

Measurement and Transmission of Atmospheric Parameters Using Radio Frequency Communication

Dushyant Pande, Sanjeev Gaba

Abstract— *The measurement of various atmospheric parameters is of utmost importance, not only for the weather forecasting process but also for future references. A smart, robust and cheap system is implemented which can not only measure the various atmospheric parameters like light, temperature, humidity, wind speed and atmospheric pressure but can also transmit the acquired data to a personal computer using radio frequency based wireless communication. This paper proposes the design and development of such system. The system can be considered to be consisting of two modules. One is the transmitter module and the other is receiver module. The use of microcontroller and various sensors make the system operational in real time. The acquired data is displayed on the transmitting terminal with the help of a LCD and on the personal computer with the help of a customized Visual Basic interface.*

Key Words—*Atmospheric parameters, Radio frequency transmission, Sensors, Visual basic, Weather monitoring.*

I. INTRODUCTION

The significance of changes in weather conditions is not unknown to anyone. It is always desirable in some way or another that we can measure the atmospheric parameters and then use those measured parameters to forecast the sudden atmospheric changes so that any kind of loss can be minimized. We always hear of the damage to property and lives caused by such atmospheric disasters. In the ancient times weather forecasting was done mostly by human experiences over the cloud cover and the wind movements. Farmers were one of the most affected by the weather conditions. With the advent of time and with a rapid progress in the field of science and technology various electronic devices were invented to forecast the weather conditions. At present there are various satellites orbiting in the atmosphere just to monitor the climatic conditions, also there are various kinds of radars available for the same purpose [1], [2]. But it is notable that such devices are very robust, expensive and are associated with high end technologies. So there is a need for a system which can monitor the weather parameters precisely and also is cost efficient, robust and real time operational so that it can be installed at any place like small industries. A wireless system is designed and developed as described in this paper which is very cost efficient and stands for a replacement of various similar traditional techniques.

This device is very simple to use, needs no specific technical knowledge, and using radio frequency communication it can transfer the measured atmospheric parameters to a personal computer for further analysis.

The atmospheric parameters which are considered here are wind speed, light intensity, temperature, humidity and atmospheric pressure [3]. We can also calculate the Dew point using the temperature and humidity values. The temperature at which condensation appears is known as the dew point of the air sample.

II. PROPOSED SYSTEM

The block diagram of the overall proposed system is shown in figure 1. The diagram can be broadly divided into two sections. One is the transmitter unit, which consists of Humidity sensor, Pressure sensor, Light sensor, Temperature sensor, Wind anemometer, and LCD along with a microcontroller and a power supply. This unit in the first phase measures all the desired atmospheric parameters and then in the next phase transmits this atmospheric data wirelessly using RF Communication. Transmission through RF system is preferred because of various reasons. Firstly, signals through RF can travel through larger distances making it suitable for long range applications. Next, RF transmission is more strong and reliable and also uses a specific frequency so that no interference from foreign equipments occurs. The RF module used in the work comprises of an RF Transmitter and an RF Receiver and the digital data is represented as variations in the amplitude of carrier wave. This kind of modulation is known as Amplitude Shift Keying (ASK). The transmitter/receiver (Tx/Rx) pair operates at a frequency of 434 MHz. An RF transmitter receives serial data and transmits it wirelessly through RF through its antenna [4], [5].

The second unit is the receiver unit. It receives data using a RF receiver and forwards that data to personal computer where it is displayed on a designed Visual BASIC interface. Also a MAX232 level convertor is used which is an integrated circuit that converts signals from an RS-232 serial port to signals suitable for use in TTL Compatible digital logic circuits. The MAX232 is a dual driver/receiver and typically converts the RX, TX, CTS and RTS signals. The drivers provide RS-232 voltage level outputs (approx. ± 7.5 V) from a single +5 V supply via on-chip charge pumps and external capacitors. This makes it useful for implementing RS-232 in devices that otherwise do not need any voltages outside the 0 V to +5 V range, as power supply design does not need to be made more complicated just for driving the RS-232 in this case. The receivers reduce RS-232 inputs (which may be as high as ± 25 V), to standard 5V TTL levels.

