DEVELOPMENT OF I/O CARD FOR PC BY USING MICROCHIP VIA RS232 PORT AND USB PORT

YEOH HOOI LIANG

UNIVERSITI SAINS MALAYSIA

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DEVELOPMENT OF I/O CARD FOR PC BY USING MICROCHIP VIA RS232 PORT AND USB PORT

by

YEOH HOOI LIANG

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List of Abbreviations

I/O	Input/Output
USB	Universe Serial Bus
PC	Personal Computer
MSSP	Medicare Shared Savings Program
WDT	Watchdog Timer
CCP	Capture/Compare/PWM
ADC	Analog To Digital Converter
POR	Power ON Reset
PSP	Parallel Slave Port
CAN	Controller Area Network
TTL	Transistor-transistor Logic
PCB	Printed Circuit Board
CMOS	Complementary Metal Oxide
MOSFET	Metal Oxide Semiconductor Field Effect Transistor
MCU	Microcontroller Unit
BJT	Bipolar Junction Transistor
AD	Analog-to-digital
DA	Digital-to-analog
ICSP	In-Circuit Serial Programming
PDIP	Plastic Dual In-Line Package
DC	Direct Current
GUI	Graphic User Interface
PWM	Pulse Width Modulation
DSP	Digital Signal Processor

IR	Infrared Radiation
LCD	Liquid Crystal Display

Abstract

The communication between the PC and I/O card which able to control the output signal to machine and read the input signal from machines. Communication is one of the important part in the industrial manufacturing process. There are many types of ports which can be used to communicate with the PC. For this project, the USB and RS232 ports are used to enable the PC to communicate with I/O card. The schematic part need to focus the part of the I/O pins. The voltage signal levels input are higher than the voltage signal levels that can be supported by the I/O card. The optocouplers can be used for switch on the high voltage signal levels output. The high voltage signal levels from the machines will switch on the low signal levels input then send to PIC18 microcontroller. The higher voltage signal levels can between 5V and 24V and the lower signal levels only cannot higher than 0.8V. The microcontroller that used in this project for control the communication of I/O card with the PC is PIC18 microcontroller. The skill of drawing the PCB layout needed in this project. Troubleshoot process need to carry on and avoid the short circuit. PIC18 microcontroller is used need the programming language knowledge to control the system of the communication. PC able to read the input that sent from the machines or sensors, the PC need to set the status of the output. The result will show as the verification of I/O card with PC communication. There are different applications used to test the I/O pins can send and read signal correctly.

Abstrak

Komunikasi antara PC dan I/O kad yang dapat mengawal isyarat output untuk mesin dan membaca isyarat input dari mesin. Komunikasi adalah salah satu bahagian yang penting dalam proses pembuatan perindustrian. Terdapat banyak jenis port yang boleh digunakan untuk berkomunikasi dengan PC. Untuk projek ini, USB dan RS232 port digunakan untuk membolehkan komputer untuk berkomunikasi dengan I/O kad. Bahagian skema perlu memberi tumpuan pada I/O pin. Isyarat voltan tahap input adalah lebih tinggi daripada tahap isyarat voltan yang boleh disokong oleh I/O kad. Optocouplers boleh digunakan untuk suis voltan tinggi tahap isyarat output. Tahap isyarat voltan tinggi dari mesin akan beralih kepada tahap rendah isyarat input kemudian menghantar kepada PIC18 microcontroller. Tahap isyarat voltan yang lebih tinggi boleh di antara 5V dan 24V dan tahap isyarat yang lebih rendah hanya boleh tidak lebih tinggi daripada 0.8V. Mirocontroller yang digunakan dalam projek ini untuk kawalan komunikasi I/O kad dengan PC adalah PIC18 microcontroller. Kemahiran melukis susun atur PCB yang diperlukan dalam projek ini. Selesaikan masalah proses perlu menjalankan dan mengelakkan litar pintas. PIC18 microcontroller digunakan memerlukan pengetahuan bahasa pengaturcaraan untuk mengawal sistem komunikasi. PC dapat membaca isyarat yang menghantar dari mesin atau sensor, PC perlu menghantar isyarat ke mesin. Hasilnya akan dipaparkan sebagai pengesahan I/O kad dengan komunikasi PC. Terdapat aplikasi yang berbeza digunakan untuk menguji I / O pin boleh menghantar dan membaca isyarat dengan betul.

Chapter 1

Introduction

1.1 Research Background

Nowadays, there are many industries use a lot of machines to replace the human resources which to improve the quality of work and make the manufacture process more fast and efficient. Machines also can work in longer period if compare with the human resources. Thus, machines are used commonly in the industries. The communication between the PC and machines is very important in the industries, because it can let the operators to know the information and control the machines. There are two main types of the communication such as wireless communication and wired communication. One of the wired communications is the I/O card.

The wired communication which will be focus in this project is I/O cards. In this project will use the microchip to do the I/O board to communicate between the PC and machines. The RS232 cables are commonly used in the industries and the USB cable is mostly used in our daily life. In this project, the I/O board is design with the RS232 port and USB port. This is because for the users can use which ports that want to use by them. The main component to design the I/O board is microchip which is the microcontroller.

