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GSM Based Advanced Digital Thermometer with Data Storage in Memory Card

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Abstract:This Paper discusses an Advanced Digital Thermometer which highlights the novel idea of adding a database storage facility along with GSM based communication to conventional Thermometer. Microcontroller based embedded system is designed using PIC controller which records body temperature of a patient and stores it in memory card periodically for future reference. The temperature is stored in the database with its date and time. We also propose forwarding the stored data directly to doctor using GSM communication. The Embedded system is designed and simulated in Proteus simulator. Test results are also compared with a conventional Thermometer. This system is beneficial to the aged people who find it difficult to visit doctors on a regular basis just to check the body temperature.

Keywords: Database Storage, Digital Thermometer, GSM, Memory Card, Patient Monitoring.

I. INTRODUCTION

Measurement of body temperature is a crucial step in medical diagnostic procedure and Thermometer is an indispensable device for this purpose. There are basic two types of Thermometers: (1) Mercury based Thermometer (2) Digital Thermometer. Now a days, Digital Thermometers have captured the market by displacing mercury based Thermometers. We have gone one step ahead by adding facility to record the readings along with the date and time of the measurement, and further forward these reading to the doctor using a GSM module.

It has been found that aged patients are required to visit the doctor on regular basis for minor check-ups. So to avoid this inconvenience we have developed a new instrument which allows patient to measure the body temperature and forward it to the doctor very easily. It provides an additional facility of storing the body temperature with date and time for future reference for doctor. Micro SD memory card is used for storing the data as it is very small in size and can be easily read.

This instrument can also be used in the areas where human intervention is not desirable and data is required to be accessed remotely from a distant place. This includes areas like Furnaces, boilers etc.

II. BLOCK DIAGRAM AND WORKING

Temperature is measured using the highly precise temperature sensor. Signal conditioning block amplifies the output voltage produced by temperature sensor so as to utilize the full scale input range of ADC. Microcontroller samples this signal using its inbuilt ADC.

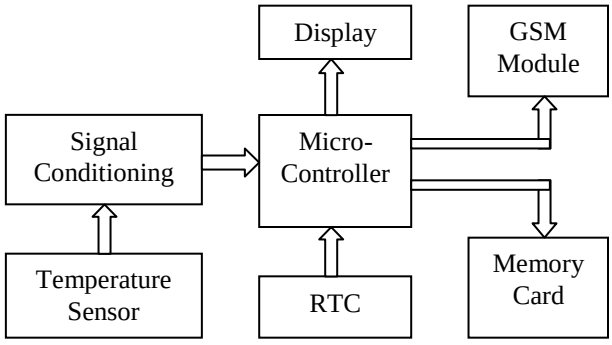

Fig. 1. Block Diagram of System

RTC (Real Time Clock) is interfaced with microcontroller to keep track of current date and time. Temperature reading along with its date and time is displayed on LCD and simultaneously stored in memory card. GSM module sends this data to distant place.

III. DESIGN

A. Temperature Sensor

Considering the temperature range for the device (which is 0°C to 50 °C) and liner variation requirement for the design LM35 sensor is selected. TO-46(metal package) is used.

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B. Signal Conditioning

LM35 gives output voltage of 10mV/°C. Temperature variation considered is 0-50 °C and without any conditioning output of LM35 for maximum temperature will be

(50*10) mV = 500 mV.

Hence to cover full range of inbuilt ADC of the microcontroller and to increase the resolution, we have amplified the output of LM35 with gain of 10. Now, for 50°C corresponding output will be

(500)*10 mV = 5000mV

C. Microcontroller

Any 18FXX series microcontroller supports 10 bit ADC. The controller should have sufficient data and program memory hence we have selected PIC 18F4620 having 4k data memory and 96k program memory. Micro SD card require larger data memory as it writes 512 Bytes at a time, data buffer should handle 516 Bytes before writing it to SD card.

