UNIVERSITI TEKNIKAL MALAYSIA MELAKA

NETWORK AND CONTROLS OF SERVOMOTOR

Report submitted in accordance with partial requirements of the Universiti Teknikal Malaysia Melaka for the Bachelor of Manufacturing Engineering (Robotics & Automation)

By

Teng Guat Theng

Faculty of Manufacturing Engineering

April 2008

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PSM

JUDUL:

NETWORK AND CONTROLS OF SERVOMOTOR

SESI PENGAJIAN:
Semester 2 2007/2008

Saya **TENG GUAT THENG**
mengaku membenarkan laporan PSM / tesis (Sarjana/Doktor Falsafah) ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM / tesis adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM / tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. *Sila tandakan (√)

☐	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☐	TIDAK TERHAD	

_____
(TANDATANGAN PENULIS)
Alamat Tetap:
1036, Taman Sri Kota,
Jalan Kuala Kedah,
06600 Alor Star, Kedah.

Tarikh: _____

_____
(TANDATANGAN PENYELIA)

Cop Rasmi:

Tarikh: _____

* Jika laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak organisasi berkenaan dengan menyatakan sekali sebab dan tempoh tesis ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I hereby declare that this report entitled **"NETWORK AND CONTROLS OF SERVOMOTOR"** is the result of my own research except as cited in the references.

Signature	:	
Author's Name	:	**NETWORK AND CONTROLS OF SERVOMOTOR**
Date	:	25 May 2008

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Robotics and Automation). The members of the supervisory committee are as follow:

Mr. Ahmad Yusairi Bin Bani Hashim

(PSM Supervisor)

ABSTRACT

The project is discussed about the network and controls of servomotor. Actually, this report is divided into two parts, the first part is discussed about the proposal of the project and the second part is discussed about the project implementation. This project totally contains six chapters starting from introduction, literature review, methodology, results, discussion and the last one is conclusion. For the first chapter, it will describe about the title of the project, objective, problem statement, scope, organization of the project and expected outcomes. The main objective of this project is to install servo motors networks to controller and to verify servomotor controls. While the second chapter is discusses about literature review. The literature search is performed to study, analysis and design for this project. The sources of this chapter can gain from internet, journal, book, magazine and etc to support the components that related with the projects. The next chapter is methodology. This chapter is discusses about the steps or procedures that used to achieve the objective of this project. Actually, in this project a simple wire connection should be done to connect the Omron PLC to the SMARTSTEP Servo Driver and then connect the SMARTSTEP A-series Servomotor. The controller is using the CX programming to control the movement of servomotor lead screw application. Therefore, some experimental results are obtained and described in chapter four. Then, the following chapter is discusses about the result, problems and suggestion to overcome the problems. Finally, the overall project and its achievements are concludes in chapter six.

ABSTRAK

Projek ini adalah menerangkan tajuk tentang “network and controls of servomotor”. Sebenarnya, laporan in adalah terbahagi kepada dua. Pertama, adalah menerangkan perkara-perkara yang berkaitan dengan laporan cadangan dalam projeck ini. Kedua, adalah menerangkan perkara-perkara tentang projek pelaksanaan. Projek melingkungi enam bab yang bermula dari pengenalan, kajian ilmiah, metodologi, keputusan, perbincangan dan berakhir dengan kesimpulan. Bagi bab satu, ia adalah untuk menerangkan tajuk projek, objektif, pernyataan masalah dalam projek ini dan juga jangkaan hasil. Objektif yang utama dalam projek ini adalah untk memasang rangkaian servomotor kepada sesuatu pengawalan unit dan juga mengesahkan kawalan servomotor. Manakala, bab kedua adalah menerangkan tentang kajian ilmiah. Bab ini adalah mempersembahkan kepada kajian, alisasi, dan lakaran dalam projek ini. Maklumat-maklumat yang berkaitan dengan bab ini boleh dicari melalui internet, jurnal, buku, majalah dan sebagainya untuk menyokong dan menerangkan komponen-komponene yang berkaitan dengan projek ini. Bab yang seterusny ialah metodologi. Bab ini menerangkan langkah atau prosedur yang digunakan untuk mencapai objektif yang dinyatakan sebelum ini. Sebenarnya, dalam projek ini, sesuatu sambungan wayar yang mudah harus disambungkan untuk menyambung Omron PLC kepada SMARTSTEP Servo Driver dan kemudian sambung kepada SMARTSTEP A-series Servomotor. Pengawalan yang digunakan itu adalah menggunakan CX programming untuk mengawal pergerakan servomotor yang terletak dalam lead screw mekanisma. Oleh itu, sesetengah keputusan kajian didapatkan dan ia menerangkan dalam bab ke-4. bab yang seterusnya menerangkan keputusan, masalah dan cadangan bagi projek ini. Akhirnya, keseluruhan projek dan pencapaiannya adalah menerangkan dalam chapter yang ke-enam.

