PLC's INTERFACE BETWEEN PNEUMATICS AND PIC WITH SEVERAL APPLICATIONS

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APPLICATIONS

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This report is submitted in partial fulfillment on the requirements for the award of
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Supervisor's Name   : Farid Arafat Bin Azidin

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To my beloved father and mother

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Siti Fatimah Binti Sulaiman

ABSTRACT

This adapter was designed to become as an interface between Programmable Logic Controllers (PLC) OMRON and pneumatics trainer; where several applications are also adapted in this project. The absence of interfacing between PLC OMRON and pneumatics trainer creates a constant difficulty among Universiti Teknikal Malaysia Melaka (UTeM) students especially during lab sessions. At present, only a button or switch could actuate a pneumatic to compress air into the pneumatics valve. This feature of the equipment is not practical for the students as well as the university since it must be handled manually. To achieve the project objectives in order to ensure a successful outcome in the project, several ways have been taken such as defined the voltage specification (input and output) via adapter, PLC OMRON and pneumatics trainer. Besides that, the ladder diagram is designed and simulated using CX-Programmer software in order to ensure the output produced at pneumatics trainer is same as the simulation. At the end of this project, the adapter will be able to receive a 24V input from the PLC trainer. It will then process the input into either a 24V pneumatics trainer or a 5V PIC. The adapter will also transfer the PLC's program to the acquired trainer; performing tasks such as a simple sequence control concept, automatic stairway light, stamping machine and traffic light. Via this project also, the wiring of the system is also reduced compared before the existence of these produced adapter. At the end of this project, the interfacing of PLC and PIC is also proven.

ABSTRAK

Alat penyesuai yang direkabentuk ini berfungsi sebagai penghubung di antara *Programmable Logic Controller (PLC) OMRON* dan *pneumatic trainer*; di mana beberapa aplikasi tertentu turut dikaitkan menerusi projek ini. Ketiadaan alat penghubung untuk menghubungkann *PLC OMRON* dan *pneumatic trainer* seringkali menimbulkan kesulitan di kalangan pelajar-pelajar Universiti Teknikal Malaysia Melaka (UTeM) terutamanya ketika sesi makmal dijalankan, kerana buat masa ini, pemampatan udara ke dalam injap pneumatik hanya dilakukan secara manual dengan cara menekan butang atau suis yang terdapat di *pneumatic trainer*. Bagi memastikan tujuan utama projek ini tercapai, beberapa langkah telah diambil; antaranya dengan menentukan spesifikasi voltan keluar dan masuk melalui alat penyesuai, *PLC OMRON* dan juga *pneumatic trainer*. Di samping itu juga, rekabentuk dan simulasi *ladder diagram* juga telah dilakukan menggunakan perisian CX-Programmer bagi memastikan keluaran pada pneumatik adalah sama dengan keluaran yang diperolehi melalui simulasi. Kesudahannya, alat penyesuai yang direka ini berupaya untuk menerima masukan voltan dari *PLC OMRON* sebanyak 24V. Voltan masukan ini kemudiannya akan diproses kepada 24V *pneumatic trainer* atau 5V *Programmable Interface Controller (PIC) trainer*. Pada masa yang sama, alat penyesuai ini juga akan menghantar program-program dari *PLC* kepada *pneumatic trainer* bagi melaksanakan aplikasi-aplikasi seperti konsep kawalan ringkas, lampu tangga automatik, mesin penghentak dan juga lampu isyarat. Melalui projek ini juga, penggunaan wayar yang terlalu banyak dan berselirat juga dapat dikurangkan. Di akhir pelaksanaan projek ini, perantaraan antara *PLC OMRON* dan *PIC* juga turut dibuktikan.

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PLC	-	Programmable Logic Controller
UTeM	-	Universiti Teknikal Malaysia Melaka
PIC	-	Programmable Interface Controller
NEMA	-	National Electrical Manufacturing Association
CPU	-	Central Processing Unit
ROM	-	Read-Only Memory
RAM	-	Random Access Memory
EPROM	-	Erasable Programmable Read Only Memory
EEPROM	-	Electrically Erasable Programmable Read Only Memory
ALU	-	Arithmetic Logic Unit
RISC	-	Reduced Instruction Set Computer
SPDT	-	Single Pole Double Throw

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CHAPTER I

INTRODUCTION

1.1   Background

A Programmable Logic Controller (PLC) and pneumatics are two most different instruments. A Programmable Logic Controller (PLC) is a device that was invented to replace the necessary sequential relay circuits for machine control. The PLC works by looking at its inputs and depending upon their state, turning on/off its outputs. The user enters a program, usually via software, that gives the desired results.

While in pneumatic systems, force is produced by air pressure acting on the surface of a piston or valve. It is to be noted here that the pneumatic tools, or the air tools as they are generally called as, can perform many difficult tasks that cannot be accomplished by other types of tools available.

