on one or more microprocessors that are used to control industrial machinery or; a special – purpose industrial computer designed for use in the control of a wide variety of manufacturing machines and systems [2] while the National Electrical Manufacturing Association (NEMA) defines a PLC as a digital electronic apparatus with a programmable memory for storing instructions to implement specific functions, such as logic, sequencing, timing, counting and arithmetic to control machines and processes.

According to Max Rabiee, PLC was first introduced in the late 1960s in the automotive industry by General Motors (GM) Corporation. PLCs were made using Transistor Transistor Logic (TTL) logic gate chips such as AND, OR, NOT, NAND, NOR, XOR, and XNOR gates.

Figure 2.2 - The SYSMAC OMRON CPM2A PLC.

PLC has its own advantages. Firstly, PLCs are very rugged and designed to withstand vibrations, temperature, humidity and noise around it. It already has interfacing for inputs and outputs inside the controller and most of all PLCs are easily programmed and have an easily understood programming language. This allows users to modified and reprogram the PLC systems within a few hours. Other than that, PLCs require minor wiring compared to the electromechanical relays that were popularly used before PLCs.

2.2.1 Programming the OMRON PLCs – Ladder Diagram

There are several ways to program the Omron PLCs. Firstly, by using the ladder diagram. Ladder diagrams are specialized schematics commonly used to document the industrial control logic systems. They are called ‘ladder’ diagrams because they resemble a ladder, with two vertical rails supplying the power and as many horizontal lines or so called the ‘rungs’ as there are control circuits to represent. This ladder diagram is read rung by rung.

The PLC will scan the inputs associated with one rung of the ladder program. Then, PLC solves the logic operation involving those inputs and set or reset the outputs for that rung. After that, it moves on to the next rung and repeats the previous operation and so on until the end of the ladder program scanned in turn. The PLC then goes back to the beginning of the program and starts again.

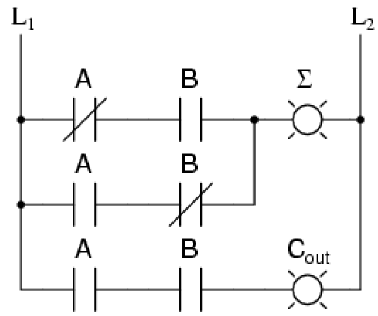

Figure 2.2.1 (a) - Example of simple ladder diagram.

There are 2 types of contacts in ladder diagram which are the normally open and normally closed. Normally open contact will turn on the load when the bit is on and the normally closed contact will turn off the load when it is activated.

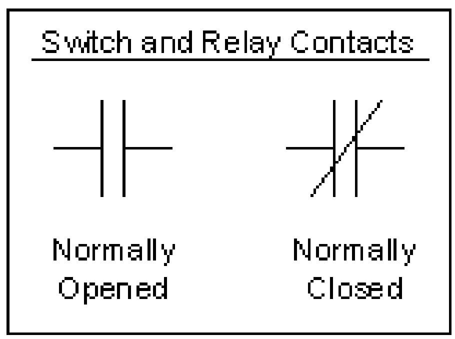

Figure 2.2.1 (b) - The normally open and normally closed contact for ladder diagram.

The contacts of ladder diagram mimics the electrical circuit diagrams used for wiring control systems in the electrical industry. The purpose of an electrical control system is to determine whether a load should be turned ON or OFF. To understand the ladder diagram much simpler, just think about the concept of the flow of the current, the load is turned ON when the current can flow on it and turned OFF when current could not flow to it.

2.2.2 Programming the OMRON PLCs – Mnemonic Code

Mnemonic code is another way to program the PLCs. Mnemonic code is actually the ladder diagram but written in alphanumeric characters for easier understanding compare to the machine language program to be executed by the Central Processing Unit (CPU). The code can be converted to a ladder diagram in the PLCs.

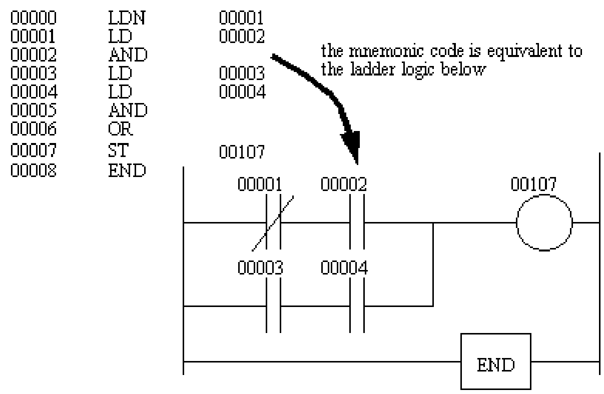

Figure 2.2.2 - Example of a mnemonic code programming.