The input pins and output pins are needed to let the PC can read or set the status of input or output via USB port and RS232 port. The card also need has the input pins and output pins for connect with the machines or sensors. The input pins are used for the machines or sensors to send the status to the I/O card and let the PC to read the status. Then, users can set the status and send from the output pins to machines or sensors.

The status of the sensors in the industries use the NPN transistors commonly, this mean the output status from the sensors or machines is zero which mean it is low or zero signal. The input pins of I/O card will receive the zero state or low signal.

Furthermore, the state to send to output pins can be assign high or low by us. The voltage of machine used commonly in the industries is 24V which is higher than the I/O board voltage. This means need to design the schematic that can allow to receive the high voltage signal from input pins and to protect the board from burst. Moreover, the output signal send from output pins must able to switch and activate the sensors or machines, since the I/O board only can send the 5V which mean not enough to support the machines and sensors.

1.2 Problem Statement

The manufacture processes are very important in the industries now. They may affect the quality of the products that produced by factory. The communication is one main part of the manufacture processes. In this project, the I/O card is developed for the PC to communicate with the machines or sensors. I/O board must have the pins for the data transfer. There are 6 pins for input pins and 6 pins for output pins in this I/O card. The PIC microcontroller is used in this I/O card. There are various types of PIC microcontrollers. The PIC18 microcontroller family provides in 18 to 80 pins packages. The PIC18F2550 microcontroller is used for this project because there are enough pins for design I/O board and it can connect with the RS232 port and USB port. Furthermore, PIC18 microcontroller family has all the popular peripherals, such as MSSP, WDT, CCP, 10 bits ADC, flexible 8 and 16 bits timers, POR, PSP and CAN

2.0B. They also operate from 2.0 to 5.5V. The PIC18 family offers the high flexible solution for the embedded applications.

The RS232 port need connect to MAX232 IC and cannot connect directly with the PIC18F2550 because for the RS232 standard is logic 1 represents -1.5V to -25V and logic 0 represents 1.5V to 25V. This standard defines the requirements at receiver and transmitter. An interface IC is needed for make it compatible with the TTL output. MAX232 is one of IC which is used for convert the TTL logic to RS232 standard and vice versa. Data transfer of RS232 is unidirectional on the transmit line and receive line and use asynchronous framing.

USB is a plug and play interface that allows a computer to communicate with other devices. Nowadays, there are many of different USB devices because the USB has the high speed for data transfer. As example like USB 3.0 can support transfer rates up to 5.0 gigabits per second. USB is more easy to connect if compare with the RS232 port. The data transfer uses is 0 or +5 V balanced differential voltage signaling. Data transfer of USB is bidirectional with ownership of the bus being an integral part of the protocol.

PICkit 3 and MPLAB IDE is used for the programming the PIC microcontroller. In the software part, need set up the command of the PC to set the output pins status and read the input pins status. Switch on the output pins also have the own command. I/O card will reply command to PC and let the PC confirm the data transfer completed. If other than the set up commands, PC will reply the error.

1.3 Objectives

The aim of this project is to develop an I/O card for the PC communicates with the machines or sensors via RS232 port and USB port. The PC can set and read the status of the I/O card and the I/O card will reply the command. The focus of this project is the ways of the PC to read the status of I/O card receive and set the output of the I/O card and also include the I/O card reply command.

The objectives include:

i. To develop I/O card by using microchip.

ii. To make the communication between the PC with I/O card.

iii. To verify the accuracy of the data transfer between PC and I/O card.

1.4 Project Scope

The focus of this project is to develop the I/O card by using PIC microcontroller. The hardware part need make sure the RS232 port and USB port connect correctly with other components. The machines and sensors using in industries is standard at output signal is 24V with logic 0 so the I/O card must make sure can able to protect the board of the input pins of I/O card so the board will not burst. The input pins need make sure the high voltage signal from machines or sensors will not burst the I/O card. Furthermore, the output pins need able to send the low voltage signal to the machines and sensors. In the I/O terminal, the optocouplers are needed because they have current protection so the I/O board can be protected from burst. The software part is to use the MPLAB IDE to programming the PIC microcontroller so it can attach the requirements.

The requirements such as the PC read one digital input terminal by send the command to I/O card and waiting the I/O card reply the command and the PC also can read all the digital terminals by sending the status top I/O card and wait the I/O card reply the command then check the case weather on or off. Furthermore, the PC will on the digital output terminal by sending the different logic such as 0 or 1 to on or off one output terminal. The PC also need check the reply from the I/O card, if the status is reply ready then the output terminal will turn on or off. The PC also need able to read the analog output and analog input such as I/O card reply status as represent the 5V is sent or received.

1.5 Thesis Outline

This part is to explain the outline of thesis. Chapter one is the introduction of this project and also includes the project background. It also consist the problem statements and also include the project scope. This outline also stated together in this part.

Chapter two is the literature review which summarizes the information from the other works which include PCB board. The basic concepts of the RS232 port and USB port which include their standard. It also explains the different between the two ports. In this part also study the microchip that use in this project such as PIC microcontroller. In this chapter also include the study of the standard of the I/O pins from other works and also study the standard of the voltage used in industries.

