CHAPTER 3

HARDWARE AND SOFTWARE DETAILS OF MICROCONTROLLER BASE HUMIDITY AND TEMPERATURE MEASUREMENT AND MONITORING SYSTEM

ABSTRACT

This chapter deals with the Hardware and Software details of the present work. This chapter also deals with the calibrations of the sensor and results obtained in the present study. The present work describes the design of a Humidity and Temperature measurement system using HSM-20G sensor.
3.1 Introduction

The best way to develop a working circuit is to reduce to hardware by minimizing the number of components within small portions, which can be individually tested and debugged. Keeping this in view point a microcontroller based humidity and temperature measurement with reducing hardware system is developed in the present work. The details are given in the following sections.

The microcontroller based systems are widely used in Industry for the measurement, display and monitoring of physical quantities like humidity, temperature, pressure, speed, flow, etc. For the measurement of such quantities, transducers or sensors are used to convert real-life information in to equivalent electrical signals. For example; the temperature sensor converts the physical data such as temperature in to an equivalent electrical signal, whose voltage level is proportional to the temperature. In the present work Humidity and Temperature measurement analog sensor HSM-20G is used to measure the humidity and temperature in the atmosphere. A brief description about the details of HSM-20G is given below.

3.1.1 Description about HSM-20G sensor

HSM-20G Humidity Sensor Module was supplied by Machete Technology, Mumbai. Humidity sensor is a device consisting of a special plastic material whose electrical characteristics change according to the amount of humidity in the air. Basically it is a sensor that senses the amount of water vapor in air. The module of HSM-20G is essential for those applications where the relative humidity can be converted to standard voltage output. Figure 3.1 shows the photograph of the HSM-20G sensor used in the present work.
The features of HSM-20G include:

□ Voltage analog output for both humidity and temperature.

□ Small size makes it easy to conceal

□ Compatible with all types of microcontrollers

□ High sensitivity to humidity in the air

The specification of the sensor is a DC5.0±0.2 V input voltage and the output voltage is 1-3V. The measuring accuracy for the detection of humidity reading is ±0.05RH. The combination of humidity output, with the temperature output being matching current or voltage signal. The sensor is high sensitivity to humidity in the air. Table 3.1 shows the connections for HSM-20G sensor. Figure 3.2 and Figure 3.3 shows layout of HSM-20G sensor.
Figure 3.1 HSM-20G sensor module
Figure 3.2 Temperature sensor layout

Figure 3.3 Humidity sensor layout
### 3.1.2 Humidity sensor connections

<table>
<thead>
<tr>
<th>PIN</th>
<th>NAME</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GND</td>
<td>Connects to ground</td>
</tr>
<tr>
<td>H</td>
<td>Humidity output</td>
<td>Voltage analog input</td>
</tr>
<tr>
<td>+</td>
<td>Vcc</td>
<td>Connects to Vcc(+5V)</td>
</tr>
<tr>
<td>T</td>
<td>Temperature output</td>
<td>Voltage analog input</td>
</tr>
</tbody>
</table>

Table 3.1 Humidity sensor pin assignments
3.2 On-chip Analog-to-digital converter

Analog-to-digital converters are among the most widely used devices for Data Acquisition. Digital computers use binary values but in the physical world, everything is analog. Some of the examples are: temperature, pressure, humidity, velocity etc. A physical quantity is converted in to electrical signals by using a device called Transducers. Transducers are also known as sensors. Although these are sensors for temperature, velocity, pressure, light, and many other natural quantities, they produce an output that is voltage or current. Therefore, we need an Analog-to-Digital converter to translate the analog signals to digital values so that the microcontroller can read them and process them.

An ADC has n-bit resolution; where ‘n’ can be 4, 8, 10, 12, 16 or even 24 bits. The higher the resolution of ADC, the smaller is the step size, which is the smallest change that can be discerned by an ADC. In addition to another major factor in judging an ADC, it is defined as the time required for an ADC to convert the given analog input to a digital number and in this present work internal 10-bit ADC is used.

3.3 Problem statement

Humidity is defined as the amount of water vapor in the air and usually measured in term of Relative Humidity (%RH). Percentage of Relative Humidity is best described as amount of moisture in the air and compared to amount the air can hold at that temperature (or) the ratio of the partial pressure of water vapour in a parcel of air to the saturated vapour pressure of water vapour at a prescribed temperature. Relative humidity is an important metric used in forecasting weather.

Now-a-days, it is of paramount importance to control the humidity between two levels such a scenario calls for the measurement of humidity in a portable far tune. Suitable
humidity level is needed to stabilize our environment and the world ecosystem including to mankind. The relative humidity in the air should be monitored in order to maintain an ideal environment. The common problem result by humidity such as dampness, dryness and condensation in surroundings cause discomfort and various problems to public. Too high or too low humidity level condition can affect the quality of wood furniture which needs an extra care of dry condition all the time.

