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A Multi-purpose Hardware Efficient Temperature Regulator with LCD Display

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ABSTRACT

This work is aimed at developing a device which can be used for multi-purpose temperature monitoring and control. At the heart of the circuit is the 8051 microcontroller which controls all its functions. A temperature sensor LM7805 is used for sensing the temperature of the environment and the system displays the temperature on a LCD in real time. This temperature is compared with the value stored by the user and if the temperature goes beyond the preset temperature then heater (bulb) switches off and if temperature goes below the preset value then heater switches on. AC bulb is interfaced with the microcontroller which is done with the help of a relay and a NPN transistor. The developed temperature regulator device can be used for multiple applications.

Keywords: *LCD, LM7805, Temperature Regulator, 8051 Microcontroller.*

1. INTRODUCTION

Temperature controllers or regulators find applications in key areas of human endeavour. In the health sector for instance, it is used in incubators that are used for premature infants [5]. They are also used in the storage of pharmaceuticals and drugs that need definite temperatures as well as in IVFs where human eggs, sperms and embryos need definite temperatures. Research in temperature controllers and regulators seem to focus mainly on these areas leaving much to be desired for other types of applications. A very good case study of an area where temperature regulation and control suffer attention is in laboratories.

In some laboratories, devices like Personal Computers probably due to lack of ventilation and other reasons need not work beyond certain temperatures hence the need to develop a device that can monitor their temperatures. [1] Opined that programmed microcontrollers are used to achieve the control and automation of devices, machines and systems. Microcontrollers have become ubiquitous in electronic engineering designs. They bring some intelligence and automation to existing systems.

This project focuses on the use of a temperature regulator to alert when equipment, machines, computers go beyond set temperatures so as to avoid the burning and damaging of these equipments. Moreover, the device we developed is multi-purpose and can be deployed to all areas, fields, buildings, laboratories, industries etc. where machines, computers and diverse equipment are in use both electronic and non-electronic devices

2. RELATED WORKS

There have been lots of work done in the area of temperature controller and regulators however, most of these works focused on biotechnological and health applications of temperature control. For instance [2] developed a fuzzy logic control that incorporates incubator air temperature to accurately regulate the temperature of infant incubators. They proposed a fuzzy logic based algorithm and performed simulation. In their simulation they compared their model with existing incubator temperature controllers and discovered their fuzzy logic based model gave a more accurate temperature regulation.

[3] Developed a temperature regulator for hashing of poultry eggs. Their incubator works within a temperature range of 35^{o}C to 40^{o}C and was used to aid the large scale production of chickens. Their work considers temperature as well humidity as requirements in egg hashing. They used AT89C52 microcontroller to develop an incubator

that gives eggs an ideal hashing environment in terms of temperature and humidity. A bulb automatically heats up the egg incubator when temperature goes down and goes off when the desired temperature is attained.

[4] Developed a low cost temperature controller for infants. He fused PIC16F877A microcontroller to a LCD and interfaced his circuit with a buzzer to blow an alarm in case the temperature of the incubators goes out of the required range. Whereas [4] was able to achieve his main aim of developing a low cost temperature controller for infant incubator, there are still some drawbacks in his work. A premature infant need no noise or alarm as that could result to shock and its negative effects on the infant. Moreover, the presence of the buzzer further makes hardware design complex and that is where our own work focuses on addressing. A good temperature regulator needs to be simple in hardware so that its large scale deployment would be easier and practicable.

3. METHODOLOGY

The plan and procedure employed to achieve result in our work can be categorized into two – the hardware design and implementation and the software development. The software ran on the 8051 microcontroller which is the control and coordinating device.

3.1 Hardware Development

An electronic circuit was designed using Intel's 8051. The 8051 microcontroller is a 40 pin IC with 16 bit address bus and 8 bit data bus. It also has 128 bytes of memory and 4kb of ROM [6]. It's cheap and available for commercial use. Apart from the microcontroller the other electronic components used in developing the hardware are: a Liquid Crystal Display (LCD), an analogue to digital converter (ADC), temperature sensor (LM7805), relay, an indicator (bulb), 9V battery and resistors.

The microcontroller can only read one's and zero's (1's and 0's) [6][8] hence, the ADC converts the analogue voltage from the LM7805 into discrete values that the digital 8051 can interpret. The LCD is an 8 bit data display device that consumes less power than other display devices. It enables more characters to be displayed hence its choice in the circuit. Relays use low voltages to switch on circuits and since our microcontroller works on low voltage, the relay is connected such that it can switch on the indicator whenever temperature goes beyond the set threshold.