D. RTC

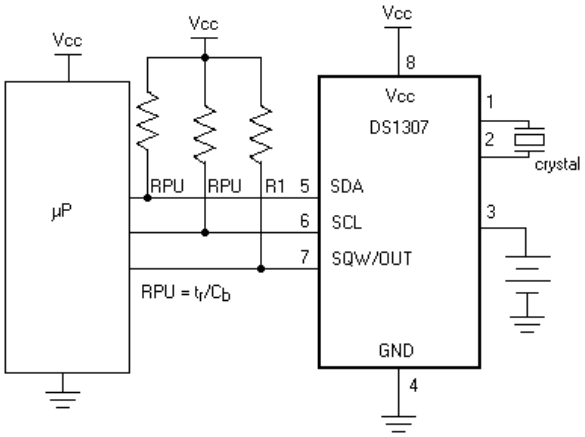

Fig. 2. Interfacing RTC DS1307 with Microcontroller

RTC DS1307 operates as a slave device on the serial I2C bus. Typical operating circuit is shown in figure 3. The time and calendar are initialized by writing the appropriate register bytes. Access is obtained to the RTC by implementing a START condition and providing a device identification code followed by a register address. When Vcc falls below 1.25 x Vbat the device terminates an access in progress. Inputs to the device will not be recognized at this time to prevent erroneous data from being written to the device from an out of tolerance system. Then the time and calendar information is obtained by reading the appropriate register bytes. The RTC registers are located in address locations 00h to 07h and they contains value of seconds, minutes, hours, day, date, month and year simultaneously.

E. Memory Card

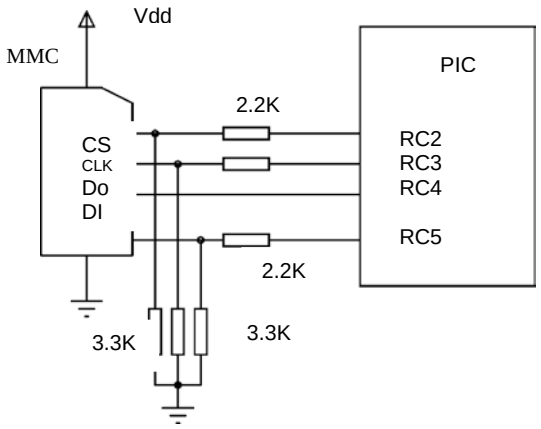

Fig. 3. Interfacing Micro SD card with Microcontroller

Micro SD card is interfaced with the microcontroller using SPI bus. At the time of interfacing memory card in any electronic circuit its interfacing signal levels needs to be considered.
Minimum logic 1 output voltage, VOH= 2.475 V
Maximum logic 0 output voltage, VOL= 0.4125 V
Minimum required logic 1 input voltage, VIH= 2.0625 V
Maximum logic 1 input voltage= 3.6 V
Maximum required logic 0 input voltage, VIL= 0.825 V

Typical logic 1 output voltage of PIC microcontroller pin is 4.3V, and this is too high when applied as an input to Micro SD card, where maximum input voltage should not exceed 3.6V. As a result of this, it is required to use resistors at the input of the micro SD card to lower the input voltage. Figure 4 shows typical microcontroller to SD card interface in which resistors 2.2K-3.3K are used as potential divider to lower the input voltage to approximately 2.48 V. SD card input voltage= 4.3 x 3.3K/(3.3K + 2.2K) = 2.48 V. Micro SD card consumes 100-200 mA current while reading or writing on to the card.

F. GSM Module

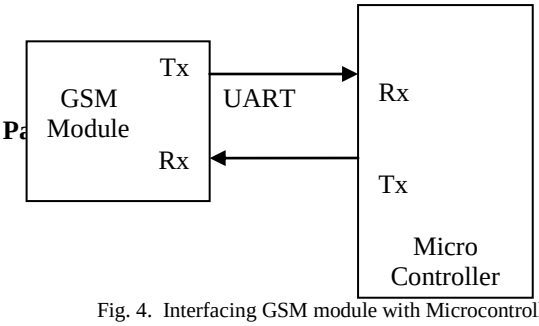

Fig. 4. Interfacing GSM module with Microcontroller

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GSM module is interfaced with PIC microcontroller using UART. Following steps needs to be performed for its configuration:

- Store all AT commands into strings.
- Set the baud rate of microcontroller to 9600bps.
- Enable serial port.
- Enable the global and peripheral interrupt bits of the INTCON register.
- Configure Port as input port.
- Use if condition to detect the pressed switch.
- As switch is pressed, process the corresponding AT command and transmit reading along with its date and time via USART.

IV. SIMULATION AND RESULTS

We have simulated and built the Embedded System and compared the results with Standard Digital Thermometer.

Fig. 5 shows simulation of embedded system on Proteus. LCD is displaying temperature along with current date and time. Time (hr:min:sec) is displayed on the first row, date (dd/mm/yy) on the left side of second row and Temperature (°C) on the right side.