Chapter three will discuss the methods to design the schematics and also do the alignment of the PCB. It includes the way to complete the PCB board to do as I/O card.

The algorithm of the programming parts such as the ways of the PC communication with I/O board. The flow chart and block diagrams will include in this part.

Chapter four focus on the result that the I/O card can function correctly and reply the command or status correctly to PC. The overall design will also show in this part.

Chapter five is doing the conclusion of this project which from the start stage to the final stage of the development. The limitation of this project and include the future works which can adding in this project and make it more functions and useful.

CHAPTER 2

Literature Review

2.1 Introduction

This chapter presents the information of the research before start this project. There are some concepts will help to apply to this project. This study will be based on the requirements of this project. For I/O card, the standard of the I/O pins that using in industries and the machines voltage standard. For the communication, the functions of the USB and RS232 port must be understand.

2.2 System for Dynamically Configuring I/O Device Adapters

The ready or not ready status need stored by the register which utilized by an application, system and method permitting dynamic configuration of I/O device adapters[1]. Dynamic configuration decision logic detect which I/O device adapters connected to the bus. It also determine the configuration parameter of the each I/O device adapter and sets the corresponding flag in the register to indicate the status[1]. From here, the I/O card can use the concept that use the ready or not ready status concept when I/O card reply to the PC after the PC send the command to the I/O card. Figure 2.1 shows the communication between the I/O devices with the I/O adapter. However, this project does not require the ready and ready status stored, I/O card also need able to compare the commands that the PC send to the I/O card.

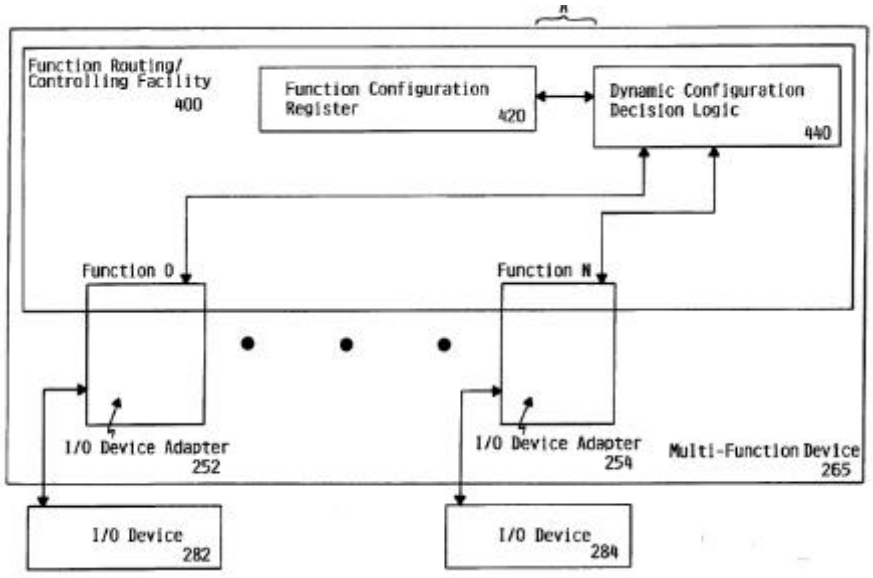

Figure 2.1: Communication between the I/O devices and I/O device adapters[1]

2.3 CMOS Low Power Mixed Voltage Bidirectional I/O Buffer

Using the lower power CMOS design as the bidirectional I/O buffer that transfer the low voltage signals into the highest logic voltage signals[2]. This can used to output a logic level signal[2]. The concept of this work can be as refer because I/O card need to use the low level signal to output the high level signal. For this invention also can help the DC power consumption that requires voltage translation to represent the binary logic levels. For this project can use the concept that transfer the low voltage signals into the highest logic voltage signals, but the for this I/O card need 6 output pins and 6 input pins cannot use the method. The reason is without the machines to do the fabrication process which need to provide a p-well for the N-transistors and a n-well for the P-type transistors.

2.4 Circuit for Obtaining DC Voltage Higher Than Power Source Voltage

I/O card need to send the signal to on the output pins by the higher voltage because industrial sensors need the higher sensor than the power source that supply to the I/O card. A voltage boosting circuit can be used to provide the high voltage as output. The boosting circuit is formed by a plurality of boosting units which connect in series and each boosting unit contain a MOSFET[3]. The disadvantage for the voltage boosting circuit need to be miniaturized by integrated circuit technique. If without have the equipment to do it, then this method cannot be used. Figure 2.2 shows the block diagram of the circuitry of electronic watch using boosting circuit.

