MICROCONTROLLER BASED REAL TIME WEATHER MONITORING DEVICE WITH GSM

K C Gouda1, Preetham V R and M N Shanmukha Swamy

***Abstract* — The measurements of temperature, atmospheric pressure, relative humidity and dew point temperature remotely by using the sensors is not only important in weather monitoring but also crucial for many other applications like agricultural and industrial processes. A device for real time weather monitoring is presented in this paper to monitor the real time temperature, atmospheric pressure, relative humidity and dew point temperature of the atmosphere via GSM network, using analogue and digital components. The analogue outputs of the sensors are connected to a microcontroller through an ADC for digital signal conversion. An LCD display is also connected to the microcontroller to display the measurements. For analysis and archiving purposes, the data can be transferred over GSM and receiver section is connected to PC. Received data is further processed to generate graphical display using weather modeling algorithms. The device has many advantages compared to other weather monitoring systems in terms of its smaller size, on-device display, low cost, portable and robust.**

Index Terms – Sensor, Microcontroller, LCD, GSM

I. INTRODUCTION

Climate plays an important role in human life. The thermal comfort of human being is known to be influenced mostly by six parameters, i.e., air temperature, radiation, air flow, humidity, activity level and clothing thermal resistance. The advancement in technology has made these small and reliable electronic sensors capable of monitoring environmental parameters more favourable.

In several earlier studies the sensors have used for the monitoring of weather parameters [1-2] more favourbly. Microclimate monitoring of indoor environments using piezoelectric quartz crystal humidity sensors is also studied by some researchers [3]. Moghavvemi et al. [4] developed a reliable and economically feasible remote sensing system for temperature and relative humidity measurement. Using capacitive-based sensors DeHennis and Wise [5] introduced a wireless sensing microsystem for monitoring the environmental parameters. monitoring,. Buff et al., [6] used surface acoustic waves devices as the temperature and pressure sensor.

However, all these systems are very expensive and complex in nature as some of them require the use of on-chip transmitter circuit and involves costly fabrication processes also.

Combination of these sensors with data acquisition system has proved to be a better approach for temperature, pressure, relative humidity and dew point monitoring. In our country some agricultural activities, industries, hospitals, storage places etc require to measure the temperature and humidity for research, production, treatment and diagnosis of the patients, storing food, beverage etc. Sometime, in weather monitoring, for instance, parameters such as, the temperature and humidity needed to be measured, thus sensors have always been given the task for doing so.

II. DESIGN CONSIDERATION

The system is divided into two main parts: transmitter and receiver section. Transmitter section mainly consists of: the sensor circuit, the microcontroller unit, the display unit and GSM module. The sensor circuit contains the temperature sensor, pressure and relative humidity sensor. One sensor provides analog output, which is converted to digital form using ADC in the controller and another sensor provides digital output and which is further processed to get temperature, humidity and dewpoint temperature. Those measured parameters will be displayed in an LCD display. Block diagram of the overall system is shown in fig 1. Receiver section consists of a GSM unit which is interfaced to laptop or desktop computer. Software collects the data coming from different weather monitoring devices and presents them in a user interface map. Data is also saved for further analysis and possible weather forecast.

1. Transmitter section

A. Sensors

Pressure:

The Microcontroller receives voltage input corresponding to the pressure of the environment from the pressure transducer; the pressure transducer already has an inbuilt signal condition circuit, which makes the correct voltage available for analog to digital conversion. The

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Microcontroller converts the analog signal to the corresponding digital equivalent and manipulates the data based on pre-programmed code to displays useful result equivalent of Pressure (KPa) on LCD. e. The output pressure sensor with 5V power supply change by 4.59mV/0.1KPa. Sensor measure pressures from 15KPa to 115KPa. Its output voltage changes for the pressure range from 0.2V to 4.8V. For the output value of atmospheric pressure varies from about 3.8V to 4.3V.

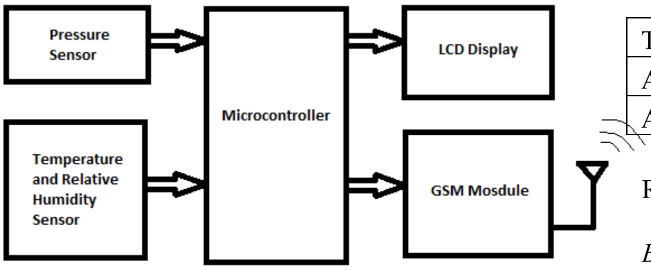

Fig. 1 Block diagram of weather monitoring device, transmitting section.