For certain industry such as chickens eggs hatching or even the incubation of immature new born chicks also needs a controlled humidity condition. In order to ensure energy efficient and optimized results, proper controlled system need to be designed. Development in sensor design lead sensor as main component to read some of the parameters and microcontroller features make it preferred choice embedded control to ease the end user to monitor the parameters, control devices and system operation. Hence we would like to propose this device that can read the humidity level and the temperature in order to help us be aware of humidity condition around us.

3.4 Scope of project

Our project entitled portable humidity and temperature reader is to read the level of humidity and temperature in a particular room. Operation of this device is that once the ON/OFF button is pressed once, the device will activated and the LCD will display both the reading of humidity level and also temperature level and also that the reading is displayed by output measured the sensors continuously. The device will stop operation as the ON/OFF button is pressed once again. The devices will need a battery of 9V but the voltage regulates the voltage to 5V for device usage.
The size is also so small and hence it is quite handily for users. The limitation of our project is that the device is only specifically to display the reading of humidity and temperature on the LCD provided. But the device is portable and available at everywhere.

Figure 3.4 shows schematic diagram of Humidity and Temperature measurement System. The block diagram of the designed system is shown in Figure 3.5. The flowchart for the measurement of Humidity and Temperature using the designed hardware circuit is given in Figure 3.15. The software is developed in proton BASIC pro and the program listing is given in 3.16 and the photograph of the experimental set-up is shown in 3.18. In this present work Humidity and temperature is measured using the sensor HSM-20G module. This sensor is checked before it is connect to the microcontroller. Table 3.2 gives the readings taken from HSM-20G sensor output at different Humidity and temperature before placing the sensor in to the hardware circuit.
<table>
<thead>
<tr>
<th>Humidity analog output</th>
<th>Temperature analog output</th>
</tr>
</thead>
<tbody>
<tr>
<td>voltage from sensor in Volts</td>
<td>voltage from sensor in Volts</td>
</tr>
<tr>
<td>measured with digital multimeter</td>
<td>measured with digital multimeter</td>
</tr>
<tr>
<td>1.326 V</td>
<td>0.792 V</td>
</tr>
<tr>
<td>1.335 V</td>
<td>0.811 V</td>
</tr>
<tr>
<td>2.032 V</td>
<td>0.936 V</td>
</tr>
<tr>
<td>2.077 V</td>
<td>0.986 V</td>
</tr>
<tr>
<td>2.117 V</td>
<td>1.32 V</td>
</tr>
<tr>
<td>2.134 V</td>
<td>1.43 V</td>
</tr>
<tr>
<td>2.140 V</td>
<td>1.65 V</td>
</tr>
</tbody>
</table>

Table 3.2 Humidity and temperature analog output voltage (Volts) from the sensor
Figure 3.4 Schematic diagram of Humidity and Temperature measurement system.
Figure 3.5 Block diagram of Designed system
Figure 3.6 Flow chart of the present work

1. Start
2. Set up the LCD commands
3. Load the ADC routines into the program
4. Create a variable to hold the data of Temperature and Humidity
5. Clear LCD
6. Read Humidity and Temperature data from sensor
7. Print the Temperature on First line of the LCD
8. Print the Humidity on second line of the LCD
3.6 Software details of present work

Software program for measuring the humidity and temperature from designed device

LCD_DTPin = PORTB.4 'LCD's data lines from D4 to D7
LCD_ENPin = PORTB.3 'LCD's EN lines
LCD_RSPin = PORTB.2 'LCD's RS lines
LCD_Interface = 4 '4-bit interface to LCD
LCD_lines = 2 'LCD contains 2 lines
LCD_Type = Alphanumeric 'LCD type is alphanumeric

Include "ADC.Inc" 'Load the ADC routines in to program

Dim volt As word 'Create a 16-bit unsigned variable to hold the analog Voltage from ADC channel AN1

Dim temp1 As word 'Create a 16-bit unsigned variable to hold the value i.e. analog voltage multiply with 48

Dim temp2 As word 'Create a 32-bit unsigned variable to hold the value Of temp2

Dim temp3 As word 'Create a 32-bit unsigned variable to hold the value Of temp3

Dim temp4 As word 'Create a 32-bit unsigned variable to hold the value Of temp4

Dim avolt As word 'Create a 16-bit unsigned variable to hold the analog Voltage from ADC channel AN0

Dim humidity1 As word 'Create a 16-bit unsigned variable to hold the value Of humidity 1

Dim humidity2 As word 'Create a 32-bit unsigned variable to hold the value Of humidity 2
Dim humidity 3 As word  'Create a 32-bit unsigned variable to hold the value of humidity 3
Dim RH As word  'Create a 32-bit unsigned variable to hold the value of RH

classopenADC (ADC_Fosc_32&ADC_RIGHT_JUST&ADC_2_TAD,ADC_REF_Vdd_Vss, ADC_1ANA,ADC_2ANA)

