MICROCONTROLLER- BASED LCD DIGITAL CLOCK WITH TEMPERATURE DISPLAY SYSTEM

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Abstract

In the research work, temperature (°C and °F) and time (hour, minute and second) display systems are designed and developed. PIC 16F877A microcontroller is used as the control device. LM35DZ analogue temperature sensor whose output voltage is linearly proportional to the Celsius temperature is used in this work. The PIC 16F877A is one of Microchip midrange 8-bit microcontroller that has a build in 10-bit resolution of Analog to Digital Converter (ADC) peripheral. The ADC converts the analog output voltages from LM35DZ temperature sensor to the digital values. Time (hour, minute and second) are displayed in the first line and temperature values are displayed in the second line of 2 x 16 LCD module. Two push buttons are used to set minutes and hours. The program in this project is based on the timer interrupt. The time is advanced by 1 second and the minutes and hours are adjusted if necessary and the hours, minutes and seconds are displayed every second on the LCD. Temperature value that can be displayed ranges from the minimum value of 0°C to the maximum value of 100°C. This process is repeated after one-second delay. The program source code is written with Pic Basic Programming Language.

Key Words: ADC, analogue temperature sensor, LCD, microcontroller.

Introduction

Microcontrollers are single-chip computers consisting of CPU (central processing unit), data and program memory, serial and parallel I/O (input/output), timers, external and internal interrupts. Microcontrollers are intelligent electronic devices used to control and monitor devices.

The temperature is the specific degree of hotness or coldness of the body. It is usually measured with a thermometer. Four types of sensors are thermocouples, resistive temperature devices (RTDs), thermistors, and integrated circuit (IC) temperature sensors.

Most digital clocks display the hour of the day in 24 hour format; in the United States and a few other countries, a more commonly used hour sequence option is 12 hour format (with some indication of AM or PM).

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Emulations of analog-style faces often use an LCD screen, and these are also sometimes described as "digital". Liquid crystal displays (LCD) have been developed that are light and rugged and almost low cost.

The scope of this research is focused on developing time and temperature display system interfaced with PIC16F877A microcontroller using LCD screen. The first row of LCD screen describes a digital clock with a built in 24 hour timer using TMR0 interrupt. LM35DZ type analog temperature sensor can measure the environmental temperature and give the analog voltage which is proportional to temperature. A/D converter of microcontroller converts the analog voltage to digital voltage and A/D reading is scaled to obtain the final results as true degree Celsius and degree Fahrenheit of temperature and display on the second row of LCD screen.The block diagram of microcontroller based temperature and time display system using LCD is shown in Fig.1.