For pressure measuring sensor, the input is pressure, and the output is voltage.

Nominal Transfer Value:

$V_{out} = V_s * (0.009 * P - 0.095) \pm Error$

$Error = Pressure\ Error * Temp\ Factor * 0.009 * V_s$

$V_s = 5.1 \pm 0.25Vdc$

Temperature and Relative Humidity:

The Temperature and Relative Humidity Relative IC supplies digital equivalent of the temperature and relative humidity of the environment at a particular time upon demand from the microcontroller, however the data supplied is raw and not useful by human, hence the microcontroller processes it and manipulate it to give accurate and corresponding reading. The temperature is measure in Degree Celsius (°C) and Humidity is measured with respect to perfect vacuum (%RH)

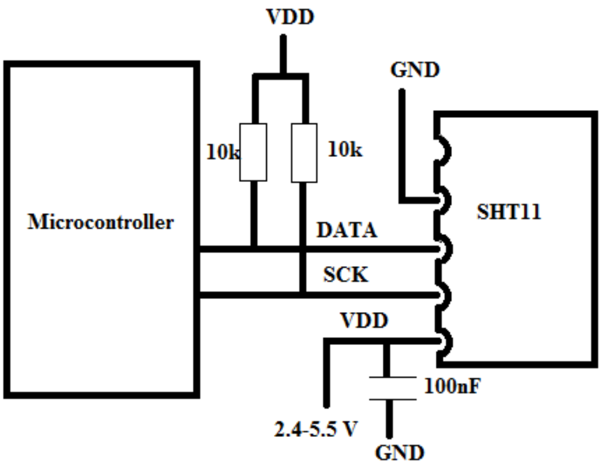

Fig 2: SHT11 connection with microcontroller

Dew Point:

Sensor not measuring dew point directly, however dew point can be derived from humidity and temperature readings. Since humidity and temperature are both measured on the same monolithic chip, the sensor allows superb dew point measurements in Degree Celsius (°C). Wikipedia indicates that Relative humidity of 100% indicates the dew point is equal to the current temperature and that the air is maximally saturated with water. However dew point is calculated through formula relating temperature and humidity, given by:

$$T_d(RH,T) = Tn \cdot \frac{\ln\left(\frac{RH}{100}\%\right) + \frac{m.T}{Tn+T}}{m - \ln\left(\frac{RH}{100}\%\right) + \frac{m.T}{Tn+T}}$$

Temperature Range	T_n (°C)	m
Above water, 0 – 50°C	243.12	17.62
Above ice, -40 – 0°C	272.62	22.46

Eq 1: Equation to calculate dew point temperature.
RH – Relative Humidity, T – Temperature

B. Microcontroller Unit

The microcontroller is the heart of the whole system. Analog and digital sensors are input of the Microcontroller. Displays unit is an output of the microcontroller. It receives Analog and digital signals equivalent to the quantity of the weather variable to be measured; from sensors connected to it and conversion and processing through pre- programmed instructions written in C language to ensure that corresponding measurement made by these sensors are available in forms that are meaningful and useful for human analysis, interpretation and record. The microcontroller PIC16F877A has been used for the measurement of weather conditions and transmission of data to the receiver. It has 40-Pin packages. It has a 10-bit A/D converter. The microcontroller uses 20MHz clock.

C. LCD Unit

The 16 x 2 LCD display is capable of displaying different characters and symbols. It is used to display the measured parameters such as pressure, temperature, relative humidity and dew point temperature.

D. GSM Module

LEON-G1/G2 series modules are cost efficient solutions offering full quad-band GSM (Global System for Mobile) / GPRS (General Packet Radio Service) data and voice functionality in a compact LCC (Leadless Chip Carrier) form factor. Featuring low power consumption and GSM/GPRS class 10 data transmission with voice capability, LEON-G1/G2 series modules combine baseband, RF transceiver, power management unit, and power amplifier in a single, easy-to-integrate solution.GSM module works at frequencies 850 MHZ, 900 MHZ, 1800 MHZ and 1900 MHZ. The Modem works with 3V and 5V DC TTL interfacing circuitry, which allows user to directly interface with 5V Microcontrollers. The modem can be interfaced with a Microcontroller using USART.

