DEVELOPMENT OF A MICRO-CONTROLLED HEAT SYSTEM APPLIED TO THERMIC WATER BEDS IN HOSPITALS

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ABSTRACT

In this paper we describe the development of a micro-controlled heat system, which is able to monitor and control temperatures from 0°C to 255°C.

The system is composed of a temperature sensor (LM 35), which output voltage is converter using an 8 bits analog to digital converter (ADC 0804) and processed by an 8 bits micro-controller (89C52). The output is driven though a thyristor to a power heater. A keyboard provides the input data and the temperature status is shown at a liquid crystal display (LCD).

We are applying this system to heat and monitoring water beds used in intensive therapy unit (ITU) in hospitals. A comparison between the developed system and a commercial one is also presented.

1. INTRODUCTION

An electronic system used to control temperature in a given volume of gas or liquid, has to detect and compare such temperature with a setting point. After that it has to drive a heat stage in order to achieve such temperature and keep it still for a given time or until a new setting point is adjusted.

Such device could be applied to control the temperature of chemical reactions, drying foods or ovens. In the present, we are using it to heat and monitoring the water temperature used into water bed in hospitals, specifically in intensive therapy unit (ITU).

2. SYSTEM DESCRIPTION

The user input the desired temperature using a keyboard as the same time as the LCD displays his choice, the actual measured temperature and the time.

After the temperature setting, by pressing the OK key, the heating process begins until the desired temperature is achieved and keeps it for a preset time. A build in software guides all this programming steps, making it very simple.

There is an alert signal to avoid full power to be driven without input signal.

2.1 Block Diagram

Referring figure 1, as soon as the system is turned on, build in instructions are load from the memory of the microcontroller (89C52) (1). This device has an 8 bits bus, 8KB EEPROM memory, 256 Bytes of RAM memory and clock up to 24 MHz.

The microcontroller activates the LCD (6) display to start showing the actual temperature, measured by a very precise solid state temperature sensor (LM35) (2), which provide a voltage output proportional to the temperature (10mV/°C).

This voltage is converted to a digital form by an 8 bits analog to digital device (ADC 0804), with conversion time around 100 µs, clock of 640 KHz and external trigger of 100ns. The ADC input voltages are from 0V (00000000) to 2,55 V (11111111), corresponding to temperatures from 0^0C to 255^0C.

The information from the temperature sensor is storage continuously into the RAM memory (register) to be displayed at the LCD.

By pressing the set point key (SP) over the keyboard (7), the system enables the input temperature (0^0C to 255^0C) using Up / Down entry keys. The desired temperature is chosen by pressing the OK key and so the heating process starts.

The system controls the heating process by a routine that compare the actual temperature with the set point (ΔT). If ΔT is higher then 10^0C, the output driven circuit is set to deliver total power to the heating device (resistance, 100Ω, 4KW) (5), otherwise if $\Delta T < 10^0$C the power is decreasing until $\Delta T = 0^0$C. The power delivered to the heating device is controlled by changing the average voltage through a thyristor (TIC 226 D, 8A, 250V) that modify conduction angle of the supply voltage. This hole control depends on the precise temporal position of the supply voltage. This is possible by a zero detection circuit (4) that synchronizes the thyristor action.

Finally, the is a buzzer (8) that indicates any key entries, running out time of the heating process or device fault