  ' open the AN0,AN1 channels of ADC
  'open the ADC
  'Fosc/32
  'Right justified for 10-bit operation
  'Tad value of 2
  'Vref+ at Vcc: Vref- at Gnd
  'Make AN0,AN1 are an analog input
Delayms 1000  'Wait for 1 second delay
Cls  'clear LCD
While 1=1  'create on endless loop
SelchanconVADC (ADC_CH1)

Volt = ReadADC(ADC.CH1)  'conversion of temperature analog voltage in to digital

  Input from ADC channel CH1
  temp1 = volt*48  'multiplication of analog voltage with 48 is stored in Variable temp1
  temp2 = temp1/10000  'Division of temp1 with 10000 is stored in variable temp2
  temp3 = temp2*9  'multiplication of temp2 with 9 is stored in variable temp3
  temp4 = temp3+6  'Addition of temp3 with 6 is stored in variable temp4
  temp = temp4*2  'multiplication of temp4 with 2 is stored in variable temp

Print “temp =”, Dec temp, ‘c’  'Print temperature value in ‘c’ on LCD
Print $FE,$CO  'Print temperature value on the second line of LCD
Delayms 1000 ' wait for 1 second delay

SelchanconVADC (ADC_CH0)

Volt = ReadADC(ADC_CH0) ' conversion of humidity analog voltage in to digital input from ADC channel CH0

humidity1 = avolt*48 'multiplication of analog voltage with 48 is stored in Variable humidity1

humidity2 = humidity1/10000 'Division of humidity1 with 10000 is stored in variable humidity2

humidity3 = humidity2*31 ' multiplication of humidity2 with 31 is stored in variable humidity3

RH = humidity3 - 12 ' Substraction of humidity3 with 12 is stored in variable RH

Print "RH = ",Dec RH , "%" ' Print humidity value in % on LCD

Print $FE, 128 'Print humidity value on the first line of LCD

Delayms 1000 'wait for 1 second delay

Wend ' Do forever
3.7 Photograph of Humidity and Temperature measurement System

Figure 3.7 Photograph of humidity and temperature measurement system developed in the present work
3.8 Calibration curves for present work

In the present work for relative humidity and temperature sensing HSM-20G is used. HSM-20G sensor is analog voltage converter. Table 3.2 shows standard characteristics of the humidity sensor. Using table 3.2 data relative humidity versus output voltage graph drawn with the help of origin lab software. In this the RH and output voltage are related by the equation (typically at 25 c) \( RH = 31 \times \text{analog voltage} - 12 \). This is the equation for measuring the humidity from designed system.

Figure 3.8 shows the calibration curve for Relative humidity.

Table 3.3 shows standard characteristics of the humidity sensor. Using table 3.3 temperature versus output voltage graph drawn with the help of origin lab software. The relation between temperature and output voltage is \( \text{Temperature} = 2[9 \times \text{analog voltage} + 6] \). This is the equation for measuring the temperature from designed system. For the calibration curves origin lab software is used.

Figure 3.9 shows the calibration curve for temperature.
<table>
<thead>
<tr>
<th>Analog output voltage (Volts)</th>
<th>Relative humidity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.74</td>
<td>10</td>
</tr>
<tr>
<td>0.95</td>
<td>20</td>
</tr>
<tr>
<td>1.31</td>
<td>30</td>
</tr>
<tr>
<td>1.68</td>
<td>40</td>
</tr>
<tr>
<td>2.02</td>
<td>50</td>
</tr>
<tr>
<td>2.37</td>
<td>60</td>
</tr>
<tr>
<td>2.69</td>
<td>70</td>
</tr>
<tr>
<td>2.99</td>
<td>80</td>
</tr>
<tr>
<td>3.19</td>
<td>90</td>
</tr>
</tbody>
</table>

Table 3.2 Standard characteristics of the humidity sensor
Table 3.3 Standard characteristics of the humidity sensor

<table>
<thead>
<tr>
<th>Analog output voltage (Volts)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.6</td>
<td>30</td>
</tr>
<tr>
<td>2.9</td>
<td>32</td>
</tr>
<tr>
<td>3.1</td>
<td>34</td>
</tr>
<tr>
<td>3.4</td>
<td>36</td>
</tr>
<tr>
<td>3.55</td>
<td>38</td>
</tr>
<tr>
<td>3.8</td>
<td>40</td>
</tr>
<tr>
<td>4</td>
<td>42</td>
</tr>
<tr>
<td>4.35</td>
<td>45</td>
</tr>
</tbody>
</table>
Figure 3.8 Calibration curve for Relative humidity
Figure 3.9 Calibration curve for temperature