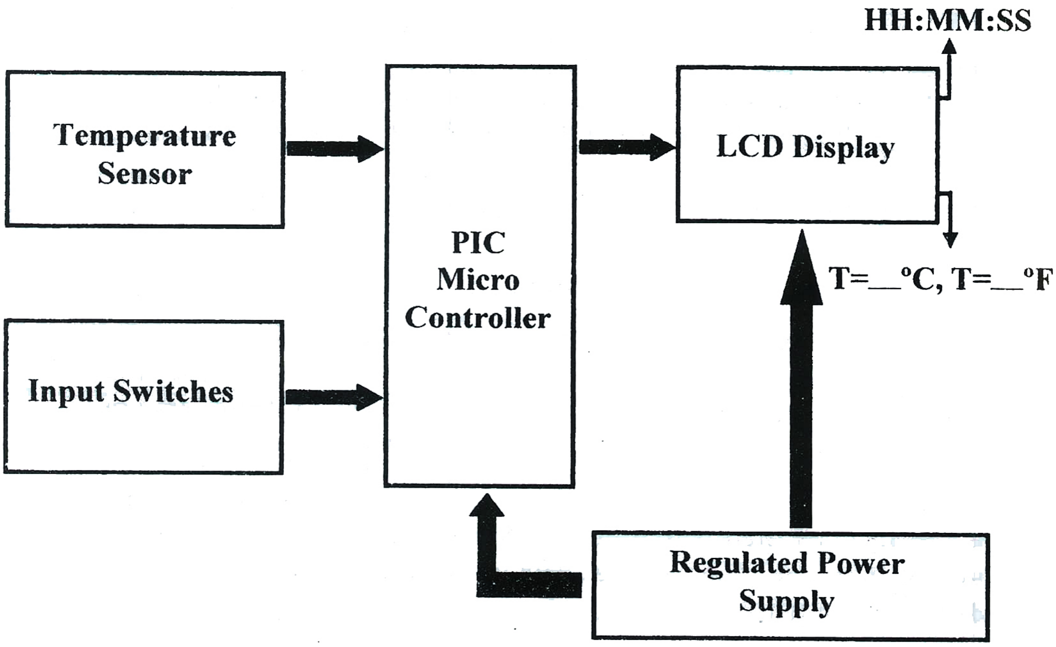

Fig. 1 Block diagram of the microcontroller based temperature and time display systems using LCD

Design and Construction of the Whole System

The circuit arrangement for temperature display system

In this device, the PIC16F877A microcontroller is used. 4MHz crystal is setup between OSC1/CLKIN and OSC2/CLKOUT pins and two 22pF capacitors are connected to the ground to establish oscillation. The circuit diagram is shown in Fig. 2. LM35DZ temperature sensor is connected to the analog input AN0 of microcontroller. The output of the sensor provides a voltage which is directly proportional to measured temperature. To minimize the electrical noise, 10Ω resistor and 1μF capacitor filter are used to the output of the sensor. The analog output of the sensor is converted to digital by analog to digital converter. The voltage corresponding to this value is calculated in mill volts and divided by 10 to find the actual measured temperature in degree Celsius and convert to degree Fahrenheit and displayed on LCD. The brightness of the LCD is controlled by 5K variable resistor.

The flowchart is shown in Fig. 3. Firstly, assign LCD connections and assign Port A as input and Port B as output. Then turn on A/D converter and A/D conversion internal RC clock. Configure analog pin AN0 and reference voltage (supply voltage VDD). After starting A/D conversion, the program waits to complete the conversion. The digital reading is converted to mill volts. And calculate true degree Celsius and convert to degree Fahrenheit using the equation ($°F=9/5°C+32$) on the second row of the LCD screen.

The circuit arrangement for 24 hour clock display system

To display the clock system on the first row of LCD screen, hour and minute buttons (PB1 and PB2) are connected to RC0 and RC1 pins of PORTC of microcontroller. These two buttons are used for setting time. Fig. 4 shows the flow chart of Interrupt Service Routine (ISR) for 24 hour clock system. In the ISR (timer0), the prescalar rate 1:64 from OPTION-REG register is chosen and turns on TMR0 interrupt. Each interrupt occur every 256μs. Then the program increases the counter. If the counter reaches 61, ($1sec=64\times256\times61\mu s$), one second is increased. If second reaches 60, minute is increased by one. If minute reaches 60, increase the hour by one digit. Fig. 5 indicates the flow chart for input key checking function. This function activates increasing minutes and hours if minute key and hour key are pressed for setting the time.