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2. Receiver section

It mainly consists of GSM unit which is interfaced with computer. Data from different weather stations are processed according to weather modeling algorithm.

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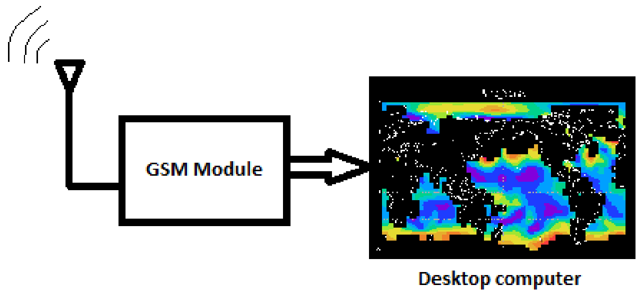

Fig 3: Block diagram of receiver section.

III. SOFTWARE IMPLEMENTATION

C programming language is used to control the operation of whole system. The most popular and powerful

A. *Flowchart*

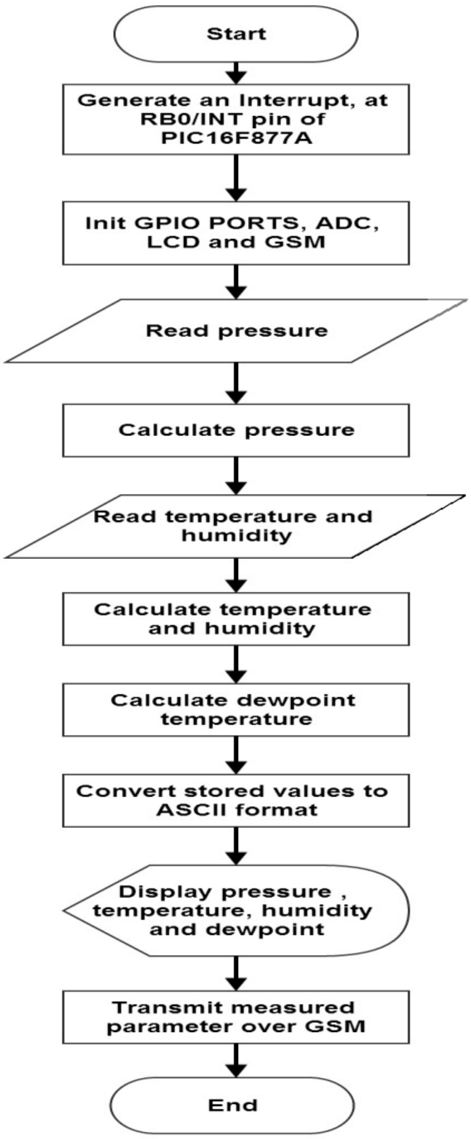

Fig 4: Flowchart of the software system

MPLAB X IDE which provides an environment to write C program for PIC controllers with a built-in simulator and an in-circuit debugger. XC8 is a compiler to convert the code from C language to machine understandable language and it provides standard inbuilt library functions.

The microcontroller, which controls the operation of peripheral devices and measures the input signal from sensors connected to it and it is preprogrammed by using PIC Kit3 debugger. Pressure, temperature and humidity are sensed sequentially by the sensors. These data are displayed on LCD and then data are transmitted to the receiver by using GSM module. SHT11 is connected to controller, controller is programmed as per the communication protocol required to communicate with the sensor.

GSM module is connected to serial communication ports of microcontroller. Serial communication occurs at a baud rate of 9600bps.

B. *Algorithm*

1. Generate an interrupt. Either manual or timer based.
2. Define microcontroller I/O pins for each peripheral such as sensors, display unit and GSM module. Initialize LCD unit, ADC and GSM module.
3. Pressure sensor is connected to AN0 of PIC16 microcontroller. After initialization ADC takes physical value and converts into digital form, which is 10 bit data stored in ADRESH and ADRESL register.
4. Controller performs necessary calculation to extract pressure.
5. Temperature and humidity sensor, start transmission with sensor, check the status register and send command to measure temperature or humidity, based on the command sensor provides raw data of temperature or humidity.
6. This raw data must be processed by the microcontroller to get temperature and humidity and which is stored in memory.
7. Dew point temperature is a function of temperature and humidity. Equation to calculate dew point is as in Eq 1.
8. Display all the measured parameters.
9. Initialize serial data transmission unit and send the AT command and data to transmit measured parameters via GSM network.

