THE TEMPERATURE CONTROL SYSTEM USING PLC

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MEI 2007

"I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Control, Instrumentation and Automation)"

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This Report Is Submitted In Partial Fulfillment of Requirements for the Degree of Bachelor in Electrical Engineering (Control, Instrumentation and Automation)

FAKULTI KEJURUTERAAN ELEKTRIK

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

MEI 2007

"I hereby declared that this report is a result of my own work except for the excerpts that have been cited clearly in the references."

Signature: ....

Name: **MOHD ZULHELMI BIN HALIM**

Date: ....4/05/2007..........................

"To my beloved mother and father"

ABSTRACT

This project is to develop a low cost and flexible for controlling the temperature. The purpose of the temperature control is to facilitate cooling system to a specified temperature, then maintain it at that temperature in a controlled manner. Programmable logical controller (PLC) is the best way in which this type of precision control can be accomplish. By using the PLC technology has made it possible, practical and desirable to have the temperature control included in the same instrument that is also controlling the other aspects of the equipments. At the end of this project, a prototype of temperature control system will be developed which respect to real system.

ABSTRAK

Projek ini adalah untuk membangunkan sebuah sistem kawalan suhu yang fleksibel dengan kos yang agak rendah.Tujuan utama projek atau sistem kawalan suhu ini adalah untuk memudahkan pengguna dari segi penetapan suhu didalam sesebuah bilik.Kemudian suhu tersebut akan terus dikekalkan menurut kehendak pengguna tersebut.Dengan menggunakan suatu perisian atau pengatucaraan yang dikenali sebagai sistem Pengatucaraan Kawalan Logik (Programmable Logical Contoller) adalah suatu cara yang terbaik untuk mengawal sistem tersebut.Dalam pada itu juga dengan menggunakan pengaturcaraan ini ianya lebih praktikal dan mampu mengawal suhu yang diingini oleh pengguna tersebut.Diakhir projek ini, sebuah prototaip sistem kawalan suhu dapat dibangunkan yang menyerupai sistem kawalan suhu yang sebenar.

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LIST OF ABBREVIATIONS

PLC	-	Programmable Logical Controller
HMI	-	Human-Machine Interface
HVAC	-	High Voltage Alternating Current
P2P	-	Peer-To-Peer
I/O	-	Input/Output
RTD	-	Resistor Temperature Detector

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CHAPTER 1

INTRODUCTION

1.1 Introduction of the Project

After going through a whole tedious working day isn't it a wonderful thing if people can just relax on the sofa and controls the temperature in the living room, just with single button the room temperature have been control an automatically, so when the room temperature is too cold the heater system will operate to a regulated temperature and otherwise when the room temperature is too hot the cooling system will be operate to a targeted temperature.

Regarding from that, the project will divide by two parts hardware development and software development. Thermostat as the sensor and also to measure the temperature parameter and will send the signal to the programmable logic controller (PLC) in "ON" or "OFF" signal. The main part of this project is programmable logic controller (PLC) which can be considered as the 'brain' of this project. Due to several considerations which will be discussed at the following chapters, PLC is chosen to be implemented in this project.

1.2 Objectives

There are four objectives to be achieved in this project. Below are the following objectives:

1.2.1 To design appropriate circuit for temperature control.

1.2.2 To design software using PLC for temperature control.

1.2.3 To interface PLC module with the inputs and outputs component.

1.2 4 To design a prototype system for temperature control.

1.3 Scope of the Project

To achieve the objectives and purpose of the project, the scope of study and research can be divided into following areas:

1.3 .1 Design and develop the prototype of the temperature control system by using PLC as the controller to enhance the existing system.

- ✓ This project will develop the prototype which is respect to the actual system.

1.3.2 The development of hardware and software.

- ✓ Hardware

1) Literature study of the hardware including PLC and others components.
2) Programmable logic controller (PLC) will used the as the brain of the project and the model is NAIS FPO –C14RS.
3) Thermostat sensor will be used as the sensor for temperature.
4) DC power supply(24V)
5) Fan will replace or represent for the air-conditioner system.
6) Hair dryer will replace or represent for the heater system.