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* Correspondence Author (s)

Dushyant Pande*, M.Tech. Student, Dept. of Instrumentation & Control Engineering, Graphic Era University, Dehradun, India

Sanjeev Gaba, Assistant Professor, Dept. of Instrumentation & Control Engineering, Graphic Era University, Dehradun, India

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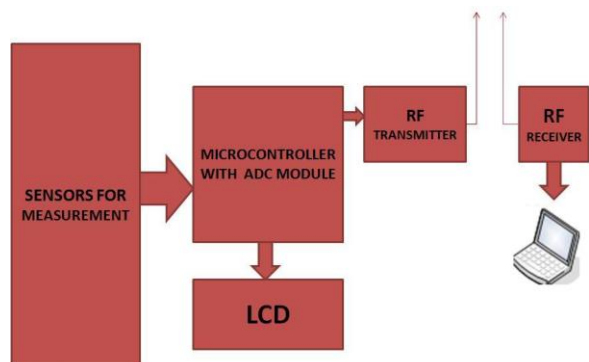


Figure 1 -Block diagram of the system

III. HARDWARE DEVELOPMENT

A. SYSTEM DESIGN

The designing of the proposed system begins with the selection of proper sensors and other electronic equipments required [6]. The selected sensors are listed in table 1. Now, in the designing of transmitter unit as shown in the circuit diagram (figure 4) the output of all the sensors are given to the input ports of the microcontroller. For this purpose we use four ports i.e. Port A-D. Pins 13 and 14 of the microcontroller are connected to the external crystal oscillator which provides a frequency of 8 MHz. A 16*2 LCD is used to display the measured parameters and is connected to the port D.. To provide electrical power to the system, a power supply module is also developed which consists of a 9-0-9 step down transformer along with some capacitors and resistors.

The center tapped transformer is preferred because it enables us to get two supplies of 9V or 18V. Further, as the microcontroller and other components operate at around 5V, so we use a LM7805 IC which converts every voltage greater than 9V to a standard 5V supply. The wireless module used for this work is Radio Frequency module. It is preferred because it operates over a long range and is not disturbed by obstructions. In this RF system, the digital data is represented as variations in the amplitude of carrier wave. This kind of modulation is known as Amplitude Shift Keying (ASK). The RF transmitter is connected to the Port C of the microcontroller. The supply to microcontroller is given through V_{DD} pins numbered 11 and 32. Ground connected pins are V_{SS} 12 and 31. The receiver module consists of an RF receiver whose data pins numbered 2 and 3 are connected to the pin 8 of the MAX232 IC.

The receiver module consists of an RF receiver whose data pins numbered 2 and 3 are connected to the pin 8 of the MAX 232 IC. MAX232 is an integrated circuit, first created by Maxim Integrated Products, that converts signals from an RS-232 serial port to signals suitable for use in TTL Compatible digital logic circuits.

Table - 1

Component	Model/Specification
Temperature sensor	National Semiconductor's LM35
Light sensor	LDR
Humidity sensor	DHT11
Pressure sensor	Freescale Semiconductor's MP3H6115A
Microcontroller	PIC 16F877A
Transformer	9-0-9
LCD	ACM 1602A
Voltage regulator IC	LM7805CV
RF Module	SUMMITEK Technologies, 434 MHz

The MAX232 is a dual driver/receiver and typically converts the RX, TX, CTS and RTS signals. The drivers provide RS-232 voltage level outputs (approx. ± 7.5 V) from a single + 5 V supply via on-chip charge pumps and external as power supply design does not need to be made more complicated just for driving the RS-232 in this case. The receivers reduce RS-232 inputs (which may be as high as ± 25 V), to standard 5V TTL levels. These receivers have a typical threshold of 1.3 V, and a typical hysteresis of 0.5 V. The output of this IC is given to a DB9 connector which takes the data to the personal computer via a connecting cable.

B. DESIGN OF WIND ANEMOMETER

An anemometer is a device for measuring wind speed, and is a common weather station instrument. The term is derived from the Greek word *anemos*, meaning wind, and is used to describe any air speed measurement instrument used in meteorology or aerodynamics. It basically consists of three or four cup shaped structures which are mounted on a metal rod. These cups are used to catch the air flowing which rotates the cups, which in turn rotates the shaft. In this project work, the wind anemometer is designed with the help of an IR LED and a Photo diode. The shaft is connected to an IR LED which also rotates with the movement in the shaft. The picture of the designed wind anemometer is shown in figure 2.