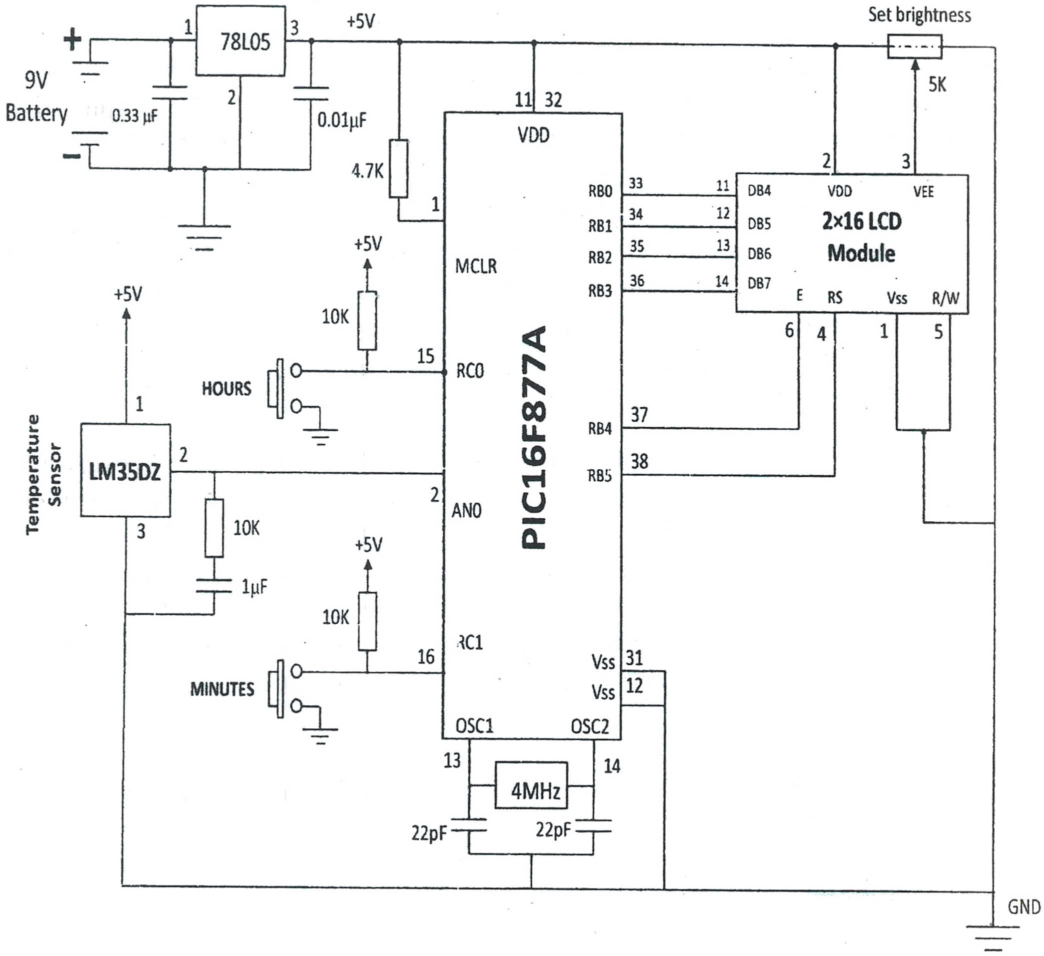

Fig. 2 Circuit diagram of the microcontroller-based time and temperature display system using LCD