This project presents the design of an adapter as one tool to interface between both PLC and pneumatics. At present, in Universiti Teknikal Malaysia Melaka (UTeM) especially, PLC and pneumatics are used separately. To activate the pneumatics for example, button or switch need to be pressed first in order to compress the air into the pneumatic valve and make the cylinder move out. The same thing happened in the used of PLC, where the output produced by PLC's is too limited; output is displayed on the trainer only. These situations seem not practically and at the same time give harm to the students itself because they can't apply both instruments (PLC and pneumatics) as good as possible.

With the existence of this designed adapter, student's knowledge will be gained because several applications involving the use of PLC and pneumatics are also included in this project. At the end of this project, this produced adapter will be tested whether it is able to interface with a Programmable Interface Controller (PIC).

1.2 Objectives

1.2.1 To design an adapter between PLC OMRON and pneumatic trainer with several applications such as a simple sequence control concept, automatic stairway light, stamping machine, etc.

1.2.2 To overcome the problem of interfacing absence between PLC and pneumatic trainer.

1.2.3 To ensure the produced adapter will allow a 24V output from PLC OMRON to convert into either 24V pneumatic trainer or 5V PIC.

1.2.4 To study the concept of GRAFCET model and PLC programming.

1.2.5 To approach how to link the software (programming) onto the hardware.

1.2.6 To study and understand the basic concepts of the pneumatic systems operation.

1.2.7 To test whether the produced adapter is able to interface with a PIC.

1.3 Problem Statement

1.3.1 The absence of interfacing between PLC OMRON and pneumatic trainer creates a constant difficulty among UTeM students especially during lab sessions.

1.3.2 At present, only a button or switch could actuate a pneumatics to compress air into the pneumatic valve.

1.3.3 This feature of the equipment is not practical for the student as well as the university since it must be handled manually.

1.3.4 Students itself can't apply both instruments (PLC and pneumatics) as good as possible.

1.4   Scopes of Work

This project primarily covered on the several parts, which are:

1.4.1   The design of adapter (24V $\rightarrow$ 24V/5V) using Multisim software.

1.4.2   The study of a Programmable Logic Controller (PLC).

1.4.3   The design of ladder diagram using CX-Programmer software.

1.4.4   The design of GRAFCET (a sequential function chart) using AUTOMGEN 7.101 software.

1.4.5   The study of pneumatic systems basic operation.

1.4.6   The study of a Programmable Interface Controller (PIC).

All the parts above will function in one system to receive and process voltage input and produces a converted output (pneumatics or PIC).

1.5   Project Significant

1.5.1   Overcome the problem of interfacing absence between PLC and pneumatic trainer.

1.5.2   Makes teaching and learning process in UTeM becomes more practical.

1.5.3   As an instrument for UTeM's students in future study purposes such as an experiments and researches.

1.5.4   Will be tested whether it is able to interface with a Programmable Interface Controller (PIC).

1.6   Project Methodology

To ensure a successful outcome in the project, the project objectives shall be achieved first. The flow chart below shows the method that will be done step by step until the goal of the project is achieved.
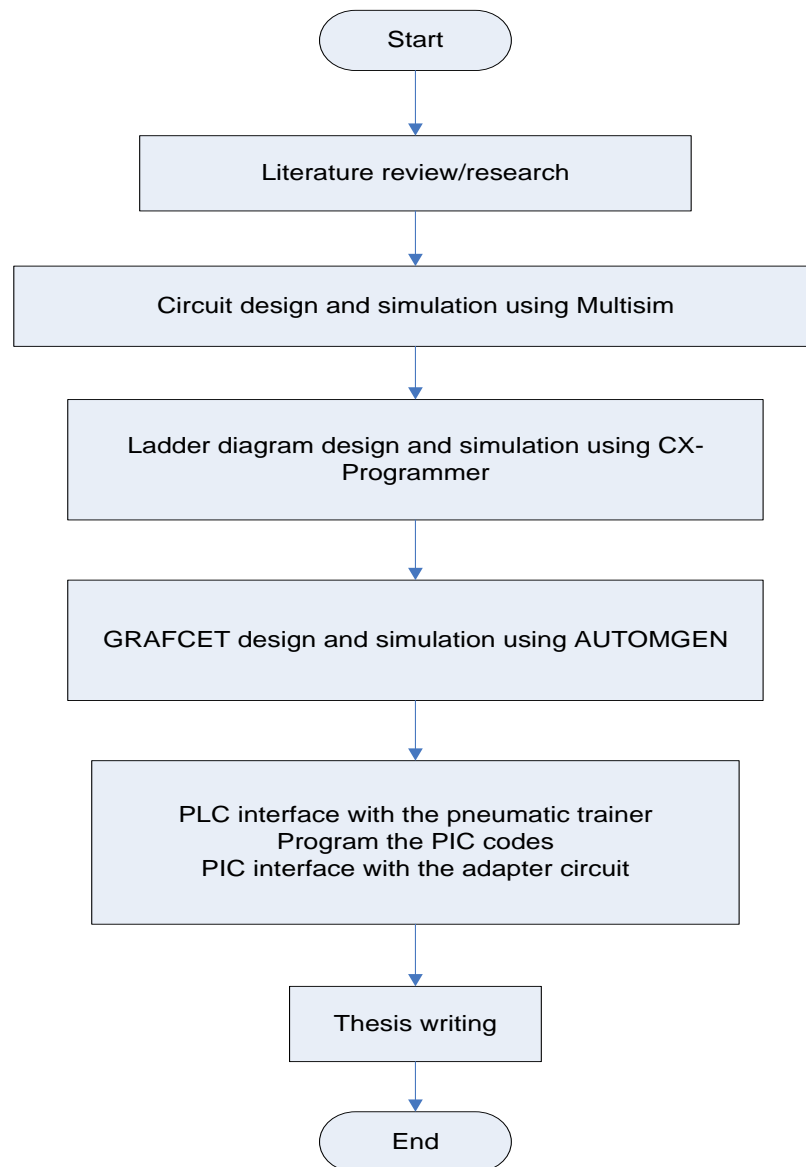
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                    ┌──────────────┐
                    │    Start     │
                    └──────┬───────┘
                           ▼
              ┌────────────────────────────┐
              │  Literature review/research │
              └────────────┬───────────────┘
                           ▼
          ┌────────────────────────────────────┐
          │ Circuit design and simulation using │
          │              Multisim               │
          └────────────┬───────────────────────┘
                       ▼
        ┌──────────────────────────────────────┐
        │ Ladder diagram design and simulation  │
        │          using CX-Programmer          │
        └────────────┬─────────────────────────┘
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        ┌──────────────────────────────────────┐
        │ GRAFCET design and simulation using   │
        │               AUTOMGEN                │
        └────────────┬─────────────────────────┘
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        ┌──────────────────────────────────────┐
        │ PLC interface with the pneumatic      │
        │ trainer                               │
        │ Program the PIC codes                 │
        │ PIC interface with the adapter circuit│
        └────────────┬─────────────────────────┘
                     ▼
              ┌──────────────────┐
              │  Thesis writing  │
              └────────┬─────────┘
                       ▼
                ┌──────────────┐
                │     End      │
                └──────────────┘
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Figure 1.1   Methodology's Flowchart