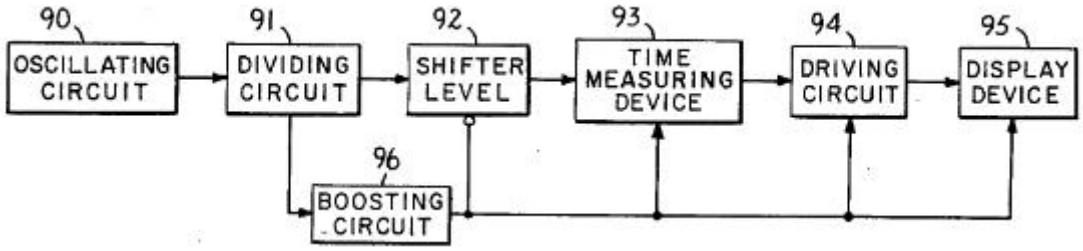

Figure 2.2: Block diagram of the circuitry of electronic watch using boosting circuit[3]

2.5 Communication Circuit Employing Optocouplers

Development of the communication circuit by using the optocoupler in the direct current control circuit[4]. Optocoupler is a component that including metal bump, a substrate, a transparent light guiding block, a light emitting unit, a receiving unit and transmitting unit. The optocoupler function is when the electrical signals input to the optocoupler, the the light will be emitted. After the light pass through the transmitting unit that control the presence of light emitting[5]. The photosensor in the receiving unit will be disposed the light. It means the light emitted will make the optocoupler in the

switch on state. The input protection circuit of an optocoupler which protects the optocoupler from damage if an over-voltage condition will be detected[6]. The benefit of using the optocoupler can also help to reduce other components used such as do not need do the current protection.

2.6 Communication Port of I/O Card with PC

Serial port is a computer interface that transmits data one bit at a time. There are different types of the serial port. For the PC, RS232 and USB ports that are able to communicate between PC and I/O card. There are many advantages of the serial port. Serial port can exchange the information such as suited for serial port often involve relays, display, or other outputs, reading sensors, switches or other inputs[7]. For some device which without built in serial ports can use USB[7]. For this project will build in the USB and RS232 port too. For RS232 port transmits speed will lower than the USB port. For USB port will used in several electronic devices. The USB cables is not longer than the RS232 cables but USB can connect with the hubs.

2.7 A Framework for Developing a Microchip PIC Microcontroller Based Application

There are many of the devices that we use today in our daily life such as telephones, household appliances and other devices, which are usually implemented as an embedded system. These are a special kind of microcomputers integrated on a single chip, which in addition to a central processing unit and a memory consists of numerous application dependent peripherals such as AD and DA converters, timers,

communication module and other else[8]. Based on each PIC microcontroller features, they will separate in the different group with same features. User can refer the features or datasheet to design the project that to attach their requirement. Microcontroller based application design can be described as the combination of the programming and the circuits constructing[9]. In the case of the development tools, the algorithms must be described in the form of different graphical representation such as flow charts or block diagram. It will help to ease and quicken the process, the C or assembly code can be programming in the faster way. Figure 2.3 shows the process design that can be refer for this project. Before start the project must know the requirements then do the specification. Then, the stimulation of circuit is needed for make sure the circuit can be functional. The component prototyping is prototype before built on to the final prototyping. This will help to verification, after the component prototyping, then the following step is build on the target to complete the prototype. Then, the development code is start then testing in software and hardware. The calibration is needed to make sure the system don't have any bugs and make sure the system operate correctly.

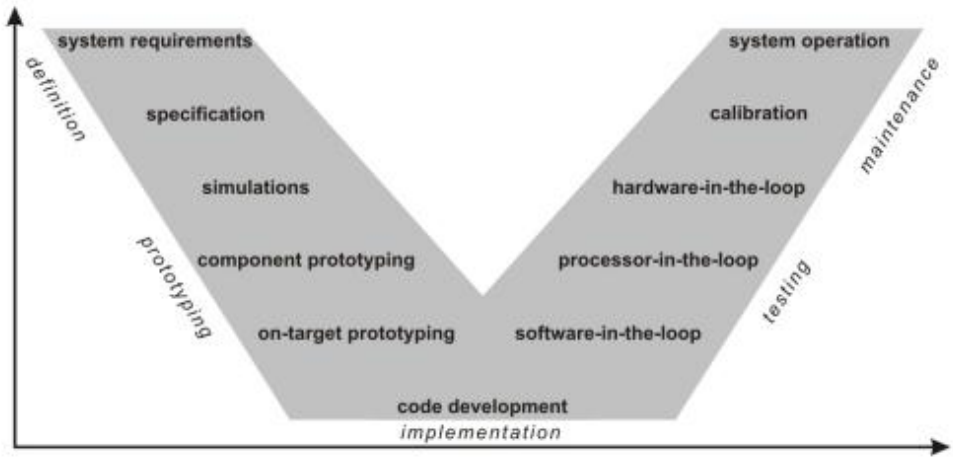

Figure 2.3: V-diagram for the project design process[9]

2.7.1 Design Assumptions

The Microchip's PIC and dsPIC microcontroller families have been selected from a range of other microcontroller families from different manufacturers due to multiple reasons[10, 11]. The microcontrollers are widely available on the market at relatively affordable. Furthermore, there are wide range of quality development and programming support tools, while the firmware transferred can be always performed with using the same interface. The choice of microcontrollers should be limited to those where the transfer of the firmware can performed using ICSP module[12]. The selection of microcontrollers is further restricted to those available in PDIP package type[12]. All microcontroller's I/O pins must be accessible on the board plug-in module connectors. The plug-in modules must be designed in such a way that even them incorrect use does not harm any components. The microcontroller that needed to use in this project must know the features and the function of pins before design the prototype.