IV. RESULT AND DISCUSSION

Proteus is a software for microprocessor simulation, schematic capture, and printed circuit board (PCB) design presented in figures 5-7. It provides many inbuilt components for simulation. Below figures shows the simulation of weather monitoring device using proteus simulation tool. After design and construction of the whole circuit, test and result is carried out. Simulation is working fine and displaying all measured parameter with very small margin of error. The calibrations of the monitored parameter are done using the validation against the observed temperature, humidity and dew bulb temperature over the different locations in the City of Bangalore. It seems the present developed device can be adopted for the real time monitoring of the weather parameters which can be used for the data assimilation in the short term prediction of the parameters.

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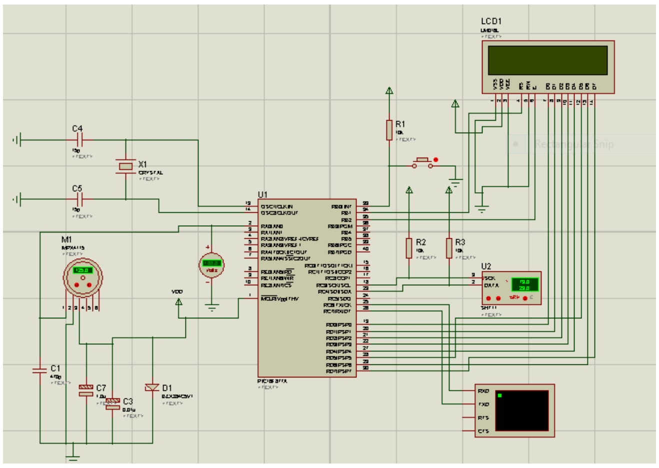

Fig 5: Screenshot of the weather monitoring device circuit

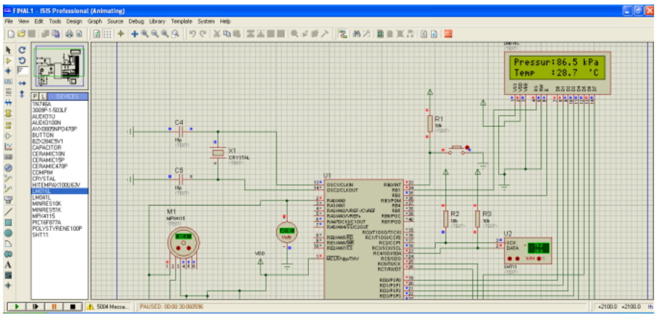

Fig 6: Screenshot of simulation result for the system displaying temperature and pressure.

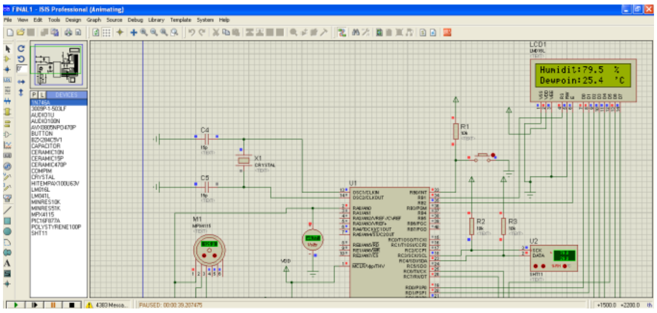

Fig 7: Screenshot of simulation result for the system displaying humidity and dew point temperature.

IV. CONCLUSION

The main goal of this research is to develop and implement a simple and low cost wireless weather station that get the weather conditions at the remote station and transmit the data to a wireless receiver board connected to the RS-232 port of the PC. GSM is the wide spread communication all over the world and can communicate from any remote area so GSM is the better choice to communicate the weather parameter in this device. C program was written for the transmitter to extract the data, process and transmit the data format to the receiver. Finally, the hardware and software implemented fulfil the goal are successful. The system is highly optimized, portable and robust.

IV. ACKNOWLEDGEMENT

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