Microcontroller-Based Temperature Control for Traditional Medicine Production

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Abstract- Temperature is one of the most important parameter to be controlled in almost all industrial plant, since it directly affects on product quality. The main objective of this paper is to study and construct 8051 based temperature control system. In this control system AT89S51 microcontroller is used. To sense the temperature, IC temperature sensor, LM 35DZ is used and its sensing range is up to 150°C. This paper aims to apply for heating process in traditional medicine production. The required temperature of heating process is under 110°C. When the temperature is greater than the required temperature, the product quality will be low and if the temperature is less than power and time consumption will be large. So this process requires temperature regulation. LM 35 is precision integrated-circuit temperature sensor, whose output voltage is linearly proportional to the Celsius temperature. Its accuracy, low cost and temperature range are desirable for this heating process.

In this control system, temperature is controlled within the temperature range 100°C to 110°C. The goal of this paper is to get development in traditional medicine production and good quality products.

Index Terms- 8051 microcontroller, LM 35DZ temperature sensor, ADC 0808 analogue to digital converter, Relay, seven segment display.

I. INTRODUCTION

Temperature is the measurement of the hotness or coldness of an object or substance. This can be accomplished to a degree by touching the object. Heat added to a material causes such changes as melting, boiling, expansion, etc. When these changes are compared with scale (any scale), we use the word “temperature”. This is just a convenience way of communicating the hotness or coldness of an object. Heat and temperature are very different things. Temperature is probably the most widely measured and frequently controlled in many industrial processes. Temperature control system has two parts; measurement and control.

A measurement system is used for making measurements. In general, measurement system may be classified into three categories:

1. Sensor
2. Signal conditioner
3. Display

Temperature cannot be measured directly but must be measured by observing the effect that temperature variation causes on the measuring device. A control system is a combination sub-system that to maintain output suitably related to input. Automatic control system is used for temperature control.

Microcontrollers make storage, programmability and on-line decision to use in temperature measurement and control applications. Microcontroller based temperature controllers are economically available to control the temperature of industrial processes. Microcontroller is an inexpensive single-chip computer and the entire computer system lies within the confines of the

integrated circuit chip. Most 8051 microcontrollers contains a CPU (Central Processing Unit), RAM (Random Access Memory), ROM (Read Only Memory), Input/output ports, timer and other built-in peripherals. RAM is used for temporary storage of data and Special Function Registers (SFRs) are special elements of RAM. Each register controls an I/O port; each of pins can be designated as input or output. For the control system, program counter is also important. It is the engine to start the program and point to the memory address of the instruction to be executed. In this research, AT89S51 microcontroller is used to control the heating system at the required range.

II. Operation Principle

The block diagram of 8051 based temperature control system is shown in Figure 1. In this diagram, the temperature is measured by using the temperature sensor. When the sensor measures the input temperature, it converts its temperature measurement to an equivalent signal. This signal is sent to the microcontroller and the programs in it instruct and command to the power switching device to cut out the heating coil if it is required.

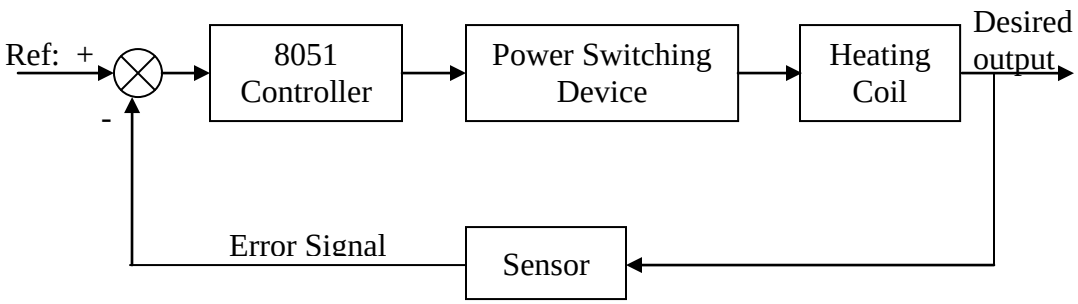

Figure 1: Block Diagram of Temperature Controller

When the drying process for the traditional medicine starts in the drying room, the heating coils get electricity through the relay. And then the room temperature is increasing steadily .The temperature sensor senses the drying room temperature continuously and converts the temperature to the voltage as its output. If the room temperature is higher, the output voltage of temperature sensor will be greater. This output voltage is sent to input pin of the analogue to digital converter (A/D converter). The input channel can be chosen by selecting bit for ADD A, ADD B, ADD C. In this paper, pin 26 is selected as the input pin of A/D converter. The analogue to digital converter converts into the equivalent digital signal to understand the 8051 microcontroller. The output pins of A/D converter for eight bit digital word are connected to the port 1 of 8051 microcontroller. On the microcontroller, port 0 is used as the output port to display the temperature in the drying room. When the temperature in the drying room reaches 100°C, the program in the microcontroller sends the signal to the relay to cut off the AC power line of heater coils. By this way, the temperature will not exceed 110°C and it will be remain around 100°C.