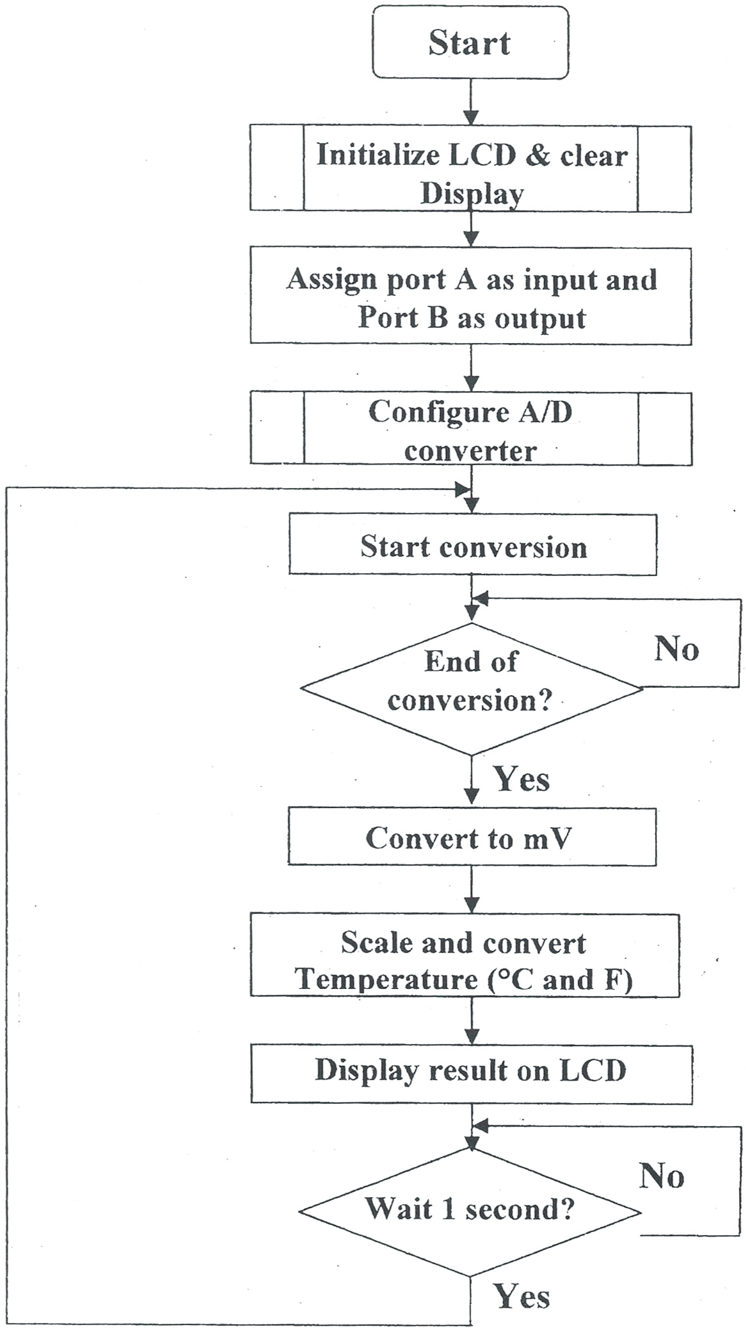

Fig. 3 Flowchart for temperature display

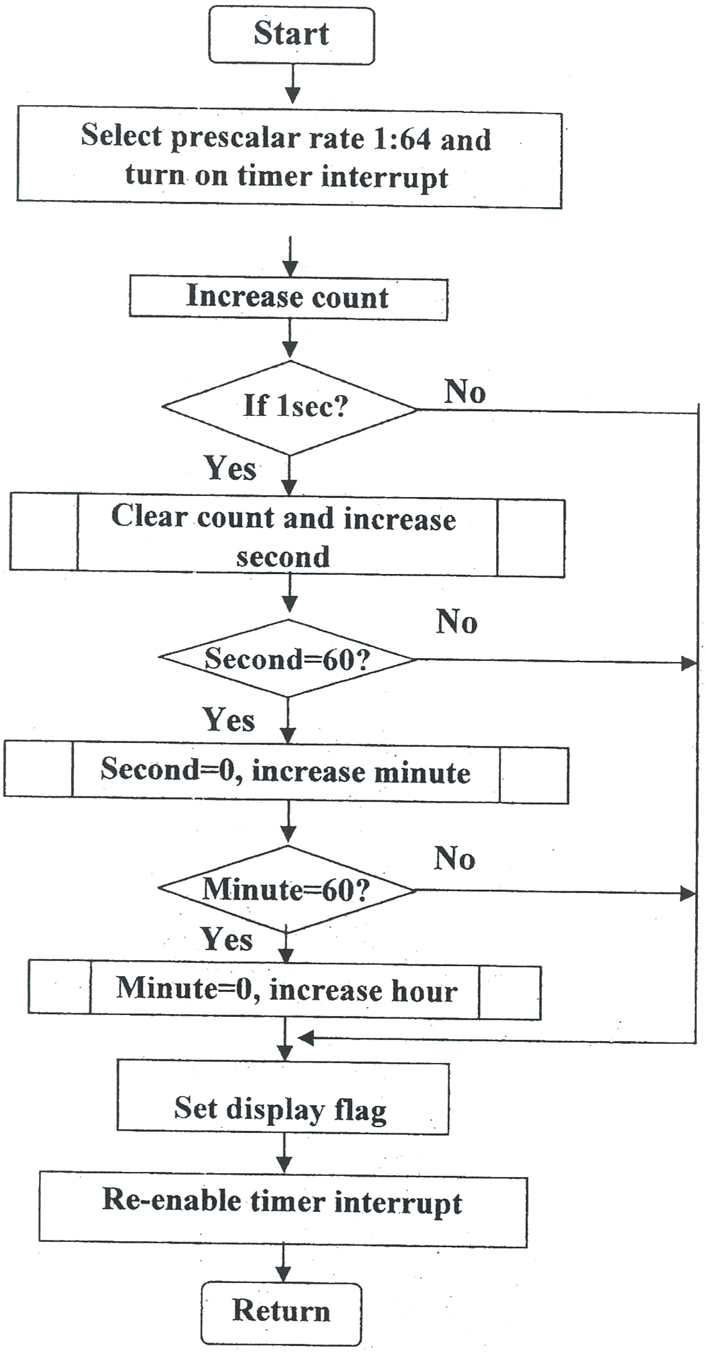

Fig. 4 Flow chart of ISR (timer0)