2.8 Systems And Applications Using PIC Microcontroller

There are many example of project that can found in the journal that show the applications or systems using the PIC microcontroller. In this subtitle will study and research the example of systems and applications such as vehicle monitoring system, study of weight measurement system, low cost single-axis sun tracker system, cooling system with temperature control, secure electronic lock, synchronisation of two wiper motors and water level indicator with alarms.

2.8.1 Vehicle Monitoring System

Nowadays, there are many drivers does not obey the limit rules even all the roads have signboards indicating the maximum speed limit for sake of driver's safety. The aims of this system can automatically monitor individual vehicle speed and also count vehicles on road[13]. This system used two IR sensor that placed at fixed distance, when vehicle comes on the road, the first sensor will place at entry of road such as entry of highway toll. The second sensor will place at the exit of road such as exit of highway toll. The first sensor will detect entry and the other will cuts it detect exit. The microcontroller internal timer and counter start and calculate the speed automatically, it also include count the number of vehicle[13]. The vehicle detectors can be categorized into two types, such as hardware based detectors and software based detectors. The hardware based detectors are based on the electromagnetic principles and require dedicated hardware, microcontrollers and embedded system. The software based detectors are based on the installing camera, take video of traffic, detect vehicles and speed, count with sophisticated image processing techniques and MATLAB programming. Figure 2.4 shows the block diagram of the vehicle monitoring system. This journal provides the idea of the implementation of the IR sensor application by using PIC microcontroller, PIC16F877A. The another idea is using the LASER beams with microcontroller to detect the speed of vehicle that is more reliable and accurate results[14].

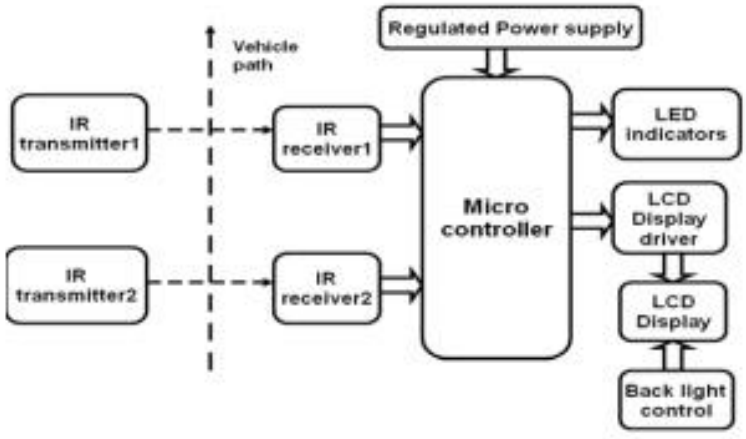

Figure 2.4: Block diagram of vehicle monitoring system[13]

2.8.2 Study Of Weight Measurement System

In daily life, electronic scales and weighing machines are important for get the accurate weight of objects. In every grocery store, vegetable shop and other else shop will use the measurement system. The PIC18F452 is using in this system. This system use to measure the weight of the object from analog output voltage and convert into digital form to display on LCD[15]. This system has a load cell to sense the weight of objects, when load is applied, the resistance of strain gauge will be changed. The change of resistance can be measured in term of voltage and amplify using differential amplifier. The inverter makes the result of the negative voltage output to positive. The output will give to the microcontroller and microcontroller will convert the output voltage into digital form by programming, then display on LCD. Figure 2.5 shows the block diagram of electronic weighing machine. The method of analog output convert into digital form output voltage can be referred if doing the analog application.

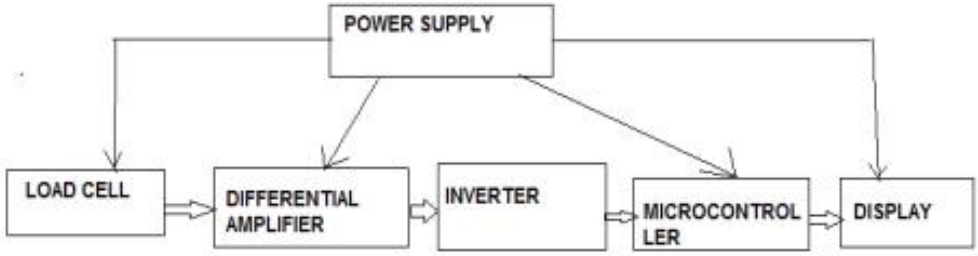

Figure 2.5: Block diagram of electronic weighing machine[15]

2.8.3 A Low Cost Single-Axis Sun Tracker System

Solar energy is a energy resource that are useful for now. A feasible approach to maximize the efficiency of solar panel systems is the sunlight tracking[16]. The solar panel moves along with the sunlight. The geared motor use to change the direction of solar panel to make sure the panel can be perpendicular to the sun's rays. The motor controlled by the PIC16F84A microcontroller. The method shows the one axis solar tracking mechanism using embedded system with minimum cost. The PIC16F84A control the DC motor with the clockwise and anticlockwise. To increase the immunity of PIC microcontroller against the electrical spikes that generated by the DC motor[17,18].

