Design and Implementation of digital thermometer by using Arduino UNO

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***Abstract* – This paper attempts to achieve a digital thermometer by using a Arduino UNO as a main processor. A digital thermometer has been designed and constructed based on LM35 as the temperature sensing device. The design is in four modules; power supply, temperature sensor, LCD device and Arduino UNO modules. While the Arduino UNO forms the main control element, the temperature sensor senses the temperature to be measured and converts it to a corresponding analogue voltage. The measured temperature is displayed on a 16 by 2 Character LCD incorporated in the system.**

***Keywords*: Arduino UNO, LM35, LCD**

I. Introduction

The name thermometer is coined from the Greek words thermo meaning "warm" and meter, "to measure" (Wikipedia, 2011). Thermometers measure temperature, by using materials that change in some way when they are heated or cooled (Bellis, 2011). The invention and creation of the first working thermometer has been credited variously to Abu Al Ibn Sina, Cornelius Drebbel, Robert Fludd, Galileo Galilei and Santorio Santorio (Helden, 1995; Sigurssen,2003;Wikipedia,2011).Modern thermometers are calibrated in standard temperature units such as Fahrenheit or Celsius and Kelvin.

A thermometer has two important elements: the temperature sensor in which some physical change occurs with temperature, plus some means of converting this physical change into a numerical value (Wikipedia, 2011). The temperature precision or resolution of a thermometer is simply to what fraction of a degree it is possible to make a reading.

II. Background Theory

Digital thermometer is an electronic device which generates accurate temperature. Thermometers are useful apparatus being used since long time for temperature measurement. In this project an Arduino based digital thermometer to display the current ambient temperature and temperature changes on a LCD unit in real time. It can be deployed in houses, offices, industries etc. to measure the temperature. This project is based on Arduino UNO which communicates here with LM35 temperature sensor and a 16x2 display unit**.** We can divide this Arduino based thermometer into three sections - The first senses the temperature by using temperature sensor LM 35, second section converts the temperature value into a suitable numbers in Celsius scale which is done by Arduino, and last part of system displays temperature on LCD. The same is demonstrated in below block diagram.- Microcontroller can be regarded as a single

-chip special-purpose computer dedicated to execute a specific application. As in general-purpose computer, microcontroller consists of memory (RAM, ROM, and Flash), I/O peripherals, and processor core. However, in a microcontroller, the processor core is not as fast as in general purpose – computer, the memory size is also smaller. Microcontroller has been widely used in embedded systems such as, home appliances, vehicles, and toys etc. There are several microcontroller products available in the market, for example, Intel's MCS - 51 (8051 family), Microchip PIC, and Atmel's Advanced

RISC Architecture (AVR). We discuss Arduino UNO and LM35 temperature sensor in this section.

III. The Proposed Digital Thermometer

In this project a digital thermometer was designed and constructed using Arduino microcontroller device. The block diagram for the thermometer is as shown in fig 1. The design is in four modules; power supply, temperature sensor, LCD device and Arduino UNO modules. While the Arduino UNO forms the main control element, the temperature sensor senses the temperature to be measured and converts it to a corresponding analogue voltage. The digital value of the measured temperature is then displayed on an LCD device. The power supply section provides the required voltages for the other three sections.

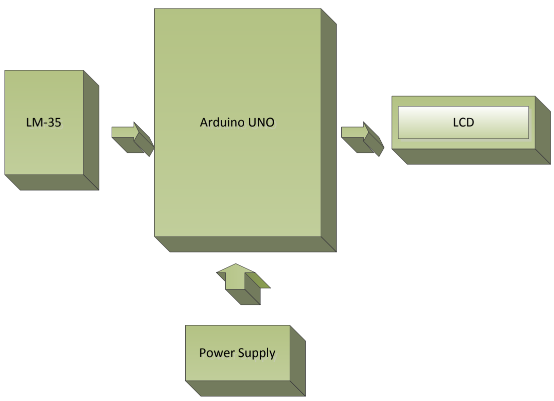

Figure 1. System Block Diagram of the digital Thermometer

IV. Hardware Implementation Process

The microcontroller-based digital thermometer by using temperature sensor is designed by both hardware and software controlled. The amounts of temperature are displayed on the LCD display system. The whole reading and controlling is done by Arduino UNO software.