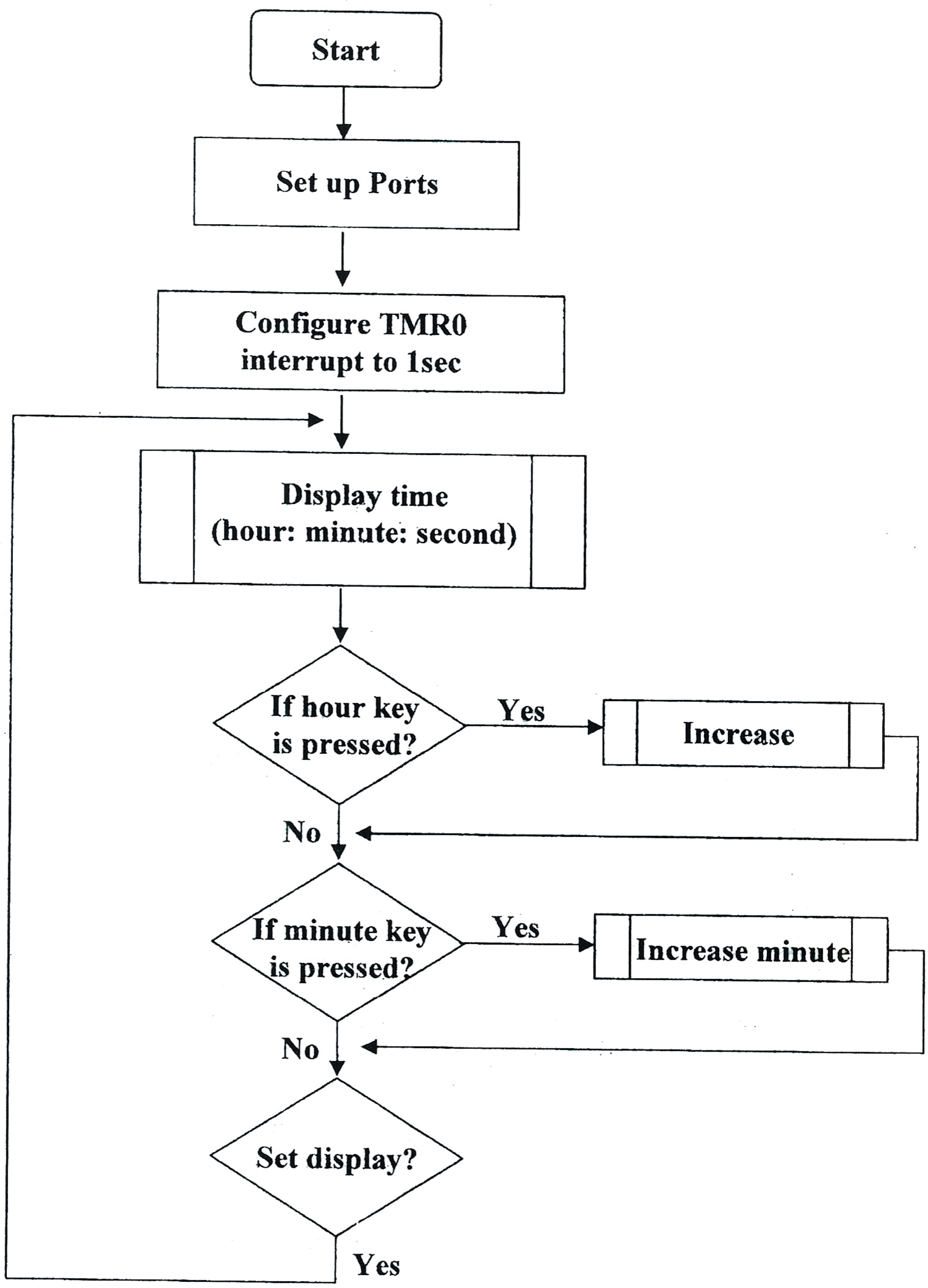

Fig. 5 Flow chart of input key checking function

RESULTS, DISCUSSION AND CONCLUSION

Constructed System

Fig. 6 indicates photograph of the front panel of constructed system. The first row of LCD shows the time **12:13:12** and the second row of LCD describes the temperature **T=29°C, T=84°F**. Fig. 7 shows photograph of the LCD showing the current time **10:23:14** and the temperature **T=23°C, T=73°F**.