- ✓ Software
  1) Several literature review of the CX-Programmer for the PLC OMRON
  2) The related software will be used is FPSOFT as the source code to the PLC.
  3) Ladder diagram as the source code to the PLC.

1.4 Problem Statement

Temperature controller is really important to monitor and adjust temperature without much operator involved basic process first requires the measuring of the temperature of the room/house who you are attempting to control and also to maintain that targeted temperature. There are various types of the controller in the market such as On/Off, Proportional and PID. In this project, programmable logical control (PLC) has been chosen as the controller. The advantages by using PLC are the number of components for example relay and timer, the wiring and additional hardware for each new configuration of logic can be reduced and easy to troubleshoot when the error is occurred.

CHAPTER 2

LITERATURE REVIEW

Previous Project

2.1 Project 1

Title: Intelligent Car Cooling System

By Tan Hang Wai (KUiTTHO Batu Pahat,Johor)

Session 2004/2005

Project overview:

The model designed to diminish the heat built up inside the car cabin by using the fan as the cooler. This project is using PIC16F874, as the controller and the NTC thermostat as the temperature sensor. When the car cabin temperature is exceeding the limitation range, the motor that attached to car window will automatically open around 2cm and 5cm.the fan will circulate the air outside the car. Then, if the day is raining, the car window wills automatically close. The rain is sensed by using water sensor.

Comment:

Using the fan as the chiller is very limited in application. For enclosed space, the system is not effective. The project is operating by opening the car window about 2cm and 5cm is not considering the security. The car that is being stolen in Malaysia is increasingly currently. Leaving the car in opening window will give the advantage to the thief to steal that car. Also, the air circulation also is not work efficiently owing to the car cabin to be chilled moreover, and the temperature at the day is too high.

Using the manual sensor is adding the complexity in circuit to gain our selective system. Using programming sensor will give the advantage to the designer to design the selective temperature range system without adding extra circuit as in my project.

2.2 Project 2

*Title:**Sistem Kawalan Suhu Dalam Oven Menggunakan Pengawal Gelombang Mikro Dan PIC***

By Mohd Azlan Bin Lokman (KUiTTHO Batu Pahat,Johor)

Project overview:

This project is using PIC to control the temperature in oven. In this project the designer have use NTC thermostat as the temperature sensor.

Comment:

The similarity with this project is the way to control the temperature. Here the manual sensor has been used. As stated above, the manual sensor will add the complexity in circuit building. Here the selective temperature selection is hard to work on. Only in certain range this model will work out.

Additional comment:

Both of these projects is using the PIC as the controller, but for my project is using the PLC as the controller. So based on the both projects, the concept of the temperature control had been used to include into my project for example take the NTC thermostat sensor as the input to the PLC.

2.3 Temperature control concept

2.3.1 The concept of homeostasis

The term "homeostasis" does not refer to a fixed and invariable end result, or to an immutably fixed state of affairs, but to a particular kind of dynamic process that matches actual output to a target. Homeostatic processes control many of our bodily functions such as deep body temperature, arterial blood pressure, heart rate and blood sugar level, and they serve to provide our body cells with an environment in which they function optimally. Blood pressure in our arteries, for instance, is basically controlled as follows. Pressure is created by the heart pumping blood through the arteries. Downstream from the main arteries are smaller arteries that are surrounded by circular bands of muscle. The more these muscles contract, the greater the increase in arterial blood pressure because there is greater resistance to blood flow, just as you can increase the water pressure in a garden hose by squeezing the opening at the end. Pressure is monitored by pressure sensors in the large arteries that carry blood to the brain. Signals from these sensors are sent to the brain, which in turn controls the pumping activity of the heart and the degree of contraction of the muscles around the small arteries. These muscles are made to relax as the blood pressure exceeds the target level, and made to contract when it drops below the target level.