There are four phases involved during a performance of this project:

    i)   First Phase   : Literature Review
    ii)   Second Phase : Design and Simulation
    iii)   Third Phase   : Implementation
    iv)   ~~Fourth Phase : Thesis Writing~~

i)   <u>First Phase : Literature Review</u>

- Gathered the information about the project via internet, journals, magazines, published work and reference books.
- Study of the software implementation (Multisim, CX-Programmer, AUTOMGEN, PIC C Compiler, Proteus 7 Professional and WinPic-PIC Programmer).
- Make research to know more detail about an adapter, PLC and pneumatic systems.

ii)   <u>Second Phase : Design and Simulation</u>

- Analyzed and designed circuit for an adapter which is able to receive a 24V input and process it into either 24V/5V.
- Used Multisim software to simulate an adapter circuit.
- Used CX-Programmer software to simulate the ladder diagram.
- Used AUTOMGEM software to simulate the GRAFCET.
- Used PIC C Compiler, Proteus 7 Professional and WinPic-PIC Programmer software to program and simulate the PIC codes.
- Used Proteus 7 Professional to design a PCB layout for the adapter circuit and PIC LCD display circuit.

iii)   <u>Third Phase : Implementation</u>

- Directly connected the simulation output produced from the PLC trainer to the pneumatic trainer. In this case, there's no need to press the button to make the pneumatics cylinder actuated.
- Directly connected the output from the adapter circuit to the PIC LCD display circuit in order to display the output conditions.

iv)   <u>Fourth Phase : Thesis writing</u>

- Stated all the ideas concentrated regarding to this project.
- Shows flow of ideas during the implementation of this project.
- Stated the project conditions (from the beginning until the end of the project).

Details explanation of the project methodology will be explained in Chapter III (Project Methodology).

1.7   Report Structure

Summarization of each chapter included in the report:

    i)   Abstract

    ii)   Chapter I : Introduction

    iii)   Chapter II : Literature Review

    iv)   Chapter III : Project Methodology

    v)   Chapter IV : Results and Discussion

    vi)   Chapter V : Conclusion and Recommendation

    vii)   References

    viii)   Appendices

i)   <u>Abstract</u>

Abstract means the whole report in miniature. In the project abstract, the main project objectives, the methods used and the summarization of the most important results are stated. Besides, a major conclusion and the project significance are also stated at the end of the project abstract.

ii)   <u>Chapter I : Introduction</u>

This first chapter is more on the general overview of the project. In this chapter, the background of the problem and the emergence of the project are stated first. Besides, the project objectives, scope of project and the methods used are also included.

iii)   <u>Chapter II : Literature Review</u>

This second chapter discusses the background of study related to the project. This chapter consists of the evidence with the broad (e.g. books, internet, lecture notes etc) and focus (previous PSM, thesis, journal papers etc) areas of the study. In this chapter, the trend, direction and research issues are also identified. It can be said that this chapter is more on the evidence of not repeating what others have done.