DEDICATION

To my beloved family

ACKNOWLEDGEMENTS

It gives me utmost pleasure to express my gratitude to who have directly or indirectly contributed to the fruition of the compilation. They include; My supervisor, Mr. Ahmad Yusairi bin Bani Hashim. Thanks for all the guidance and critics given to me directly or indirectly, and also his scarification in time to teach and explain to me without a word of complains. My family, who inspired me weather through the storm and carry on, and last but not least lecturers, friends and relevant personnel who helped in one way or another.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

PLC	-	Programmable Logic Controller
RTOS	-	Real Time Operating System
I/O	-	Input/ Output
CPU	-	Central Processing Unit
DC	-	Direct Current
AC	-	Alternating Current
V	-	Voltage
ROM	-	Read-Only Memory
RAM	-	Random-Access Memory
EPROM	-	Erasable Programmable Read-Only Memory
EEPROM	-	Electrically Erasable Programmable Read-Only Memory
LAN	-	Local Area Networks
LLD	-	Ladder Logic Diagrams
ST	-	Structured Text
FBD	-	Function Block Diagrams
SFC	-	Sequential Flowcharts
IL	-	Instruction Lists
IEE	-	Institution of Electrical Engineers
IET	-	Institution of Engineering and Technology
IEC	-	International Electrotechnical Commission
BS	-	British Standard
NEC	-	National Electrical Code
AWG	-	American Wire Gage
CM	-	Circular Mil Area

CHAPTER 1

INTRODUCTION

Servo motors are best known for their rapid acceleration and deceleration capability, made possible by delivering high-peak torque in conjunction with a high torque-to-inertia ratio. Servo motors are famous for their high dynamic response and precision accuracy in traditional motion control applications, such as machine tools and robotics.

Nowadays, many servomotors are controlled by using some controllers such as PLC (Programmable Logic Controller), PAC (Programmable Automation Controller) and etc. Actually, this project will present about the network and controls of servomotors. The controller that will use in this project to control the servomotor is Omron brand's PLC.

The purpose of this project is to install servomotors networks to controllers according to the connection diagram on the operation manual. After installed the servomotor to PLC, then the following step is verify the servomotor controls. The focus of this report is on system investigation with some analysis in control engineering such as speed, stability, movement and etc.

1.1 Objective

The purpose of this project is to install complicated servo motors networks to controllers according to the connection diagram on the operation manual. Through this project, students can understand about the equipment, device and component that used in this project. All this information and knowledge is very important to easier student install the complicated servomotors network to controller. After complete install the servomotor to controller, student should write a PLC's program to control the servomotor. Through this, student will know how to apply the PLC programming to execute the servomotor. After that, student should verify the servomotor and investigate some analysis in control engineering such as speed of motor, stability of motor, movement of motor.

1.2 Statement of Problems

There have five sets of servomotor with controller are provided in this project. The servomotor does no function as a result of incomplete networking and installation. So, the important thing that should do in this project is find some suitable electrical connector or device to connect the wiring from PLC to servomotor. The electrical device that mention just now is start/stop button, emergency stop, relay, wire and so on. To connecting all the wiring of this project, student should study out the diagram that provided by the manufacturer (refer to Appendix A). Through this diagram, only students will know how to install and network the motor.

After connecting all the electrical circuit of servomotor and PLC, the control strategies shall verify the correct system integration. The control strategies such as movement, speed, pulse and so on are used to determine the capability of the servomotor. Beside that, the application of servomotor which suitable used in laboratory session should apply in this project. In this project, Lead Screw Mechanism is chosen as a laboratory model to show out the capability of servomotor which involved of rotary movement and torque.

1.3 Scope

The focus of this report is on system investigation with some analysis in control engineering which is the engineering discipline that focuses on mathematical modeling of systems of a diverse nature, analyzing their dynamic behavior, and using control theory to create a controller that will cause the systems to behave in a desired manner. In this project, the control engineering such as speed, movement and transient response should take in consider to obtain an excellent result. After connecting all the wire connection and also finish assemble the mechanical part of this project, the analysis of control engineering should take in account to get the perfect result.

