INEXPENSIVE PLC INPUT PORT EXPANSION USING MICROCONTROLLER

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Supervisor's Name : Mr. Zulhairi Bin Othman

Date : ... 12/05/08 ... ...

To my beloved Ummi, my late father, my family and members of the electronics academia.

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ABSTRACT

This project is about the expansion of PLC input port using the microcontroller. It involves two important control systems; One is a Programmable Logic Controller (PLC) and the other is the Programmable Integrated Circuit (PIC). These two systems have different behaviours and programming techniques. This project shows how the two control systems are interfaced and thus increasing the input port of the PLC. Both hardware and software are complimented to each other it in terms of design and written programme.

ABSTRAK

Projek ini menekankan penambahan masukan bagi litar kawalan logik menggunakan teknik kawalan mikro. Ia melibatkn dua sistem kawalan; satu ialah litar kawalan logik dan yang kedua ialah litar kawalan bersepadu. Kedua-dua sistem ini mempunyai teknik kawalan yang berlainan dan perisian yang tersendiri. Projek ini menunjukkan bagaimana kedua-dua sistem kawalan ini di satukan menjadi sistem kawalan yang baru. Sistem ini akan menambah bilangan masukan untuk litar kawalan logik. Perkara yang di lakukan bagi menyatukan dua sistem ini juga serasi dengan perisian dan perkakasan sistem itu.

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LIST OF ABBREVIATIONS

UTeM	Universiti Teknikal Malaysia
PLC	Programmable Logic Controller
PIC	Programmable Integrated Circuit
PC	Personal Computer
IDE	Integrated Development Environment
PSM	Projek Sarjana Muda
DC	Direct Current
LED	Light Emitting Diode
LCD	Liquid Crystal Display
REALCOM	Real-time Communication
SORCON	Software Relay Control System

CHAPTER 1

INTRODUCTION

1.1 Project Introduction

PLC is a digital computer used for automation of industrial processes, such as control of machinery on factory assembly lines. The PLC is designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. The input and output arrangements are controlled by switches or sensors through programs written beforehand. A system with a large number of sensors often suffers connect ability when using basic PLC system. Buying additional standard PLC Input port is often not a cost-efficient solution because of its high cost.

This project aims to expand PLC port inexpensively using microcontroller while maintaining standard PLC input properties and functionality. PIC Microcontroller is a computer system that is fabricated in single integrated chip. A PIC consists of a Central Processing Unit (CPU), memory modules and several input and output peripherals. In short, both PLC and PIC are able to be control elements for machines. PLC however has very limited input and output, thus the limitation of instruction and direction given to it. To add the input and output to a PLC, a PIC is needed. The project is about interfacing PIC with PLC. In this case, more input will be provided to the PLC. The way that both these things will interface will be determined during this research. As a component PLC attachment project, the project furnishes a user instruction manual.

1.2 Project Objectives

The objectives of this project are as stated below:

1. To add more input ports to PLC using PIC microcontroller.
2. To allow the interface of the two control elements, the PLC and PIC using means that will be researched.
3. To ensure that the input data is compatible with the output data.
4. To research on the effects of using switches and sensors to the input or output port after the interface.
5. To research on the possibilities of expanding this port expansion technique.
6. To implement this port expansion technique to industrial use or any other control elements that needs a lot of instructions in order to function.
7. To prepare a user instruction manual for the finished product.

1.3 Statement of Problem

PLC has very limited input and output, thus the limitation of instruction and direction given to it. PLCs typically use 16-bit signed binary processors. The PLC has only 16 input and output ports that makes it very limited to certain processes. PLCs were usually configured with only a few analog control loops. Certain processes require hundreds or thousands of loops. This is very true when industrial processes are concerned. Machines and robots need a lot of instructions for it to function properly. PLCs are still used for these machineries mainly because they are rugged and sturdy. With this limitation to instructions, the PLC is at a disadvantage when it comes to budget. This is because PLC needs to be added if the current amount of PLC cannot store as much information (in forms of programmed instructions) as it should for the machine to operate.

This is where the problem arises. Input and output ports need to be added for it to receive and produce more output as more instructions are given. Interfacing PLC and PIC needs a lot of things figured out. Things like discrete signals sent to PLC with voltage of 24 V DC I/O, while PIC only needs 5 V DC I/O. With different

activation voltages, both PLC and PIC must interact and able to send and receive data from each other. This project however will concentrate more on the input of the PLC.

1.4 Scope of Work

When discussing about control systems, a control element needs to chosen. In this project, two control elements are to be determined. The PLC chosen is the OMRON PLC CJ1G/H and the PIC that will be used is the PIC16F877A. The reason for this choice was these two models are easily found and researched.

The software programming that will be used for the PLC would be the CX-Programmer whereas designs and creation of diagrams are made. The software programming tool for the PIC however is the SourceBoost IDE and the Proteus. SourceBoost IDE will be used to write the programs while Proteus is the software for its simulation.

The main idea is to add more input ports to PLC via PIC since ports from PLC are very limited. If the PLC needs more input, the PLC will send a data to the PIC that will operate the PIC. PIC then will resend the data and provide more input to the PLC without compromising the previous data input to the PLC.