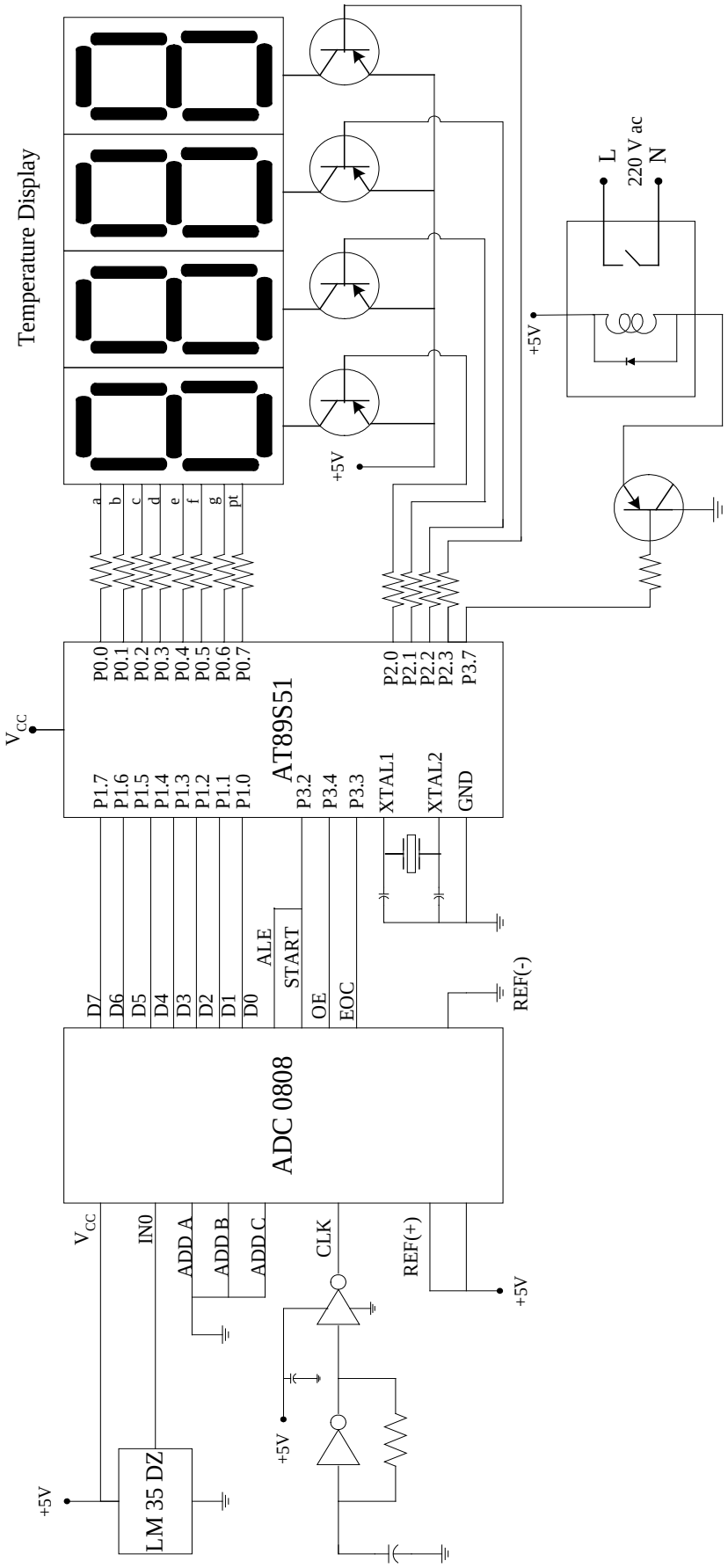

Figure 4: Complete Circuit Diagram of 8051 Based Temperature Control System

III. Hardware and Software Implementation

All electronic components require a steady dc power supply. Thus a regulated dc power supply unit was buit for this temperature control system. That regulated power supply is constructed with stepdown transformer, rectifier diodes, filter capacitor and voltage regulator IC as shown in figure 5.