Figure 1 below shows the circuit diagram for our hardware development. The circuit is less complex in terms of hardware requirement hence its commercial deployment would be cheap and profitable.

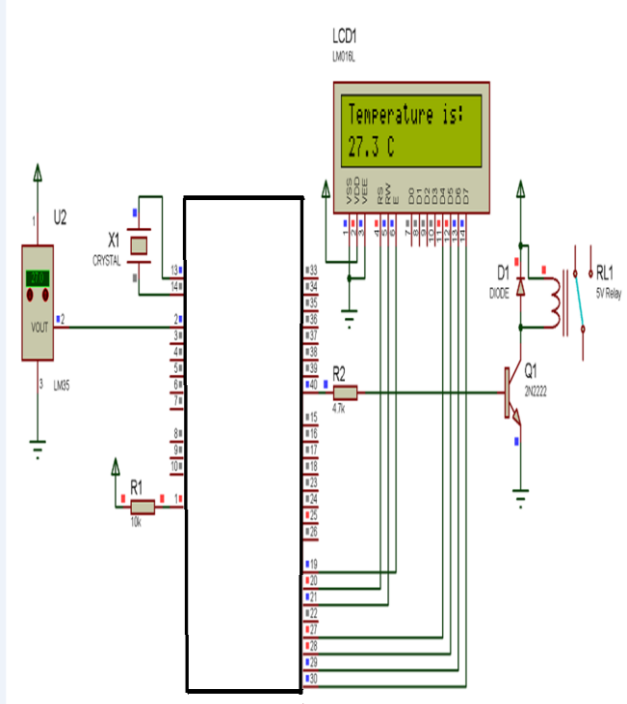

Fig. 1. Circuit Diagram For The Proposed Device

3.2 Control Software Development:

Most microcontrollers require a computer program as control for a given application. In our work, the program development was in three stages - the coding platform to generate the HEX code, program compilation and lastly burning the compiled program into the microcontroller. The control program was implemented in C language using AVR studio 7. AVR is a family of microcontrollers developed by Atmel of which 8051 is a member.

AVR studio is an integrated development platform (IDP) for coding and debugging the control program for AVRs [9]. It was used to code the C control program as can be seen in figure below. The program compilation was done using Win AVR. The final stage of the control software development was the downloading or burning of the compiled HEX file program into the 8051 microcontroller using Sinaprog. Sinaprog is utility software used in downloading Hex files to AVR based microcontrollers. Sinaprog environment is depicted in figure 2 below.

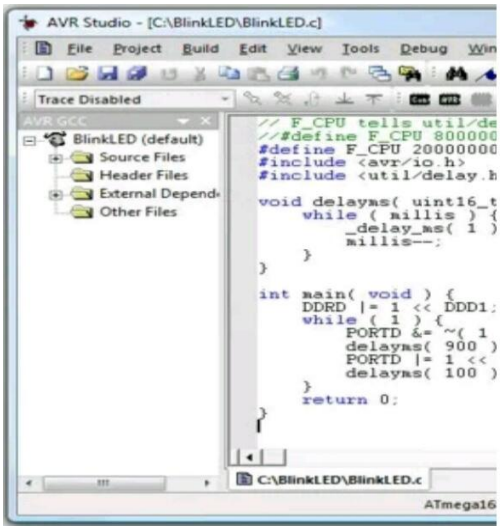

Fig. 2. Screenshot of the control program in AVR studio

4. RESULT AND DISCUSSION

The constructed microcontroller based temperature controller with real time display is a simple and useful circuit which can be used to control the temperature above a set value using LM7805 temperature sensor. The circuit was developed and components where purchased. The circuit was first laid in a bread board. Then we designed the PCB and the circuit was soldered and set values of temperature were displayed on the screen.

The set temperature was found changing with the help of preset buttons. Output was verified by setting the temperature at different levels and it was found that the heater (bulb) turn on and off when the device crosses the set value. Figure 3 depicts the constructed temperature regulator with display. It is simple in design and less complex in hardware. It can easily be produced on a large scale.

Fig. 3. Snapshot of the developed multi-purpose temperature regulator

5. CONCLUSION

This paper presents a laboratory work on the development of a device with the ability of regulating the temperature of an environment as well as displaying same on a LCD. The basic hardware and software development methods were presented. The developed device is unique in the sense that unlike most works in literature, it can be used for multiple purposes. The work is less intensive in terms of hardware requirement hence, can easily be deployed on a commercial scale.

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