Microcontroller Based Automatic Temperature Controller

Conference Paper · January 2017

Muhammad Auwal Abubakar
Federal Polytechnic, Ede

International Conference of Science, Engineering & Environmental Technology (ICONSEET), 2(16): 127-131, 2017
ISSN 0794-9650

www.repcomseet.com

Microcontroller Based Automatic Temperature Controller

Abubakar Muhammad Auwal*, Adepoju Temilola Morufat, Rabiu Muhammad Lawan & Muslim Usman Abubakar

Department of Computer Engineering, Federal Polytechnic Ede, Osun state, Nigeria.

Abstract – This paper presents, a microcontroller based automatic temperature controller. The system is based on PIC16F877A microcontroller interfaced with LM35DZ temperature sensor, LCD, switching transistors and relays. The system design is divided into two parts; hardware and software. The LM35DZ temperature sensor senses the temperature of a given room and feed it to the PIC16F877A microcontroller which then decodes it and compared it to a predetermined temperature value stores in it. The microcontroller in turns automatically switches on/off a heater or a fan based on the result of the comparison. The measured room temperature is displayed on the LCD accordingly. This design considered a predetermine temperature values of 26 ^{0}C as minimum and 29 ^{0}C as the maximum. The system was tested and the result showed that the switching occurs at temperatures of 25 ^{0}C and 30^{0}C. Thus, the system will be useful in rooms, offices, departmental stores and other places requiring temperature regulation.

Keywords: Microcontroller, Temperature, Controller, Automatic, PIC16F877A, LM35

1. Introduction

Temperature controller is a system that monitors and controls the temperature of a room or any place under consideration such that if the temperature is higher than required, the system brings the temperature down. Similarly, if the temperature is lower, the system makes it high as required. Temperature controller can be manual or automatic. The former requires full human intervention to operate, while the latter requires little or not at all.

Furthermore, most temperature controller and related systems designed earlier make used of discrete components design such as timers, counters, decoder drivers and thermistor temperature sensor [1] [2]. Though, some used microcontrollers with external analogue to digital converter (ADC) [3] However, these devices occupied much space, have more weight, consume much power and are less flexible such that modification of the system requires replacing hardware components. And the temperature sensor is non-linear among other problems associated with it [4].

This paper present a microcontroller based automatic temperature controller. It is based on PIC16F877A microcontroller. Figure 1, gives the system block diagram and is in five units; power supply, temperature sensor, PIC16F877A microcontroller, display and the switching units. The LM35DZ temperature sensor senses the temperature of a given room and feed it to the PIC16F877A microcontroller which then decodes it and compared it to a predetermined temperature value stores in it. The microcontroller in turns automatically switches on/off a heater or a fan based on the result of the comparison. This design considered a predetermine temperature values of 26 ^{0}C as minimum and 29 ^{0}C as the maximum, such that the system switches ON the heater when the room temperature is below 26 ^{0}C switches ON the fan when the temperature is above 29 ^{0}C and the measured room temperature is displayed on the LCD accordingly. For temperature range; 26 ^{0}C – 29 ^{0}C, the circuit remained idle.