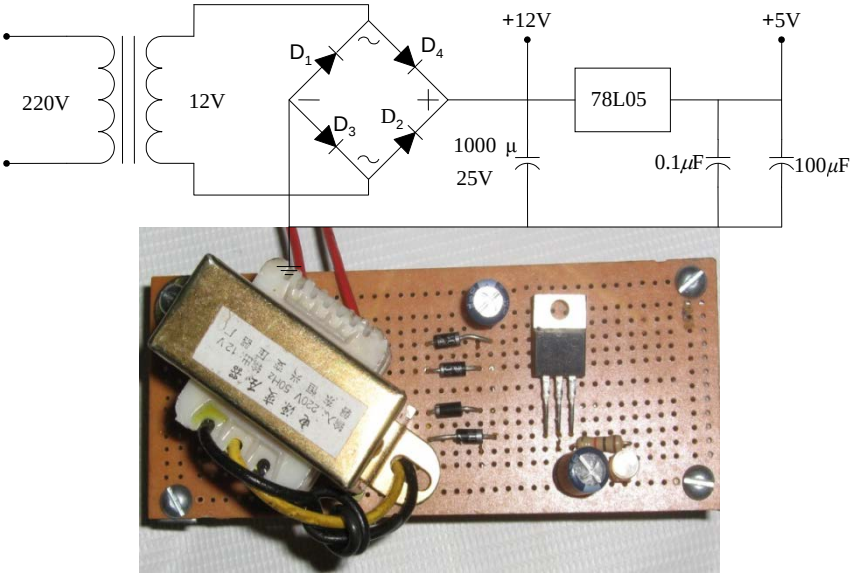

Figure 5: Power Supply

The LM 35 DZ is precision integrated-circuit temperature sensors. It converts the temperature to the equivalent output voltage. The output voltage is linearly proportional to the Celsius temperature because of scale factor is +10 mV/°C. When the temperature increases the output voltage will increase. The typical accuracies of LM 35 are ±1/4 °C at room temperature, 0.5°C accuracy at 25 °C and ±3/4 °C over a full -55 C to +150 °C temperature range. Its cost is very low. The analogue to digital converter (ADC0808) is used to convert the output voltage of analog temperature sensor, LM 35DZ. In this paper, pin 26 is selected as the input pin of A/D converter. The output pins of A/D converter for eight bit digital word are connected to the port 1 of 8051 microcontroller. It is constructed as shown in figure 6.

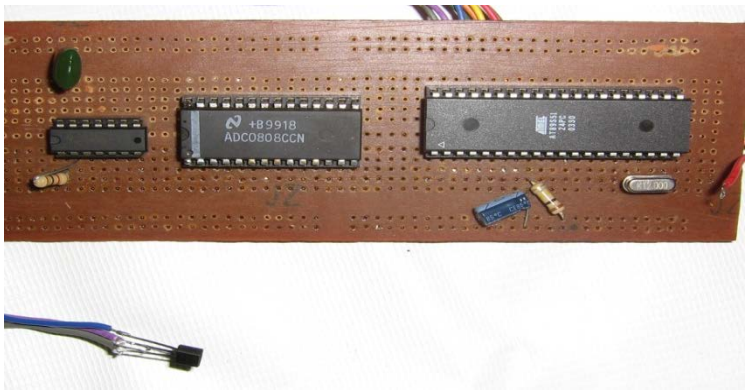

Figure 6: Temperature Sensor connected with Microcontroller

The temperature in the heating process is display by the 4 seven-segment displays and when the temperature reaches 100°C, the microcontroller will command the relay to be cut-off the AC power line of heater coils. The following figure 7 shows the implementation of display and cut-off relay.