2.8.4 Cooling System With Temperature Control

Cooling system temperature control using PIC microcontroller is the operation that control the temperature without human invention by set the temperature and low degrees of cooling gradually when approaching ideal class[19]. The PIC microcontroller used for this system is PIC1650. The DC motor can be controlled

directly by microcontroller. The other mode is control the DC motor by using analog temperature sensor to detect temperature and measure the value. The analog temperature need to convert the analog voltage in to equivalent binary bits, so the A/D converter is needed[20]. The C# visual studio and GUI are used to show the result. The PIC microcontroller is used to transmit the data from sensor to PC and receive the signal from sensor. The programming will control the motor application automatically.

2.8.5 Secure Electronic Lock

The electronic embedded lock provides a great benefit than the traditional lock which use a key manually. This electronic lock system uses the keypad, HD44780 LCD and PIC16f628a microcontroller. Key scanning is need for the microcontroller scan the number that pressed by user. Giving the every row to zero at a time, then scan the column that pressed by user[21]. The PIC16f628 will get the signal from the pin that connect to the column of keypad, thus send the signal to LCD to display the result. This system can save the password key in and reset the password. It is simple and easy for user and also suitable for different secure system.

2.8.6 Synchronisation Of Two Wiper Motor

Synchronisation is normally used for drive mechanisms in industries such as Belt drive and Chain drive. Using two motor to achieve the accuracy position and control the speed of motors. Furthermore, this system also reduces the bulkiness and the power that will be consumed during reversing of the wiper arm. PIC microcontroller used is PIC18f4520 to control the two DC motor. The synchronisation

is achieved using DSP that to compare with the result get from the PIC microcontroller. The PWM block used to vary the duty cycle for both motors to use the different speed options[22]. The IR sensors use in the collision avoidance of both wipers. The two IR sensors will always check the position of the wipers with send the analog output voltage to microcontroller.

2.8.7 Water Level Indicator With Alarms

PIC microcontroller can be used to design the water level indicator for the water tank in home or industries. PIC18F452 microcontroller is used in this system. This system is pump in the water automatically when water level until a certain low level and stop the water when full. The water level controlling used the comparison of the different level of the voltage inputs to the microcontroller[23]. If the water level more than 100% level, the buzzer will be switched on and the water pump will switch off. LCD display the option start the water flow in and the 7 segment display the water level.

CHAPTER 3

METHODOLOGY

3.1 Introduction

Development of I/O card includes the hardware and software design. The outline of this chapter includes all the process of the development of I/O card. The processes include the planning, designing, troubleshooting, testing and performance. This chapter also describes the hardware and software design methods. The most important is to make sure all the steps of the design processes are done correctly and efficiently. The design of PCB board for hardware of the I/O card and the programming part need attach the requirements of the communication of I/O card with machines and PC. The parts need to be focused is about the design the I/O pins. Furthermore, the command of the programming part need make sure the I/O card can operate with correctly and reply the command to PC. This methodology includes many subsections such as project implementation flow, PIC microcontroller, MPLAB IDE software, development of PCB board, schematic design, I/O pins and the RS232 and USB ports.

For the current progress are until the PCB layout design. The next processes are programming part and the verification progress to make sure the I/O card can operate accurately.

3.2 Project Implementation Flow

Before starting the project works, research and literature review have been done to understand many concepts to develop I/O card. Furthermore, there are many useful information and methods which used previously in the other works. This will help to form the efficient process to complete the project. The PIC microcontroller is the main component of the I/O card. From the study can help to understand the functions of the PIC microcontrollers and their features. Studying the standard of I/O pins needed to use in this project. The standard of the I/O pins is refer to the industries machines and sensors. Then, the components that need to be used in this project can be decided. Then, next step is to design the schematics of the I/O card. After stimulate the I/O card, the following step is to design the PCB layout. The fabrication PCB started from step by step. After complete the PCB board, start troubleshooting the circuit, this method to help to make sure all the connection of wires is connected and without any short circuit. The hardware part is completed.

The programming part is using the MPLAB IDE software to programming the I/O card. Firstly, study the MPLAB IDE tutorials that provided by the software and using the demo board to study the assembly language for use in the demo board. The hardware for programming the PIC microcontroller is PICkit 3. At here, I also need to understand the PICkit 3concepts and functions. After understood the assembly language by using at MPLAB IDE software, start to programming the I/O card, first need to attached the requirements for the PC communication with the machines and the I/O card can reply the status to the PC to let the output pins switch on or off. At here, the comparison the status of different cases are important, so PC can send the different commands to I/O card depend on the status that read by the PC. The troubleshoot process of the programming part is done from subroutine to other subroutine. Then

combine all the subroutines together and upload to the PIC microcontroller which at the I/O card.

After complete the software and hardware parts, the testing and debugging process are started and make sure the I/O card can function correctly. If the I/O card cannot communicate or cannot get the correct verification, then need to check the software part. If the software part without any mistakes then may be the I/O board get problems. Checking and troubleshooting the I/O board. If get any connection of wires burst or other connection of components wrong or other issues such as the signal level standard get problem which mean not enough high or too low. Then the schematics need redo and do the new PCB board.

The processes written at above show as the flow charts in Figure 3.1, Figure 3.2 and Figure 3.3.