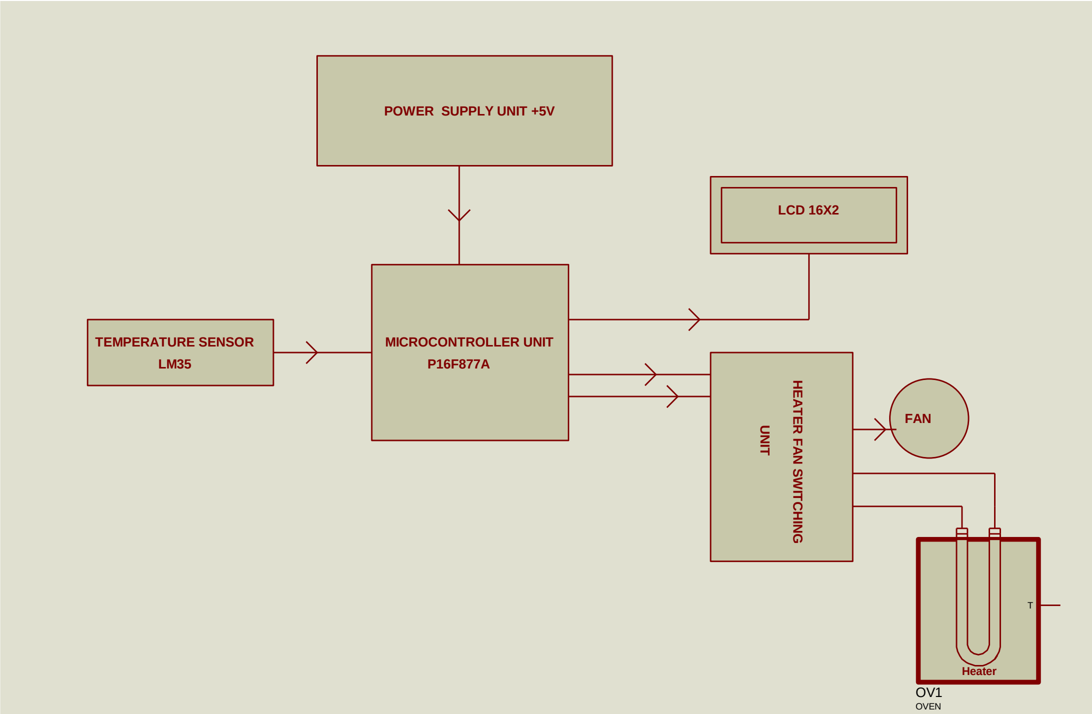

Fig. 1. System block diagram

2. Design Methodology

The microcontroller based automatic temperature controller design is divided into two parts; Hardware and Software.

2.1 Hardware Design

The hardware design is divided into five units; power supply, temperature sensor, PIC16F877A microcontroller, display and the switching units as shown in fig. 1 above. The power supply is considered basic and not discussed in this paper. Figure 2 below gives the microcontroller based automatic temperature controller diagram.

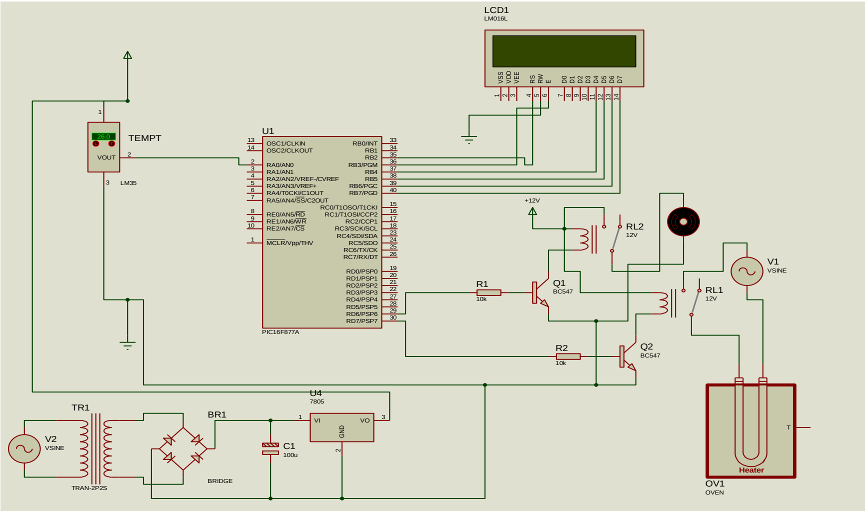

Fig. 2. System circuit diagram

2.1.1 Microcontroller unit

The microcontroller selected is PIC16F877A [5]. It is an 8-bit, 40-pins dual inline package (DIP), having five ports (A-E), 8- input channels (ADC module), and many more features. It is selected due to its in-built analogue-to-digital module [5] and it's readily availability in the market. Fig. 3 below gives it diagram and pin connection.