1.5 Methodology

This project began with the research of the proposed title. The result of that research is then discussed with the supervisor. Once we have agreed with the supervisor on the title, the background of study for this project is searched. Here, theories on this project are found. When the project has progressed thus far, the process of designing the system can be done. Components can now be chosen and the control elements programmed using the desired software. An interface device should also be chosen. The correct software is chosen to comply with the control elements. The connection of the PIC and PLC is as seen below:

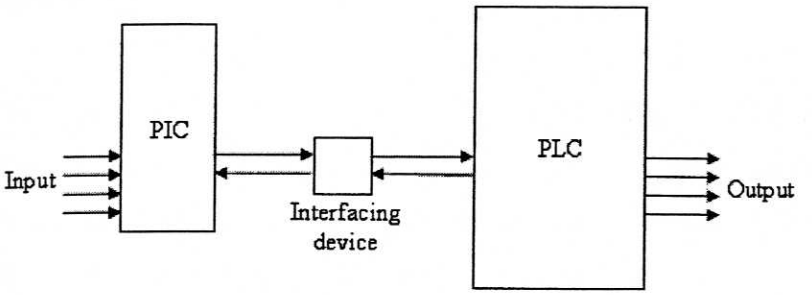

Figure 1.1: PIC and PLC connection

The PIC will be connected to the PLC through a series of relays. The main concern here is to maintain PLC input and output properties. This means that the input and output voltage should always be the PLC operational voltage; 24V. The relays come into motion when changing the voltage value. PIC operates only with 5V of supply. What happens here is 24V from the PLC power supply is regulated to 5V in order to operate the PIC. When data from the PIC is sent to the PLC, the voltage is changed from 5V to 24V using relays. The figure can be seen below:

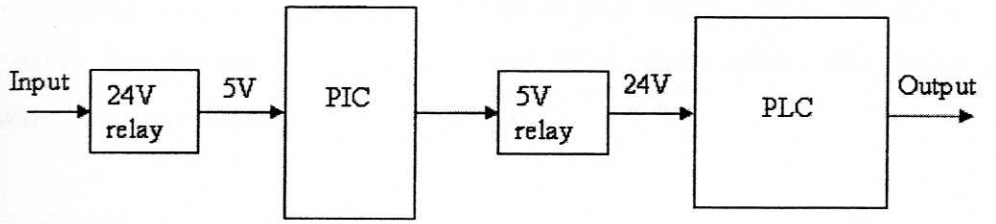

Figure 1.2: PIC and PLC connection through relays

PLC input is added by programming the PIC to respond to the PLC. Eight input ports and three output ports in the PIC are used to execute this. The three output ports are connected to three input ports of the PLC. Here, the input port of the PLC is added from three to eight input ports. The PLC is also programmed to execute the instructions given to it. Although the input port is added by the PIC, the PLC is still the main control unit. To execute other instructions given to this module, the programming only needs to be done in the PLC.

1.6 Report Structure

This report shall explain how this project came to be. What is done thus far is compiled in this report. All of contents of this report are useful to fast pacing this project to the next level. So it is important that the contents of this report to be thoroughly researched and put into place.

Chapter 1 introduces the project as a whole. The early and basic explanations are mentioned in this chapter. This chapter consists of the project's objectives, statements of problems, scope of work, and the simplified methodology.

Chapter 2 is literature review. Past projects or researches are taken into consideration when completing this chapter. The ways those projects and researches are done are compared with what this project is all about. These comparisons are done to understand what this project is all about and where it stands.

Chapter 3 enlightens on the components used in this project. It is divided into two parts; the hardware and the software. Each part explains the components, software and programmes used in this project.

Chapter 4 explains how this project came to be. It is the methodology. The ways and procedures in which this project is done. This chapter will enlighten the part most important of all, the flow this project. What is researched and what needs to be done is explained in this chapter.

Chapter 5 concentrates on the result and discussion of this project. What has been done thus far is explained in diagrams and written programs. Why the results are like so will also be explained. The reasons and setbacks that cause the project to be halted are discussed in this chapter. The expected results will also be mentioned in this chapter.

Chapter 6 is the final chapter in this report. The conclusions and recommendations are placed in this chapter. The conclusion is the final overview of this project. In other words, the conclusion is the summary of what has been done

throughout this project. After the project is done, recommendations are made for the betterment of this project or any expansions or upgrades that might be done in the future.

CHAPTER 2

LITERATURE REVIEW

2.1 Previous Study and Research

There have been projects in the past that were done which shows similarities to this project. This chapter compares the studies as such to the one being researched. One of the articles that were found in one of the many IEEE journals states that there is software controls for PLCs and that the controls are varied and have their own differences. This chapter shall prove that there are possibilities for such interface (PIC with PLC).

In 1989, two researchers presented their findings on PLC control in an article entitled "Software Control Interface to a Programmable Logic Controller" where the possibility of interfacing PLC with a computer is possible. This research, done by Deborah L. Blocker and David G. Green summarizes the design, development, and implementation of a Software Relay Control system interface to a Struthers-Dunn Director One Programmable Logic Controller. This research was done for their university, The University of Alabama, Birmingham, A1abama. The control called SORCON was used in this project. SORCON is short for "Software Relay Control System".

There are many versions of SORCON and the first version system involved a Prime 550 minicomputer and a time-sharing LSI-11/23 computer. The hardware consisted of sixteen input converters and sixteen output switches. The LSI-11/23