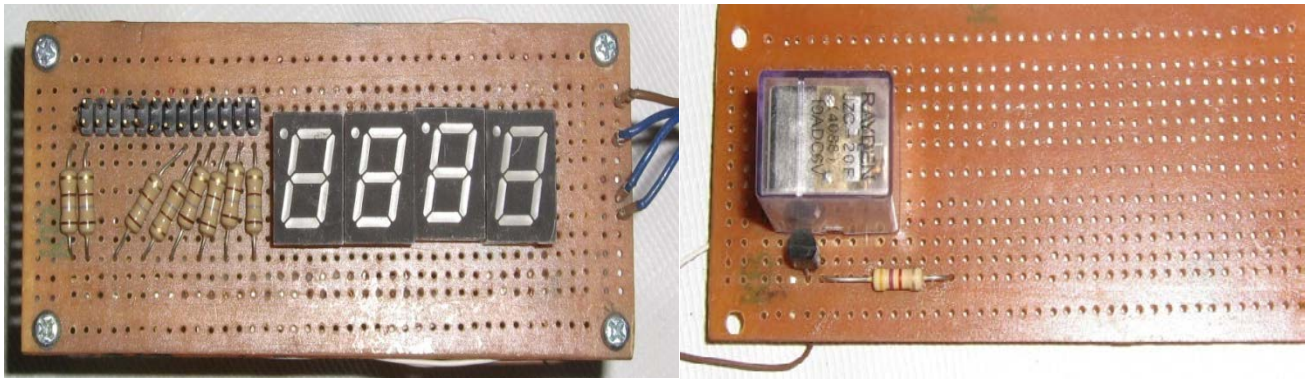

Figure 7: Temperature Display and Cut-off Relay

For the software implementation, the program is type in the notepad and saves as “temperature.c” in drive C. And then compile the program. In case of syntax error in program code, program will not be compiled and HEX file will not be generated. The figure 8 shows error free and HEX file is ready for the microcontroller.

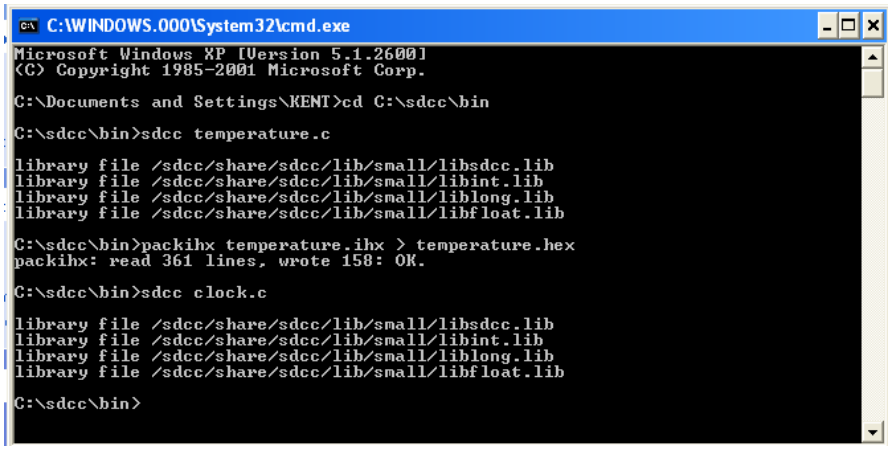

Figure 8: Converted to HEX file

IV. Test and Result

The test was done by powering the system. When powered, the present room temperature 30°C is displayed and the heating coil starts the heating for the purpose of the traditional medicine drying process. To ascertain the workability of the system, the temperature sensor LM35 is placed near the heating coil. The temperature increased rapidly to the 90°C in a few seconds. In a few minute the seven segments displayed 100°C. At that time the relay coil cutoff the AC power line of heating coil. Although cutting off the AC power, the temperature still increased slowly. After a few minute the temperature decreased less than 95°C and at that time the relay connected AC power supply with the heating coil. By this way, the temperature will not exceed 110°C and it will be remain around 100°C.

V. Conclusion

A very important process in many industrial fields is temperature regulation. An automatic temperature regulator has its application in various industries where constant temperature is required to be maintained. In all closed-loop temperature control system, temperature of system is constantly compared with the desired temperature and then controlled temperature of system. This system needs temperature measuring device. There are several temperature sensors. According to the system requirement, the sensor was chosen. There are many factors to choose sensor: They are-

1. Low or high temperature range
2. Linearity or non-linearity
3. Accuracy
4. Output scale factor
5. Response time and
6. Cost

In this paper, LM 35 DZ is used to measure the temperature. The features of LM 35 are good accuracy, linearity, low cost, low self-heating and calibrated directly in degree Celsius. The heart of this control system is 8051 microcontroller. The temperature is controlled by the program in the microcontroller. In AT 89S51, there are not included analog-to-digital converters. As the output of LM 35 is analog, it requires to convert digital format which inputs the microcontroller. So AT 89S51 microcontroller is linked to the A/D converter of an external peripheral device. The sensing temperature is displayed by seven segment display. The temperature is controlled by cutting off the AC power line to the heater coils. If we want more accuracy and low cost update control system, we will need very good instruments, to measure, i.e. digital sensor DS 1620. It can covert temperature to digital word in 750 ms. By replacing this sensor, no need to use analog-to-digital converter. So the system cost will effectively low. TIL 311 hexadecimal displays can be used as seven segment display. By using these displays, the outputs of microcontroller are not need to convert the decimal number because of its internal structure has 4-bit latch and decoder. Its display screen has 4×7 light-emitting diode (LED), and left and right hand decimals LED. By replacing these two components, the control circuit will be very small, compact and fast response.

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