Results and Discussions

In this research, the internal clock of microcontroller is used as the clock source. LCD is update whenever any of the push buttons PB1 and PB2 are pressed on the front panel of LCD display board. The push button PB1 is used to set hour and PB2 is used to set minute. Timer0 interrupt runs from 0 to 255 and the prescalar rate 1:64 is chosen from OPTION-REG register. So that the timer interrupt occurs at 16.384ms intervals (64×256=16.384ms). Then the program increases the counter and the counter reaches 61. (61×16.384=999.424ms~1sec), variable second is increased by 1. When second reaches 60, it is cleared to zero, minute is increased by 1. Similarly hour is increased by 1 if minute reaches 60. Although 24 hour clock system is constructed, it can be modified as 12 hour clock system. In this LCD display system, it has minimum hardware requirements and simplest circuitry among its counterparts.

In this research, we can measure environmental temperature like thermometer and then display as degree Celsius and degree Fahrenheit on the second row of the LCD screen. This temperature display process is repeated after one second. PIC16F877A microcontroller has built in 8 channel 10 bit resolution A/D converter and so 1024 steps corresponds to reference voltage of 5000mV (5V). Each step corresponds to 5000mV/1024=4.88mV. A/D converter of microcontroller with a larger amount of bits has a higher resolution and better currency when converting from analog signal to digital signal. LM35DZ temperature sensor provides output voltage which proportional to measured temperature (V_O=10mV/°C). If the temperature is 30°C, the output voltage will be 300mV. The sensor can measure temperature from 0°C up to 100°C.

The characteristic curve for LM35DZ temperature sensor is shown in Fig. 8. Temperature is measured by thermometer and O/P voltage of sensor is measured digital multi meter. It is found the V_O is a function of temperature (°C). Fig. 9 describes the calibration curve for LM35DZ sensor output and digital reading. The calibration curve for temperature on LCD and output voltage of the sensor is illustrated in Fig. 10.

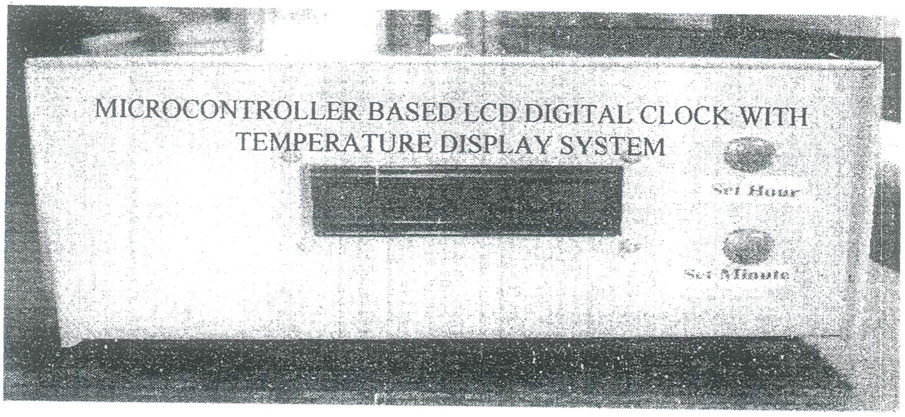

Fig. 6 Photograph of the front panel of constructed system

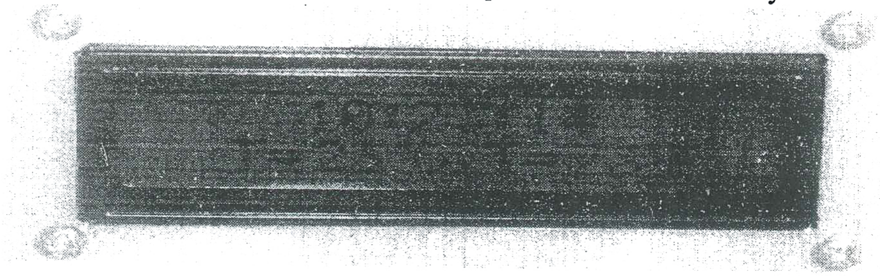

fig.7 Photograph of the LCD showing the current time **10:23:14** and the temperature**T=23°C,T=73°F**