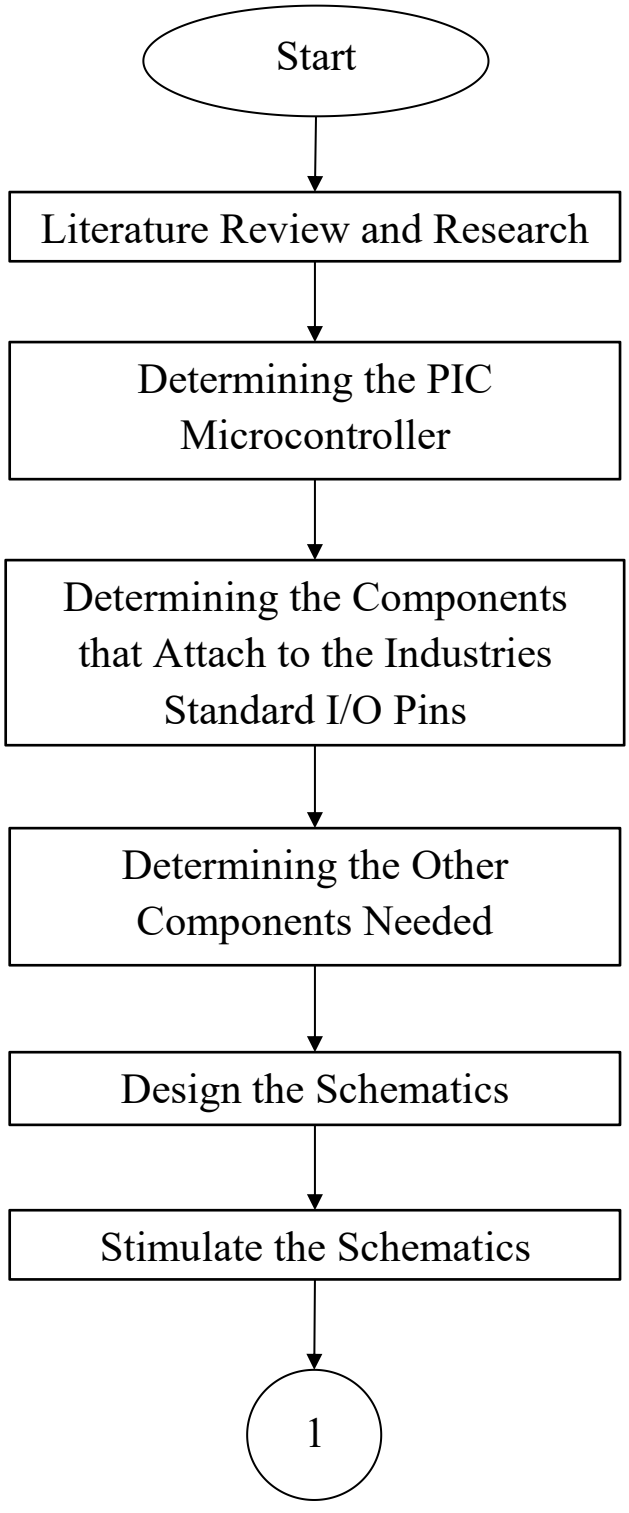

Figure 3.1: Overall process flow chart (continued)