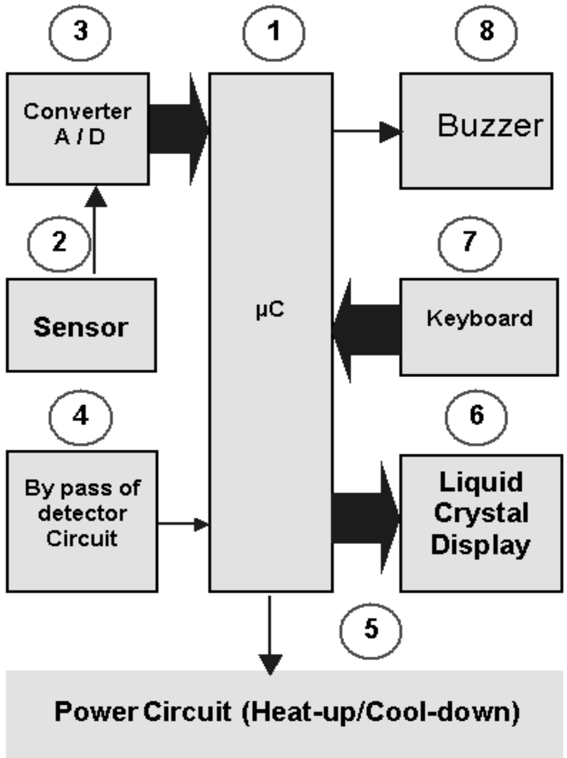

Figure 1 – Block diagram of the heating device.

3. RESULTS AND DISCUSSION

In order to verify the performance of the developed system and compare with a commercial one (MTA 5900) already used at hospitals, we set up a simple experiment of heating up to 90°C the amount of 10 liters of water and register the elapsed time. We choose this water quantity that has in the reservoir of the commercial equipment.

For the developed system, two different settings were used, one without the control of the tryristor, e.g., the heating device was at full blast, and the other with the control activated. For the commercial equipment the data (1) was obtained from the catalog and with two major differences: - the water was close looping between the equipment and the water bed, and the maximum temperature was about 42°C, since is designed for human application.

The results is shown in figure 2, where can be observed that with active control of the tryristor, there is a small time delay, less than 2 minutes in the worse case, comparing without control. This can be explained from the changing of the voltage conductance as soon as the desired temperature is reach.

Comparing with the commercial system, one can observed that the developed system has a more linear response and more time efficiency to reach a given temperature. This can be explained by the water circulation used in the commercial equipment that delays its response.

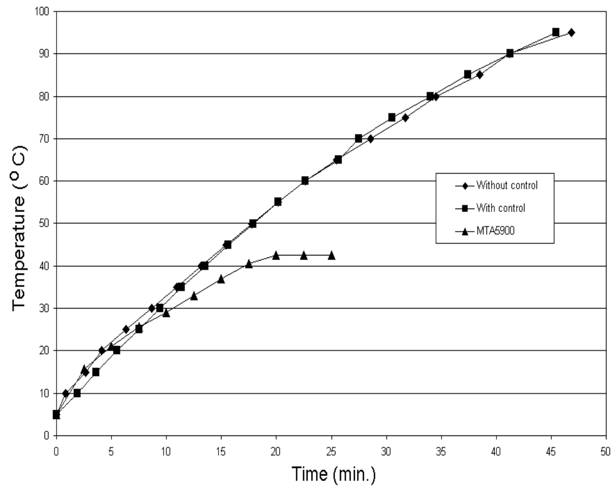

Figure 2 – Calibration curve of the developed device for two different conditions and comparison with the commercial equipment (MTA 5900).

4. CONCLUSION

We describe the development of a micro-controlled heat system, which is able to monitor and control temperatures from 0°C to 255°C.

The hole system was shown in details an is based on a temperature sensor (LM 35), which output voltage is converter using an 8 bits analog to digital converter (ADC 0804) and processed by an 8 bits micro-controller (89C52). The output is driven though a thyristor to a power heater (resistance). A keyboard provides the input data and the temperature status is shown at a liquid crystal display (LCD).

A simple experiment was performed to generate calibration curves of the developed device for two different conditions and comparison with the commercial equipment (MTA 5900), already used at hospitals.

The results showed that with active control of the tryristor there is a small time delay explained from the changing of the voltage conductance as soon as the desired temperature is reach. Results with the commercial equipment showed that the developed system has a more linear response and more time efficiency to reach a given temperature

5. ACKNOWLEDGMENT

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6. REFERENCES

[1] Automatic Heating System MTA 5900, Operational Handbook, 1998.