Target levels vary as the need arises. Blood pressure is reduced during sleep, while during exercise it may double. This does not mean a deficiency, let alone a breakdown of the homeostatic mechanism, but simply that the target level has been reset, because the body's needs have changed. The same holds for fever.

2.3.1.1 Thermostatic control

While homeostasis is a common feature in living organisms, this process has also been made to operate in many engineered devices such as washing machines and clothes driers, automatic pilots, humidifiers and dehumidifiers, cruise control in automobiles, refrigerators, air conditioning units and central heating. When applied to heating or cooling equipment, the homeostatic process provides for thermostatic control and thus for thermostasis with the help of the familiar thermostat. As the operation of thermostatic control is easier to inspect than the inside workings of your body, this will serve as a practical example to illustrate the process of homeostasis in more detail.

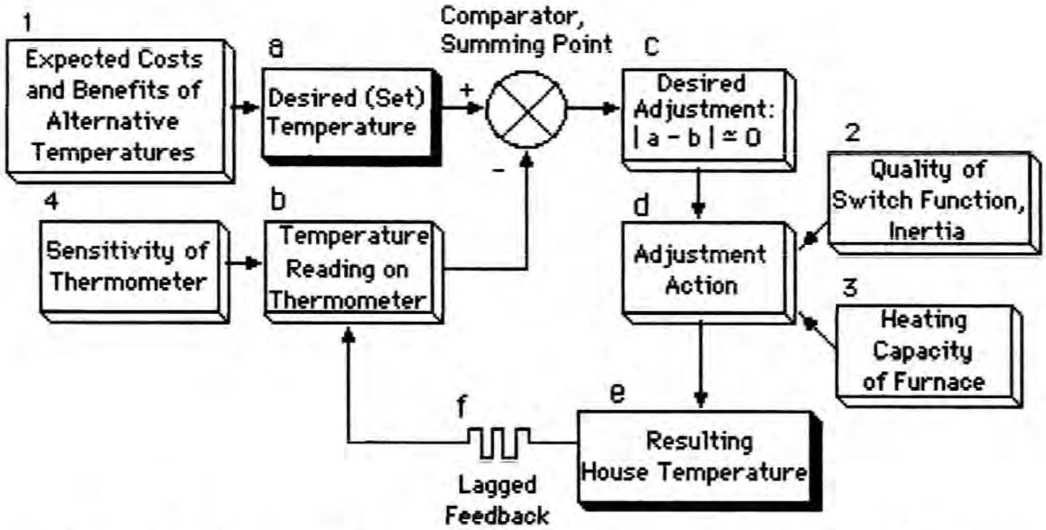

Figure 2.1: Homeostatic model relating house temperature to heating system activity and vice versa: relating heating system activity to house temperature, with the set-point (target) temperature as the controlling variable.

The basic features of homeostatic temperature control in a heating/cooling system are shown in the flow diagram in Figure 2.1. The operating principles may be explained as follows:

Box 1: You, the user of this control system, consider various factors in determining the preferred temperature. The temperature preferred usually is a compromise between the degree of physical comfort you ideally wish, on the one hand, and the cost of the energy needed for heating or cooling, on the other.

Box a: The preferred temperature is set on the thermostat control; this is called the set-point variable. It is a variable, because you have the choice between an entire range of set points. If energy costs go up, you are likely to choose a different compromise between considerations of comfort and cost, and you set the desired temperature to a different level.

Box b: The thermostat control continuously compares the actual temperature reading of the thermometer with the set-point temperature; this comparison is made at a point in the regulating process that is called the comparator or summing point.

Box c: Whenever there is a discrepancy (symbolized as [a-b]) between the thermometer reading and the set point, and this discrepancy is greater than a given tolerance of, say, 2% to 5%, the generator of warm air (furnace) or cool air is activated. The purpose of this is to keep the difference between **a** and **b** close to zero and this is achieved through a temperature-sensitive switch that tells the unit to produce either warm air or cool air, or to do nothing at all.

Box d: In order to adjust the house temperature to the set point, the air being forced into the house is somewhat warmer than the set point in the case of thermostatic heating, and somewhat cooler in the case of air conditioning.

