INDUSTRIAL TEMPERATURE MONITORING SYSTEM

SIA JIA LING

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To my beloved family and friends who support me, are most precious to me.

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ABSTRACT

This project describes the device that is able to use to measure the industrial temperature in manufacturing industry by using the PIC16F877A as the main control unit to monitor the operation of the overall system so that the best quality can be achieved. It also allowed other hardware module to embed to it to perform more functions to the system. CCS C Compiler is used to program the C coding into the PIC16F877A and will convert the C file into hex file so that it is easier and faster to perform. This industrial temperature monitoring system can measure temperature of the system up to 1000 degree Celsius. Visual Basic is used in this project to create the Graphic User Interface (GUI) to display the temperature readings, graph and control buttons. The limit of the temperature can also be set and the buzzer will alert when the temperature is exceeding the range of limit of the temperature. K-Type thermocouple is used as the temperature module on this system as it can measure a very high range of temperature which is more suitable as the industrial temperature monitoring system. MAX6675 is used to connect the microcontroller with the K-Type thermocouple and digitize the analogue signal obtain from the K-Type thermocouple. The results are recorded and analyzed so that the system is precise and stable.

ABSTRAK

Projek ini menerangkan fungsi bagi alat pengukuran suhu untuk mengukur suhu perindustrian dalam industri pembuatan dengan menggunakan PIC16F877A sebagai unit pemprosesan utama untuk mengawal operasi bagi keseluruhan sistem supaya dapat mencapai kualiti yang paling memuaskan. Ia juga membenarkan modul perkakasan lain untuk disambung kepadanya supaya ia dapat menjalankan fungsi lain bagi sistem itu. CCS C Compiler digunakan untuk program C Coding ke dalam PIC16F877A dan akan menukarkan C file kepada hex file untuk membenarkan sistem ini melaksanakan operasi dengan lebih senang dan cepat. Sistem bagi mengukur suhu industri ini dapat mengukur suhu sehingga 1000 darjah Celsius. Visual Basic juga digunakan dalam projek ini sebagai Graphic User Interface (GUI) untuk memaparkan bacaan bagi suhu, graf dan juga butang kawalan. Had bagi industri suhu juga dapat ditetapkan dan pembaz akan membunyi and memberi isyarat apabila suhu telah melebihi julat suhu yang telah ditetapkan. K –Type thermocouple digunakan sebagai modul suhu dalam sistem ini sebab ia dapat mengukur julat suhu yang sangat tinggi dan menjadikannya sebagai penderia yang paling sesuai dalam sistem ini. MAX6675 juga digunakan dalam projek ini untuk menyambung pengawal mikro dengan K-Type thermocouple dan mendigitalkan isyarat analog yang diperolehi dari K –Type thermocouple. Keputusan telah direkodkan dan dianalisis supaya sistem ini adalah tepat dan stabil.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATION

PIC	-	Programmable Interface Controller
LCD	-	Liquid Crystal Display
GSM	-	Global System for Mobile
LED	-	Light Emitted Diode
PCB	-	Printed circuit board
MCU	-	Microcontroller
IC	-	Integrated circuit
ADC	-	Analog-to-Digital Converters
DAC	-	Digital-to-Analog Converters
I/O	-	Input/Output
GUI	-	Graphic User Interface
SMS	-	Short Message Service
PC	-	Personal Computer

CHAPTER I

INTRODUCTION

This chapter will discuss the introduction and the concept idea of the project. Besides that, the objectives of the project will also discussed and the problem statement will be explained clearly with the specified scope of the project. After that, the methodology of the project will also be described and the report structure will be presented in this chapter.

1.1 Introduction of Project

Temperature is the parameter that is important in daily lives [2] and industrial production [4]. Temperature acts as an important role in modern detection technique for production safety and energy conservation [2]. Temperature has been developing slowly due to the complexity of it. However, it had improved as man gained wider knowledge while trying to work with metals through the iron and bronze ages.

Thermometer is the earliest design of the temperature measurement instrument around 16^{th} and 17^{th} century. The evolution of the temperature measurement after the development of thermometer is the temperature probes such as resistance temperature detector (RTD) which includes the thermistor. After that, it comes to thermocouples where it is actually a highly flexible device where the measurement happens on the interface of the two metals [6]. Hence, measurement

devices have been produced in order to provide for the needs from a range of sectors of the industries and applications.