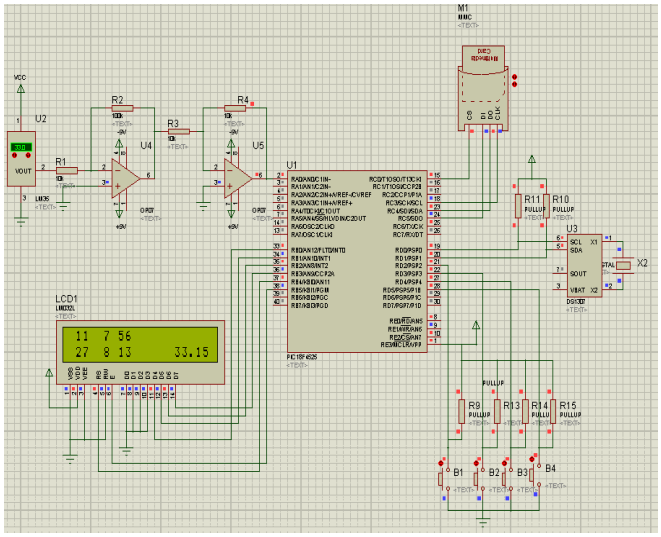

Fig. 5 Circuit Simulation showing Temperature, Date and Time

We have also provided user the facility of formatting memory card when required.
Fig. 6 shows option of formatting the memory card when Format button is pressed.

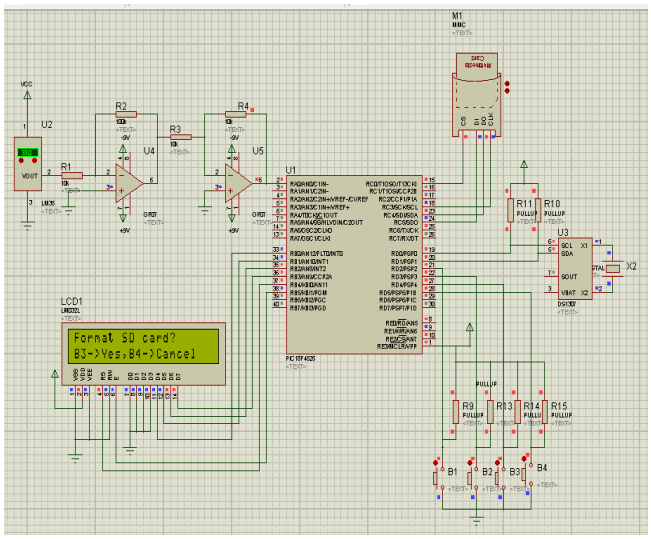

Fig. 6 Circuit Simulation showing Formatting of memory card

TABLE I
RESULT TABLE

Sr. No.	Standard Digital Thermometer(°F)	Advanced Digital Thermometer(°F)	Error (%)
1.	98.76	98.90	0.14
2.	100.20	100.56	0.35
3.	102.42	102.68	0.25

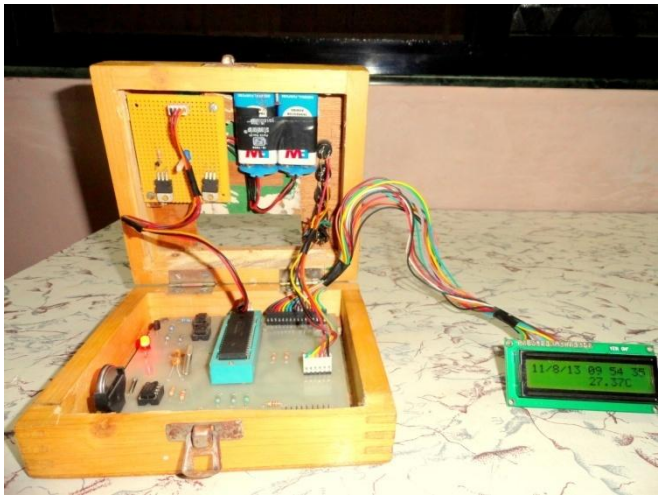

Fig. 6. Practical system showing Temperature, Date and Time

Referring to the Table 1, maximum error was calculated as 0.35% and average error was 0.246%.

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Fig. 6. Formatting of memory card

V. CONCLUSION

We have augmented the features of Standard digital Thermometer with facilities of data storage and GSM communication. Added facilities can be seen as a tradeoff between the cost and convenience offered to the patient.
Considering the obtained error percentage, better results can be achieved by incorporating highly precise temperature sensor.

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