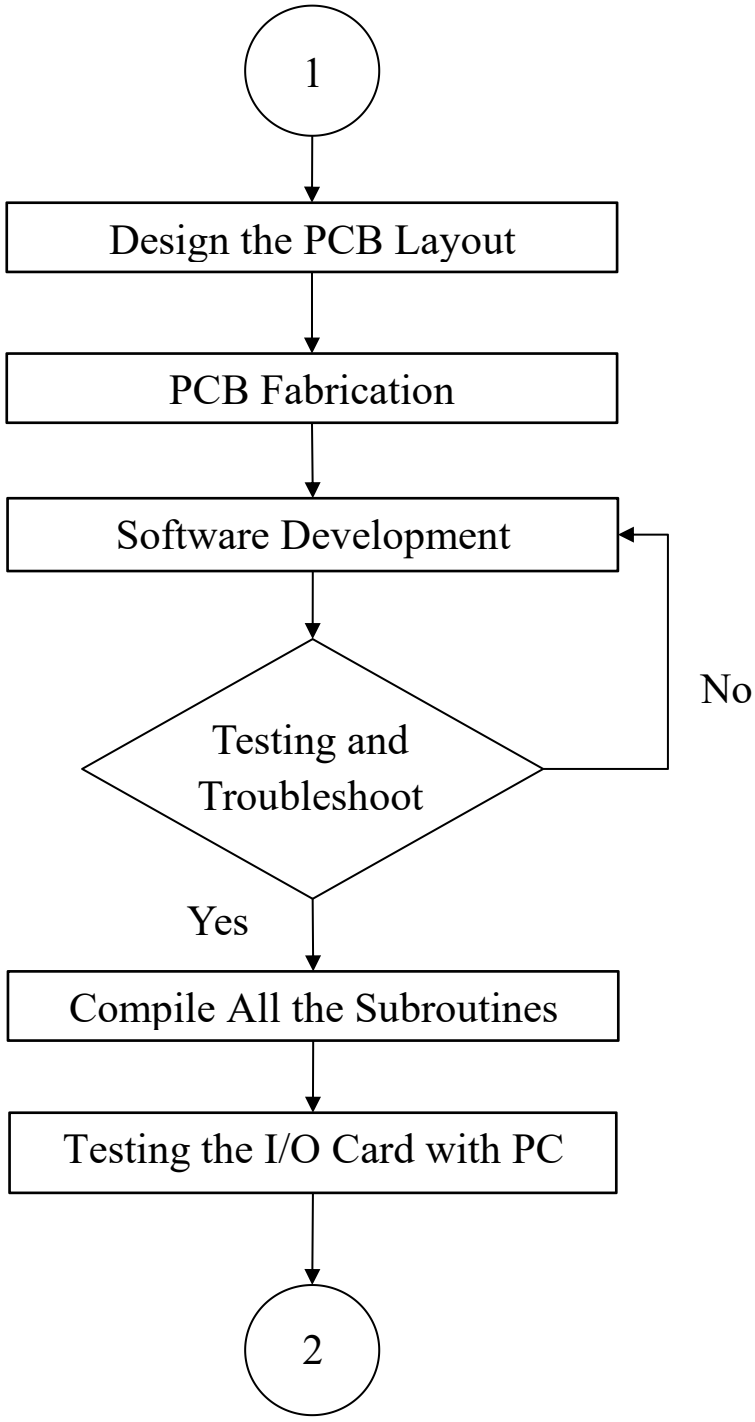

Figure 3.2: Overall process flow chart (continued)

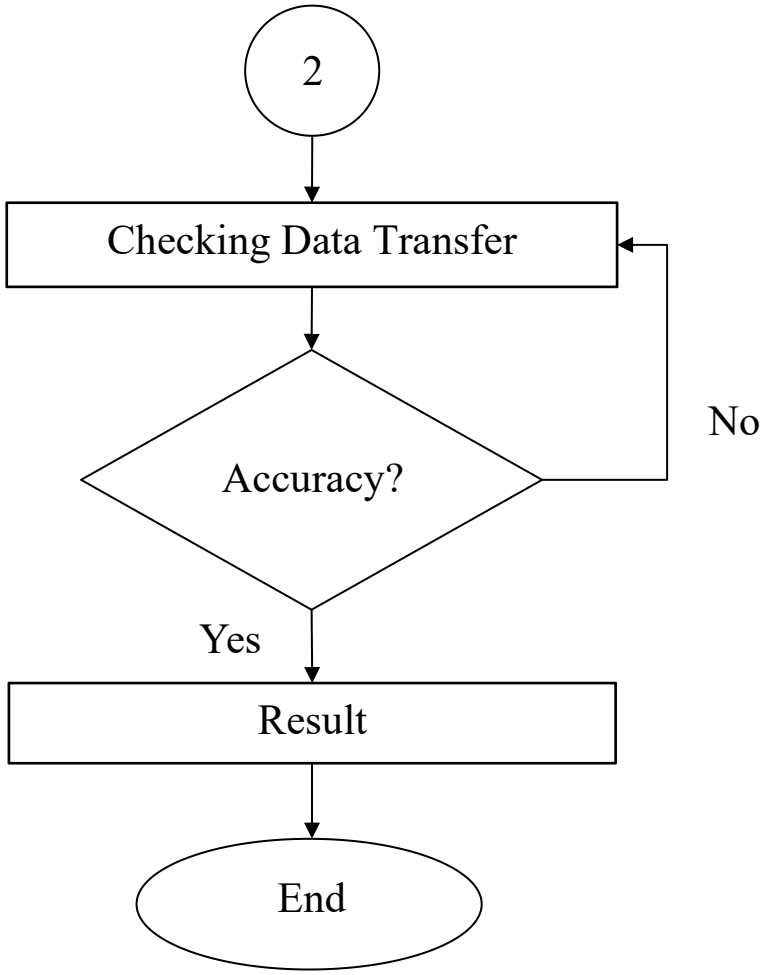

Figure 3.3: Overall process flow chart

3.3 Project Requirement

Development of I/O card by using the PIC microcontroller will need to involve the hardware and software. The details of hardware and software parts will explain at the following subtitles.

3.3.1 Hardware

The development of I/O card using the PIC microcontroller and communicate with the PC and machines or sensors by the RS232 port and USB port. The PICkit 3 needed for programming the system. The pin header connector is used for the input and output pins of I/O card. The I/O pins connection of schematics is important because it will influence the signal level that needed to receive and send. The Microchip's PICkit 3 In-Circuit Debugger/Programmer provide a low cost hardware debugger and programmer. It contains some benefits such as low cost, minimum the additional hardware for used in debugging and without required the expensive sockets or adapters. PICkit 3 In-Circuit Debugger/Programmer is not a production programmer. It is only used for the development purposes. In this project, there are many components to use on the I/O card such as resistors, capacitors, crystal, optocouplers, MAX 232 IC, pin header connector such as female pins and male pins, RS232 port and USB port.

3.3.2 Software

Development of I/O card by using PIC microcontroller must include the software because need to programming the microcontroller of the I/O card. The PCB board need to use the software to draw the schematic and do the PCB layout. Testing in