Temperature is a very important element in manufacturing industry as it is used as the parameters to monitor the overall process and it will affect the quality of the product [2] if the temperature is out of specified range.

The aim of this project is to implement an industrial temperature monitoring system by using GSM alert with the use of PIC 16F877A as the main processing unit and thermocouple as the sensor module. The temperature will present on the Visual Basic as the hyper terminal and it is interface with microcontroller through the use of USB to UART converter in order to monitor the temperature on personal computer. If the temperature is exceeding the specified range of temperature, a message will be sending out through the GSM modem to alert the user as showed in Figure 1.1.

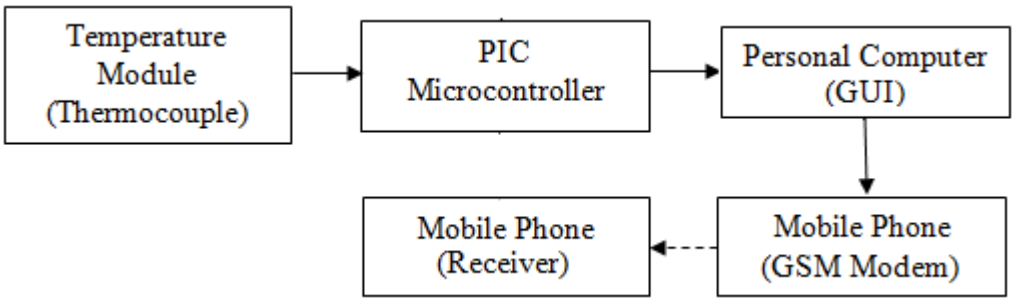

Figure 1.1: The Basic Idea of Project Block Diagram

1.2 Objectives of Project

The main objective of this project is to develop an industrial temperature monitoring system. The following sub-objectives of this project were stated as to meet the main objective.

1. To enable user to adjust the range of the temperature anytime.
2. To develop the GUI in the personal computer by using Visual Basic.
3. To provide alert via SMS notification to user if the temperature is out of range.

1.3 Problem Statement

Nowadays, device with manually monitoring are inconvenient since it consumed more waiting time for human resource [3]. All the temperature parameters within the device have to be monitored manually if there is any error occurs. Besides that, it is very troublesome since it cannot be access anywhere and anytime if the temperature monitoring device is build-in within the monitoring system [3].

Besides that, the readings for most of the device with temperature monitoring system [5] are display through the use of LCD screen [4]. This is inefficient because the data shown on the LCD screen is very limited and it will be not convenient if there is any adjusting of the temperature.

In addition, the storage of the microcontroller for the historical data is very limited as it can only store up to 3 days with 5 seconds for each interval [4]. It is not efficient if the data for about a week ago is needed for the user for analysis of the product.

1.4 Scope of Project

There are several points that have been outlined in order to accomplish the objectives of the project. The scope of the project included:

1. Development of the Temperature Monitoring System that can be used to measure the temperature of the chamber based on PIC16F877A microcontroller.
2. Interfacing PIC microcontroller and personal computer using RS232 cable.
3. Interfacing the PIC microcontroller with the mobile phone by using another mobile phone as the GSM modem for user to receive alert whenever the temperature is out of range.
4. Development of the Graphics User Interface by using Visual Basic in order to set the upper and lower temperature limit.
5. Development of C Language as the program code for PIC chip.

1.5 Brief Explanation of Methodology

This project is first started with the discussion with supervisor regarding the basic ideas of the project. After that, the scope and concept used also have been discussed. The background study and literature review of this project are done by referring to several sources such as I.E.E.E journals, conferences paper, reference book, data sheets and internet. After that, the components needed for this project such as microcontroller, temperature sensor and so on has also been searched in order to obtain more information on it. Then, suitable parts will be chosen to implement on this project. After that, the software required for this project is also studied and the most suitable programming language is used to program the codes for the system. In addition, the software used for simulation is also studied so that the simulation can be done successfully and can be proceed to the hardware part of the project. For the next stage, hardware is interfacing with the software and will progress to system testing. If there is any error occurs, the system required troubleshooting in order to achieve the desired result. Finally, the project is finalized and presented and can be proceed to thesis writing on the overall project.