The mnemonic code is important to understand because the program is stored in memory in mnemonic code form. Both ladder diagram and mnemonic code are equally important in programming the PLCs.

2.3 GRAFCET

GRAFCET, stands for "*Graphe de Commande Etape – Transition*" in French or stage transition command graph is a standard graphical language for expressing the control flow, which supports the expression of both combinational and sequential control logic. GRAFCET is a function chart, a graphical representation and thus easy to understand. It shows a clear understanding of the input – output behavior of a logic controller. GRAFCET is capable of describing the sequence of states of a discrete – event system which may contain a very large number of states. It describes only the behavior of the corresponding input changes.

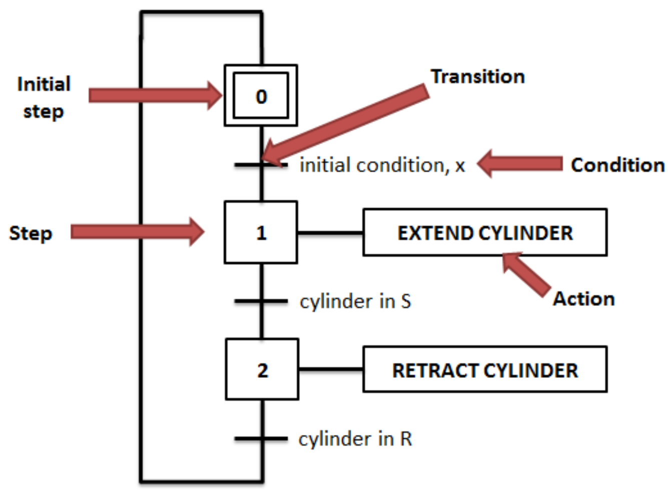

Figure 2.3 - Example of GRAFCET.

GRAFCET has been developed by a committee for standardization of specification of logic control systems. GRAFCET is based on the stage and receptivity concept. The basic concept of this model is the state, the step, the transition and the condition associated to transition. The state can be defined as the memory specifications and their activity is characteristics of the steps. The steps or called as actions are used to specify the value of the outputs according to the active steps and value of input. The transitions are used to describe the evolution of the state according to the changes of input variables.

2.4 Sensors

2.4.1 Reed Switch

Reed switch was invented by Walter B. Elwood in the middle of 1930s at the Bell Laboratories. His original patent application was filed on 27th June 1940 and was officially granted on 2nd December 1941.

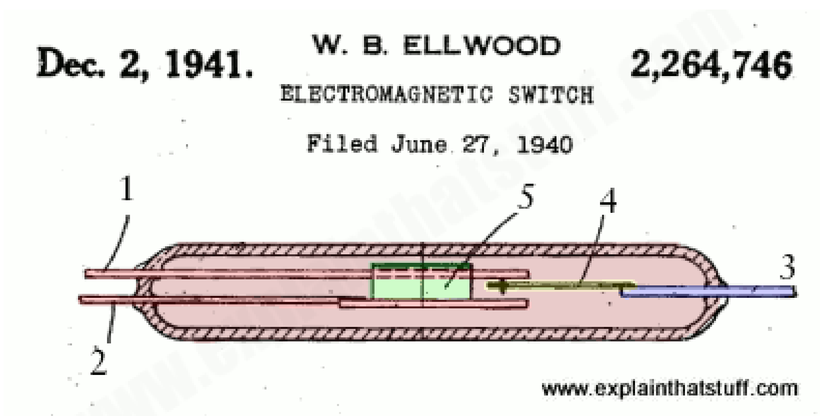

Figure 2.4.1 (a) - The patented reed switch by W.B. Elwood.

Reed switch or reed sensor is a device used to control the flow of electricity. It consists of two ferromagnetic blades, generally composed of iron and nickel, sealed in a glass capsule filled with inert gas. This switch work on a simple principle. Two overlapping blades are sealed into a tube separated by a distance of only few microns. The tube is filled with high purity inert gas. Under non – operating conditions, the two blades do not touch each other. The north and south poles around the blades is created by an externally applied magnetic field and as the result, these two blades attracted to each other and the switch closes. This technique allows small – sized switching components with quick switching operations and high reliability.