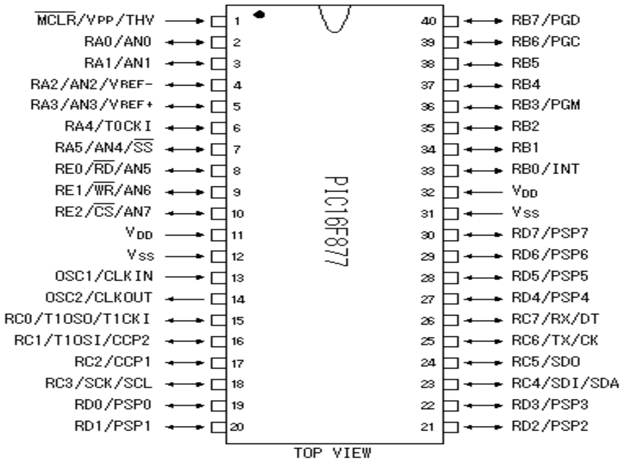

Fig. 3. PIC16F877A [5]

Quartz crystal is selected for this work due to its high stability with two 15pF capacitors [5] and 4MHZ clock frequency. The crystal oscillator set up diagram is shown in fig. 4 below.

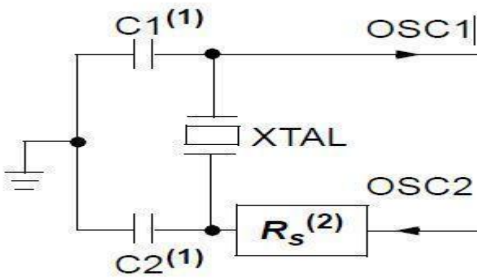

Fig. 4. Crystal oscillator set-up diagram [5]

2.1.2 Temperature sensor unit

LM35DZ [6] temperature sensor was selected for this work. Its output is linearly proportional to the Celsius (centigrade) temperature scale, as user does not require any calibration to obtain convenient centigrade scaling [6]. Its linear output, low output impedance, inherent precision calibration, easy interfacing [6] and availability make it the choice for this work. Its output voltage is given by;

$$Vout = 10mV * T \quad [6] \qquad (1)$$

Where V_{out} is the LM35 output voltage and T is the temperature in ^oC

The output temperature range of LM35DZ is 0 ^oC to 100 ^oC [6]. Using eqn.1 above, the output voltage range is 0V to 1V.

2.1.3 Display unit

A Liquid crystal display (LCD) (16 x 2) [7] type capable of displaying 32 characters in alphanumeric form is employed in this work to display the measured room temperature. It is configured as 4 bit interface enabled to transmit or receive data in 4 bits. It is chosen due to its low power consumption and ability to display a high precision result. Figure 5, below gives the interfacing diagram.

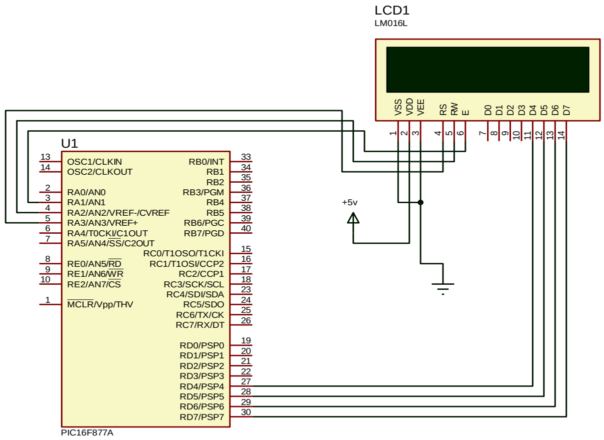

Fig. 5. PIC16F877A and LCD interfacing

2.1.4 Switching circuit

The switching circuits consist of transistors and Relays that serves as an interface between the low voltage microcontroller and the high voltage loads i.e. the heater and fan. Figure 6 below gives the interfacing diagram.