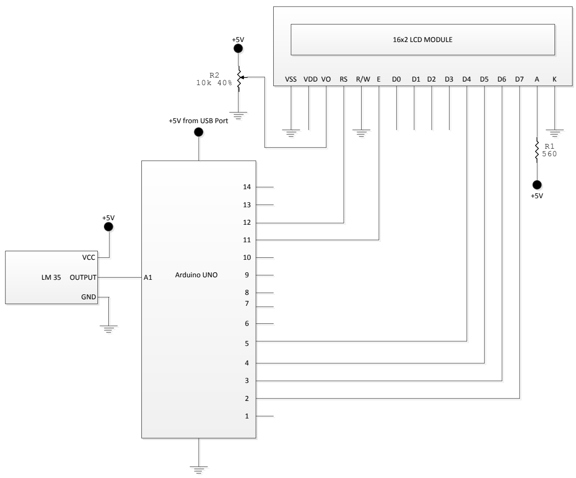

Figure 2. Overall Circuit Diagram

A1 pin of Arduino UNO is configured by input pin and 2,3,4 & 5 are configured as digital output to send data to 16x2 character dot matrix LCD (Liquid Crystal Display).

A. Arduino UNO

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-to-serial converter.

Uno" means "One" in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

Arduino UNO is used as a main processing unit. A1 of Arduino UNO connected vout of

LM35. Pin 5, 4, 3 , 2 , 11 & 12 of Arduino are configured as digital output pins to send data to 16x2 character dot matrix LCD (Liquid Crystal Display).

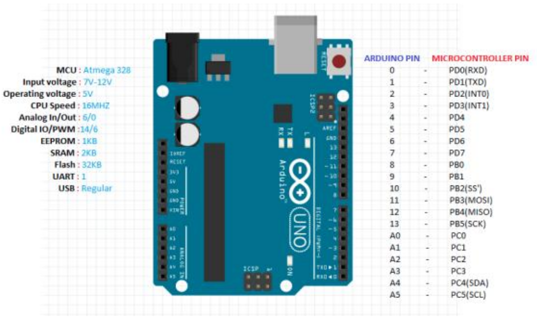

Figure 3. Arduino UNO

B. Liquid Crystal Display (LCD)

The 2 line 16 characters LCD, is used to display current temperature. It is also used to display temperature in Celsius and Fahrenheit changing time to see easily which digit is changing.

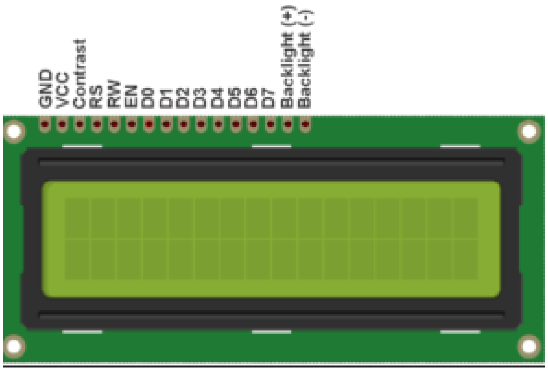

Figure 4. Liquid Crystal Display (LCD)

The LCD is configured as 4-bit data interface D4 to D7 pins are used for data inputs. R/W(5) pin and VSS(1) pin of LCD is pulled to ground. The E(6) pin of LCD is controlled by Arduino to store the data. The RS(4) pin of LCD is controlled by Arduino to select whether the input data is command or data. V0(3) pin is used to adjust LCD brightness by using variable resistor, R2.

The LCD employed is a 16 x 2 type capable of displaying 32 characters in alphanumeric form. It has a wide range of LCD driver power from - 3 to 1V with high speed MPU bus interface of 2MHZ when the supply voltage is Vcc = 5V. It can also be configured as 4 bit or 8 – bit interface enabled to transmit or receive data in either 4 bits or 8 bits. It consumes very small power with automatic reset circuit that initializes the controller/driver after power on. Internally there is an oscillator that has external resistors (LCD Data book).