Figure 2 - Wind Anemometer

Just opposite to the IR LED is a structure designed to support a Photo diode. This diode receives the signal whenever the IR LED crosses it, and initiates a counter in the controller. Now as the distance travelled by the IR LED is known, which is the circumference of the circle formed and the time taken by this LED to travel the distance is measured. We can calculate the speed of movement of shaft by using the simple formula:

$$speed = \frac{distance}{time}$$

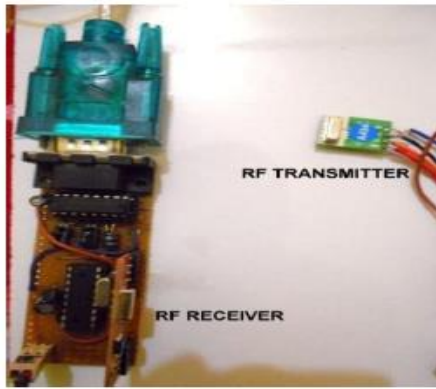


Figure 3 - RF Module

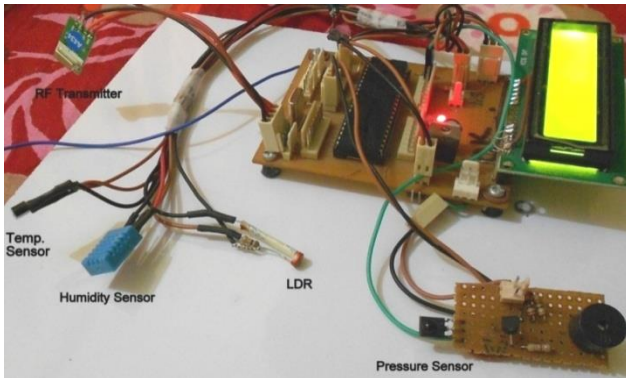


Figure 4 - Microcontroller Module

IV. CIRCUIT DIAGRAM OF THE SYSTEM

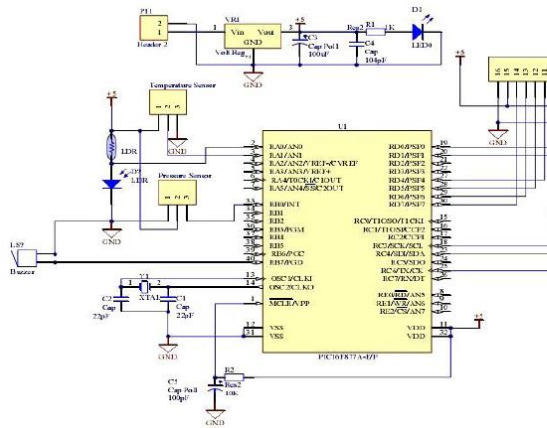


Figure 5 – Circuit diagram (Transmitter section)

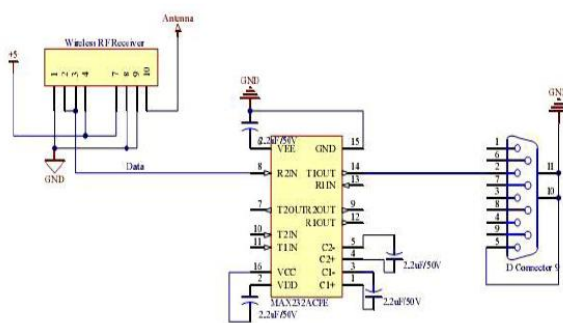
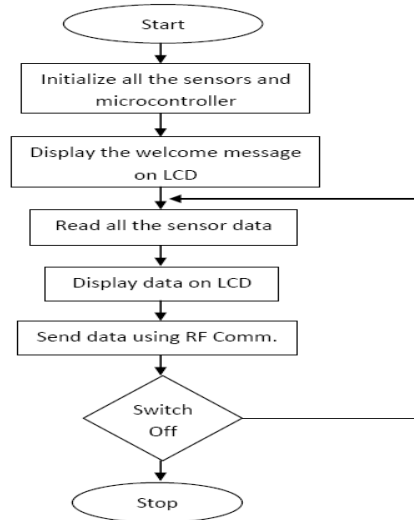


Figure 6 – Circuit diagram (Receiver section)

V. SYSTEM FLOWCHART



VI. SOFTWARE DEVELOPMENT

A. MICROCHIP'S MPLAB

MPLAB IDE is a software program that runs on PC to provide a development environment for embedded system design. The MPLAB X Integrated Development Environment or IDE is the new graphical, integrated debugging tool set for all of Microchip's more than 800 8-bit, 16-bit and 32-bit MCUs and digital signal controllers, and memory device. It runs as a 32-bit application on MS Windows, is easy to use and includes a host of free software components for fast application development and super-charged debugging [7]. MPLAB IDE also serves as a single, unified graphical user interface for additional Microchip and third party software and hardware development tools. Moving between tools is a snap, and upgrading from the free software simulator to hardware using a compiler that allows a more natural language for creating programs. With these Language Tools we can write and edit code that is more or less understandable, with constructs that helps to organize the code. Debug and programming tools is done in a flash because MPLAB IDE has the same user interface for all tools.