1.6 Report Structure

This thesis discusses the design of the industrial temperature monitoring system. In general, it consists of five chapters.

Chapter 1 contains the general information of the project where it includes the introduction, objectives, problem statements, scope of work, methodology and the report structure of the project.

Chapter 2 contains the background studies and the literature review of the project. It discussed the fundamental information of the design and the main components used in this system.

Chapter 3 introduces the methodology of the project which includes the flow chart of the overall system and the method used for implementation. This chapter also contained the software development for the project.

Chapter 4 documented the design and the result for the project outcome. the circuit diagram, program coding and the data collected are presented are discussed in this chapter.

Chapter 5 presented the conclusion of the project and the recommendations that can be implemented in this system for future improvement.

CHAPTER II

LITERATURE REVIEW

This chapter reviews on the related projects so that the idea and the concept of the design can be obtained. Besides that, the related elements such as the microcontroller, temperature sensor, MAX6675 integrated circuit and some related software such as CCS C Compiler, Proteus 7 software and Visual Basic 6 are also discussed in this chapter.

2.1 Microcontroller

Microcontroller (MCU) is a processor unit with work voltage of 5V [9] and build-in memory. It contains a number of components integrated on a chip [14]. It can directly reduce the size of the PCB and save costs in terms of time, money and space. Microcontroller can be used on various application based on the types of the microcontroller used as shown in Figure 2.1.

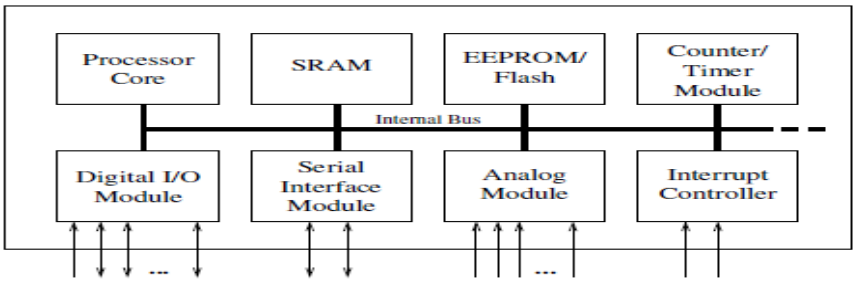

Figure 2.1: Basic Layout of Microcontroller

The processor core acts as the CPU of the microcontroller where it contains the control unit, registers and arithmetic logic unit. For the interrupt controller, it is very useful for interrupting the program flow in internal or external events and can help to conserve the power when it is in sleep modes [14]. Besides that, most of the microcontroller has two or three timer which it can be used to measure the intervals and so on. In addition, microcontroller contains at least one serial interface so that it can be used to download some program and communicate with the personal computer. Most of the microcontrollers offer various types of interfaces such as SPI since it can be used to communicate with external peripheral devices. Moreover, watchdog timer has been used so that crashes in microcontroller can be reset and it is very important to prevent errors occur in the program [14].

Microcontroller has implement all the useful elements on a single chip and thus helps in saves space and the manufacturing costs has been lower down and the times of the development has become shorter as compare with other devices [14]. Besides that, it is easier to upgrade and consume less power with higher reliability which made it very important factors in embedded system. The microcontroller that has been chosen to use for this project is the PIC16F877A where it will acts as the main control unit for the system [14] as shown in Figure 2.2.