The LCD was configured to drive its dot - matrix under the control of 4-bit output of the microcontroller. A regulated supply of 5V was used to supply the chip which is within the recommended supply voltage of the chip. A 560Ω resistor was included as a current limiting resistor. The pin 16 of the chip is the K(16), VSS(1) and R/W(5), are the ground and was connected to the 0 line of the supply.

While pins 11 to pin 14 were connected to receive the 4 - bit data from the main micro. A variable resistor is provided to adjust the brilliance of the LCD. The value as recommended in the datasheet is from 10k to 30k. For this project, a 10k variable resistor was used to vary the brightness of the LCD. Pin 4 is the reset pin that is used to clear the registers of the LCD.

C. LM35 Temperature Sensor

The fundamental necessity of the research is the conversion of the measured temperature into a corresponding electrical signal. There are many transducers capable of performing this, among which are thermocouple, thermistor and LM35 IC series. For convenience, availability and many inherent advantages a version of the LM35 series is chosen for this project. The LM35 series are precision integrated - circuit temperature sensors, whose output voltages are linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over other temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming and has low output impedance, linear output, and precise inherent calibration that make interfacing to readout or control circuitry especially easy. As it draws only 60 µA from its supply, it has very low self -heating (LM35 Data book, 2010).

One common temperature sensor in the LM35 series available in the market is LM35DZ. There are other temperature sensing components in the same series like LM334, DS1820 etc. This project has made use of the LM35DZ; this is because of its availability and the range of temperature it can handle. The LM35DZ is a precision semiconductor temperature sensor giving an output of 10mV per degree Centigrade rise. According to its data sheet (LM35 Data book, 2010) an RC circuit should be connected across the output and ground of the LM35DZ, if a long cable is used. This is to reduce the capacitive effect of the cable. A capacitor of 1uF and a resistor of 100 ohms were connected across the IC as shown in figure5.

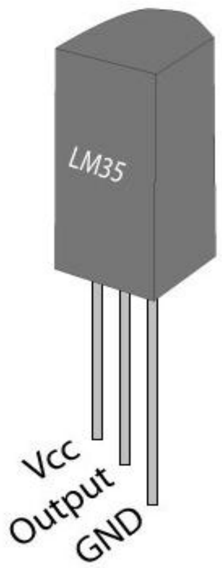

Figure 5. LM35 temperature sensor

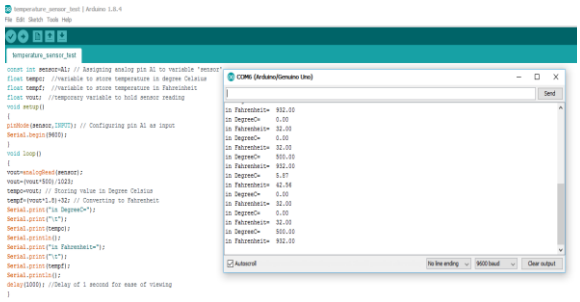

Figure 6. LM35 and Arduino UNO interfacing output screen shoot of Serial Monitor

V. Software Procedure for Controlling the Whole System Function

ARDUINO 1.8.4 the open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software. This Software can be used with any Arduino board. Refer to the Getting Started page for Installation instructions.

VI. Overall Discussion

The aim of this project is circuit implementations digital thermometer by using a Arduino UNO. The microcontroller is used to get user input from LM35 temperature sensor to calculate and display temperature value, to send display data for the LCD module.

VII. Conclusion and Future Work

In this manuscript, a digital thermometer has been designed using an Arduino as the heart of the system. To sense the temperature to be measured and LM35 sensor was employed. The measured temperature is then converted to digital format by an ADC located internally in the Arduino and displayed on an LCD. It is suggested that this thermometer may be improved upon by using a more sensitive sensor to make it suitable for measurements at lower temperatures. A memory device may also be incorporated to store the measured results.

VII. Project Extensions

We have designed and implemented a Microcontroller – based system for monitoring server room temperature. We utilized Arduino and LM35 temperature sensor. Based on the testing results, the system works according to our predefined specification. This system can be used to help the administrator to monitor server room temperature and control electronic appliances in real - time using text message (SMS), in case the administrator in not inside the server room. The system also can raise an alarm and send a text message to warn the administrator if the server room temperature is above normal.

References

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