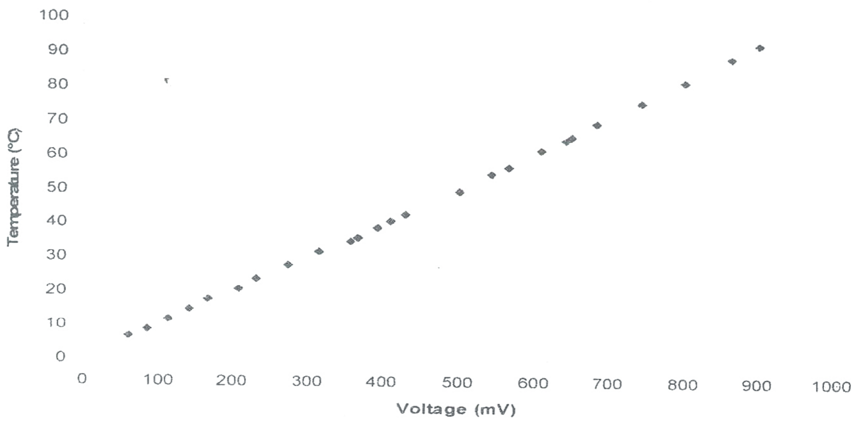

Fig. 8 The characteristic curve for LM35DZ temperature sensor

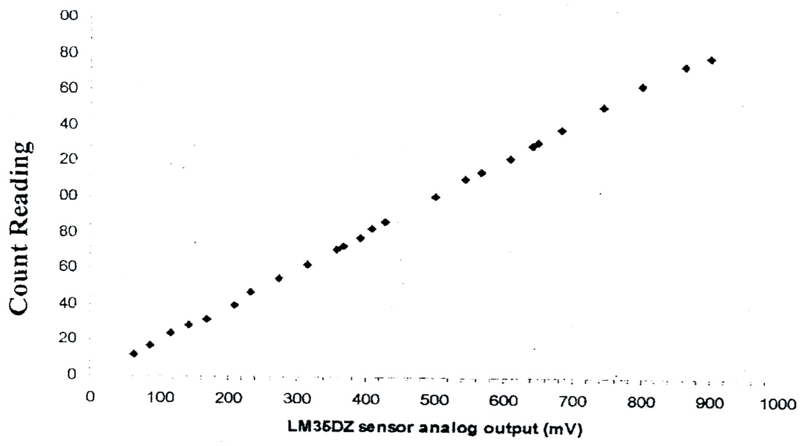

Fig. 9 The calibration curve for LM35DZ sensor output and digital count

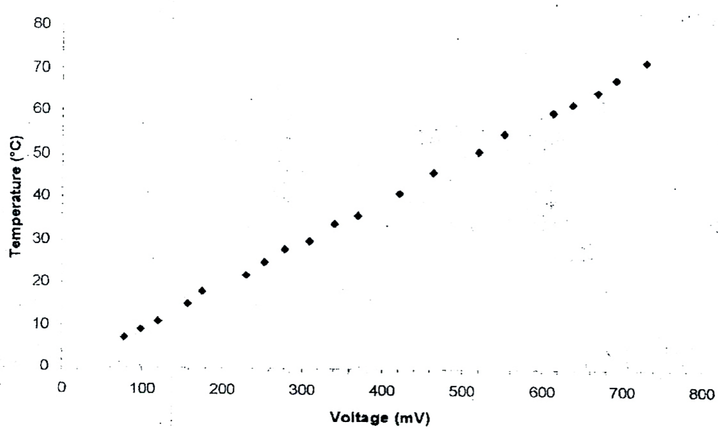

Fig. 10 The calibration curve for temperature on LCD and O/P voltage of the sensor

Conclusion

Temperature and time display system is successfully designed and constructed by using microcontroller, temperature sensor and other device. Because of special feature of microcontroller, we can reduce external components. Thus cost and power consumption can be reduced and system reliability can be enhanced. Although the circuit is very simple, this device is the most commonly used in home appliance.

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