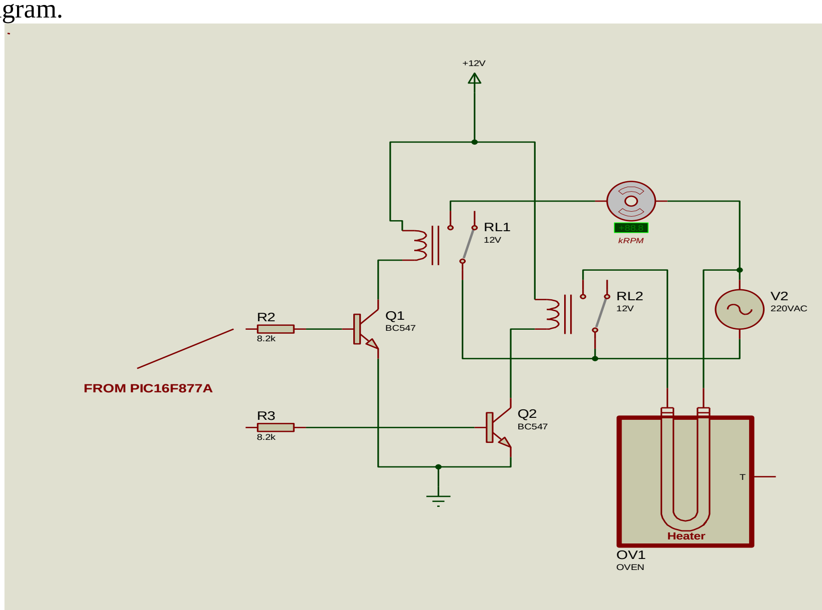

Fig. 6. Switching circuit interfaced to heater and fan

2.2 Software Design

The PIC16F877A being the heart of the system, controls the system activities with the help of the program codes embedded in it. For this work, one of the most popular high levels programming language, specifically C, is used for the PIC 16F877A source code. This is due to its ease of programming when compared to assembly language. The program is later compiled to have the hex (object code) to be used by the microcontroller.

3. Construction

The components were tested separately and assembled on a breadboard and finally on vero board. A plastic casing was used to house the designed circuit after its implementation. The casing was perforated on each side to give room for ventilation and heat dissipation.

4. Discussion of Results

After the final assembly, the system was tested. The test was done by dismantling the control switches sections of a manually operated dual heater/fan system and incorporating it to the automatic temperature controller system. The combined systems were then place in a room where an air conditioning system is ON. It was observed that when the room temperature is 30 ^{0}C and above, the fan switches on automatically. However, when the room temperature is 25 ^{0}C and below, the heater automatically switches on. And for a room temperature between the range 25 ^{0}C – 30 ^{0}C, the system remains idle.

It could be seen from the result above that the system doesn't behave as expected. This is possibly due to the ADC conversion process that doesn't cover the full scale resolution i.e. using 8-bit instead of the 10-bit resolution. This also shows the linearity of the temperature sensor.

5. Conclusion and Recommendation

This paper present a microcontroller based automatic temperature controller. The LM35DZ temperature sensor senses the temperature of a given room and feed it to the PIC16F877A microcontroller which then decodes it and compared it to a predetermined temperature value stores in it. The microcontroller in turns automatically switches on/off a heater or a fan based on the result of the comparison.

It is suggested that a means of changing the temperature limits such as matrix keypad be added to the system.

References

[1] Lubabatu B. I. Design and construction of a digital thermometer. Undergraduate project. Department of Electrical Engineering, B.U.K. Kano, Nigeria; 2010.

[2] Sadi S. S. Design and construction of a room temperature regulator. Undergraduate project. Department of Electrical Engineering, B.U.K. Kano, Nigeria; 2012.

[3] Aditya srivastava, Anuj Upadhyay, Tanya Sharma & vishal Srivastava (2016). Automatoc Temperature Control using PIC Microcontroller. International Journal of Research, 3(8), 91-96. Retrieved from http://internationaljournalofresearch.org/

[4] Overview of temperature sensor types. (n. d.). Retrieved from http://www.appliedsensortech.com/pdf/sensor-overview.pdf/

[5] PIC16F87XA Datasheet (2003). PIC16F877A. Retrieved September 13th, 2017, from Microchip: http://www.microchip.com

[6] LM35 Datasheet (2016). LM35 Precision centigrade temperature sensors. Retrieved September 13th, 2017, from Texas Instrument: http://www.ti.com

[7] LCD datasheet (2002). 16 X 2-character LCD. Retrieved October 15th, 2017, from engineers garage: https://www.engineersgarage.com/electronic-components/16x2-lcd-module-datasheet.

.