Box e: As a result of this adjustment action, the house temperature is changed in the direction of the set-point temperature.

Symbol f: Because the thermostat control is usually (and for an obvious reason) not located in the vicinity of the air vents, and because it takes some time for the altered air temperature to diffuse throughout the house and to finally reach the location of the thermometer, there is some time delay between the production of the adjusted house temperature and the reading on the thermometer. This brings the process back to Box b and starts another adjustment cycle. Hence the term "closed loop".

CHAPTER 3

PROJECT BACKGROUND

3.1 Temperature sensors

There are various types of the temperature sensor available in the market. But the specification of the temperature sensor is different from sensitivity, concept of the functional and depends on the capability of the sensor. Also all the temperature sensors have an advantages and disadvantages.

3.1.1 Thermocouple Sensor

A thermocouple is a sensor for measuring temperature. It consists of two dissimilar metals, joined together at one end. When the junction of the two metals is heated or cooled a voltage is produced that can be correlated back to the temperature. The thermocouple alloys are commonly available as wire.

A thermocouple is available in different combinations of metals or calibrations. The four most common calibrations are J, K, T and E. There are high temperature calibrations R, S, C and GB. Each calibration has a different temperature range and environment, although the maximum temperature varies with the diameter of the wire used in the thermocouple. Although the thermocouple calibration dictates the temperature range, the maximum range is also limited by the diameter of the thermocouple wire. That is, a very thin thermocouple may not reach the full temperature range.

3.1.2 Radiation Thermometers (RTs)

Radiation Thermometers are non-contact temperature sensors that measure temperature from the amount of thermal electromagnetic radiation received from a spot on the object of measurement. This group of sensors includes both spot or "point" measuring devices in addition to line measuring radiation thermometers, which produce 1-D and, with known relative motion, can produce 2-D temperature distributions, and thermal imaging, or area measuring, thermometers which measure over an area from which the resulting image can be displayed as a 2-D temperature map of the region viewed.

These are significant devices in all their manifestations because they enable improvements in processes, maintenance, health and safety that save both lives and money. They are used widely in many manufacturing process like metals, glass, cement, ceramics, semiconductors, plastics, paper, textiles, coatings, and more.

They enable automation and feedback control that boost productivity while improving yield and product quality.

They save lives and improve safety in fire-fighting, rescues, and detection of criminal activities. In hospitals, nursing homes and home care, they have enabled a new, quick and reliable method to monitor and measure human body temperatures with one second time response.

In reliability and maintenance needs from building heating to electrical power generation and distribution, they save downtime and help optimize practices. Without these devices, our lives would be vastly different, much like the status of the 1950's and 60's.

3.1.3 Thermistors (THERMal resISTORS)

Thermistors are special solid temperature sensors that behave like temperature-sensitive electrical resistors. No surprise then that their name is a contraction of "thermal" and "resistor". There are basically two broad types, NTC-Negative Temperature Coefficient, used mostly in temperature sensing and PTC-Positive Temperature Coefficient, used mostly in electric current control.

Thermistors typically work over a relatively small temperature range, compared to other temperature sensors, and can be very accurate and precise within that range, although not all are.

3.1.4 Resistance Temperature Detectors (RTDs)

Resistance Temperature Detectors or RTDs for short, are wire wound and thin film devices that measure temperature because of the physical principle of the positive temperature coefficient of electrical resistance of metals. The hotter they become, the larger or higher the value of their electrical resistance.

They, in the case of Platinum known variously as PRTs and PRT100s, are the most popular RTD type, nearly linear over a wide range of temperatures and some small enough to have response times of a fraction of a second. They are among the most precise temperature sensors available with resolution and measurement uncertainties or ±0.1 °C or better possible in special designs.

Usually they are provided encapsulated in probes for temperature sensing and measurement with an external indicator, controller or transmitter, or enclosed inside other devices where they measure temperature as a part of the device's function, such as a temperature controller or precision thermostat.