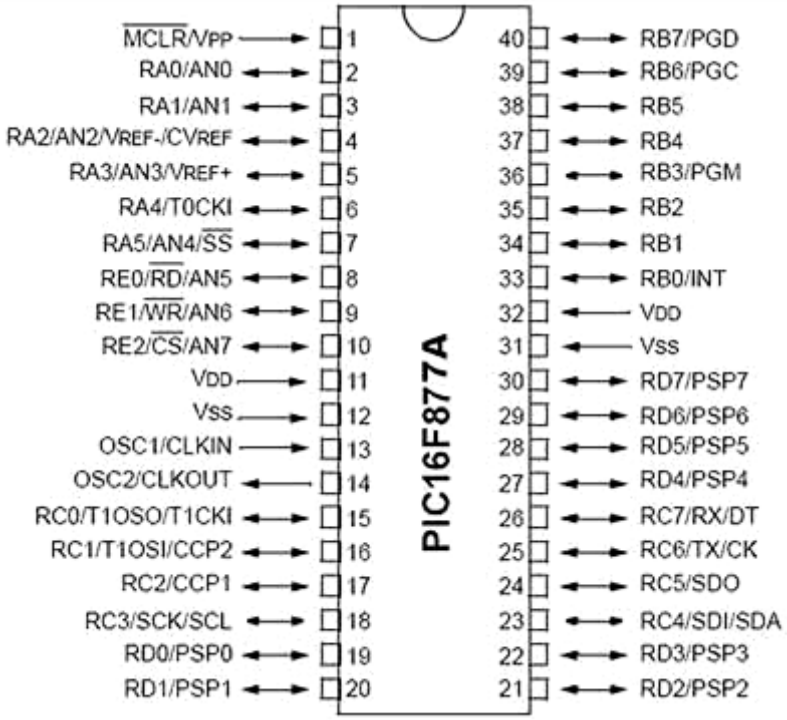

Figure 2.2: PIC 16F877A Pin Diagram

The number of pins for the input and output of the microcontroller is different based on the types of microcontroller used. It can be programmed to acts as either input or output to switch during the operations of the microcontroller. For the PIC16F877A, alternate function has been added for the I/O ports and will not be use as general purpose when the peripheral is enabled.

Universal Synchronous/ Asynchronous Receive Transmit (USART) have been used to execute for the off-board and serial connections function. RS-232 has been used to interface the PC with PIC. MAX232 which acts as a converted chip has been used in order to convert the voltage level of the PC into corresponding voltage level of the PIC MCU. It can be acts as a driver or receiver and convert the signals of the transmitter or the signals of the receiver. MAX 232 can be used to operate with single 5V power supply. The operation of USART is showed as Figure 2.3.

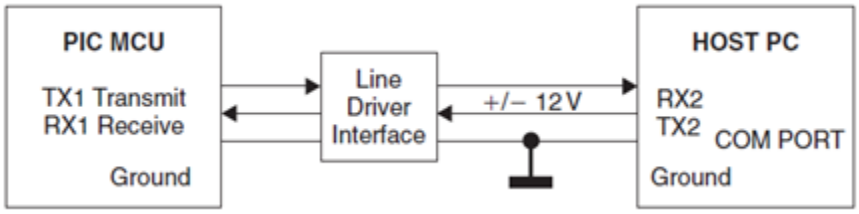

Figure 2.3: Operation of USART

2.2 Temperature Sensor

Based on the article of embedded temperature monitoring and control unit [1], it stated that by implement a temperature monitoring circuit, the working temperature can be monitored and control with the time set in the system. Every application required different types of temperature sensor and technology. There are three types of commonly used temperature sensor for the temperature measurement system.

Thermistors are a thermally variable resistor where the actual temperature can be estimated by the approximation between the resistance towards the electronics and the changing in temperature [1]. Positive temperature coefficient thermistors is type of a thermistors where the resistance increases as the temperature increase while the negative temperature coefficient thermistors is another type of thermistors where the temperature decrease as the resistance decrease. Thermistors are inexpensive, simplest and most sensitive temperature sensor used. However, it is easily broken and has a limited range where the temperature is not allowed to exceed 200°C. Hence, thermistors are more suitable for low cost and simple electronic circuit.

LM35 series also included as one of the temperature sensor where its output voltage is linearly proportional to the Celsius (centigrade) temperature [1]. The voltage value will then pass to the ADC to convert the analogue signal to digital signal. The end user does not need to subtract constant voltage from its output in order to get the temperature readings in Celsius. This made it as one of the advantages of LM35. Besides that, it does not required external calibration in order to get more accurate readings for temperature measurements. Besides that, linear output and low output impedance also make the circuit easier to control. However,