1.4 Organization

The organization in this report is as follows; first, chapter one of this report, describe the background, objective and scope of the project, as well as the organization section. Second, chapter two provides the literature review about the device that used in this project and also some theoretical concept in engineering field which related to this project. Next, chapter three presents the methodology of the project that including the description of methodology, material selection and process involved in this project. Chapter four, list out all the result that gain in this project such as list of part, description of the structure and analysis result. Chapter five discuss the improvement that should done, target application of the project and give some recommendations on this project. Finally, chapter six serves as the conclusion of the project.

CHAPTER 2
LITERATURE REVIEW

This chapter discusses about the literature discourse and review of structural analysis and some definition of the components used in this project such as PLC (Programmable Logic Controller), servomotor, CX programmer and etc. through the world, there have many difference sources and researches about the concept, design and implementation of the servomotor by using PLC. It also included the investigation of what others have done in this area. This study included the areas of mechanical, electric, electronic and software development. Literature reviews are based of information that obtained from various sources, articles, technical reports, general reports, websites, books and personal communication.

2.1 Programmable Logic Controller (PLC)

Nowadays, almost all control applications require switching (on or off) which contain of various outputs as a function of a number of inputs [1]. The programmable logic controller is known as logic control or switching control. This switching control are quite simplicity that why it attractive for use in automatic machines where there is a requirement for the machine to follow a set sequence of operations to gives rise to the term sequential control by using switching control.

Normally, a PLC is an industrialized dedicated microcontroller. It is operation based primarily on sequential control of a process. Its Real Time Operating System (RTOS) scans a program in a repetitive cycle and actions are taken (outputs set) depending on logical relationships (specified by the programmer) between the inputs [1].

In fact, a PLC or Programmable Controller is a digital computer used for automation of industrial processes, such as control of machinery on factory assembly lines. Unlike general-purpose computers, the PLC is designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to control machine operation are typically stored in battery-backed or non-volatile memory. A PLC is an example of a real time system since output results must be produced in response to input conditions within a bounded time, otherwise unintended operation will result [2].

The PLC has been part of manufacturing automation for over two decades, replacing the hard-wired relay logic controllers (Figure 2.1). For smaller-scale, event-driven processes and machines with limited I/O points, stand alone PLCs are the controller of choice. PLCs are rugged, relatively fast, and low cost with excellent sequential control performance [3].

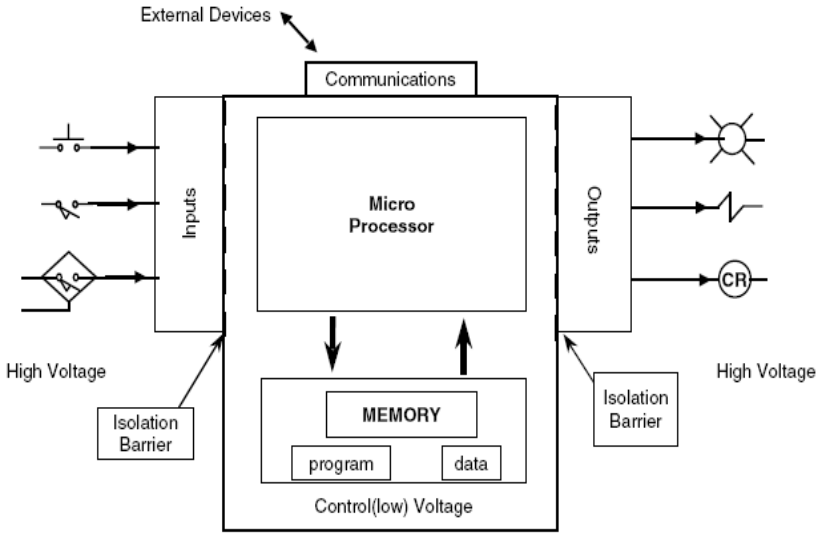

Figure 2.1: PLC – I/O structure [3]

Recently, PLCs have been gaining popularity on the factory floor and it will probably remain predominant for some time to come. Most of this is because of the advantages they offer. The advantages of the PLCs are:

§ Cost effective for controlling complex systems

§ Flexible and can be reapplied to control other systems quickly and easily.

§ Computational abilities allow more sophisticated control.

§ Trouble shooting aids make programming easier and reduce downtime.

§ Reliable components make these likely to operate for years before failure.

2.1.1 PLC Hardware Structure

A PLC is an industrial computing device that continuously and sequentially checks its input ports to determine the most recent events that have occurred within the system it is controlling, and it activates or deactivates its output ports to allow or disallow other events to happen within the system as show in Figure 2.2. The core unit of the PLC, as with any other computing device, is the central processing unit (CPU). The CPU controls all the operations within the PLC based on instructions specified by the user in the form of a program stored in its memory. The CPU