The process for writing an application is often described as a development cycle, since it is rare that all the steps from design to implementation can be done flawlessly the first time. More often code is written, tested and then modified in order to produce an application that performs correctly. The Designed cycle consists of following steps:

1. High level designing –From the features and performance desired, we decide which PICmicro or dsPIC device is needed, then the associated hardware circuitry is designed.
2. After checking which peripherals and pins control the associated hardware, the software is written. Assembly language is generally used as it is directly translatable into machine code or
3. Compile or assemble the software using a Language Tool to convert the code into machine code for the PIC micro device. This machine code will eventually become firmware, the code programmed into the microcontroller.



4. Testing – Testing of the code is always necessary as usually a complex program does not work exactly the way it is expected to, and “bugs” need to be removed from the design to get it to act properly.
5. Burning - “Burn” the code into a microcontroller and verify that it executes correctly in your finished application.
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B. VISUAL BASIC

After programming the microcontroller using the MPLAB`S IDE, the next work is to design a interface for windows desktop which can display the received atmospheric parameters on the computer. This is achieved by designing a interface on Visual BASIC. Visual BASIC is a high level programming language evolved from the earlier DOS version called BASIC. BASIC means Beginners All purpose Symbolic Instruction Code. It is a fairly easy programming language to learn. The codes look a bit like English Language. Different software companies produced different version of BASIC, such as Microsoft QBASIC, QUICKBASIC, GWBASIC, IBM BASICA and so on. Visual Basic was one of the first products to provide a graphical programming environment and a paint metaphor for developing user interfaces. Instead of worrying about syntax details, the Visual Basic programmer can add a substantial amount of code simply by dragging and dropping controls, such as buttons and dialog boxes, and then defining their appearance and behavior[8]. Although not a true object-oriented programming language in the strictest sense, Visual Basic nevertheless has an object-oriented philosophy. It is sometimes called an event-driven language because each object can react to different events such as a mouse click. A programmer can create an application using the components provided by the Visual Basic program itself. Programs written in Visual Basic can also use the Windows API, but doing so requires external function declarations. The final release was version 6 in 1998. Microsoft's extended support ended in March 2008 and the designated successor was Visual Basic .NET (now known simply as Visual Basic). The final designed Visual Basic interface which is displayed on the computer screen is shown in figure 7.

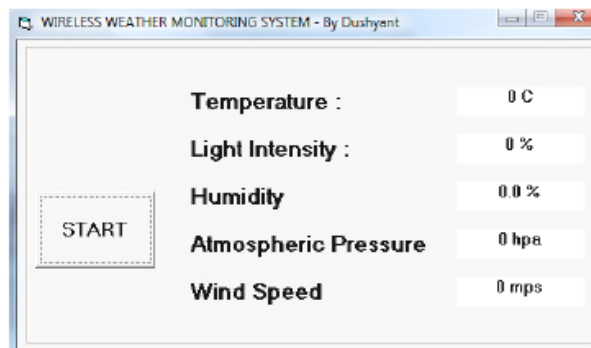


Figure 7 - Designed VB interface

VII. RESULTS AND DISCUSSION

The hardware system comprising of all the sensors and other electronic equipments has been successfully designed and programmed. This system is able to transmit the measured parameters like temperature, atmospheric pressure, wind speed, humidity and light intensity wirelessly to a personal computer where it is displayed on an interface designed with visual BASIC. Also, by using the measured values of temperature and humidity we can calculate the Dew point. Relative humidity is a measure of the quantity of water vapor present compared to the maximum water vapor possible. The maximum quantity of water vapor that can exist in the air decreases with temperature. Thus, if a sample of air is cooled without removing any water vapor, the relative humidity will increase. As the air is cooled, at some temperature the relative humidity will reach 100% and moisture will begin to form as fog or dew. The temperature at which condensation appears is known as the dew point of the air sample. It is calculated by using the formula:

$$T_D = \left(\frac{RH}{100}\right)^{1/8} (112 + 0.9T) + 0.1T - 112$$

Where, T_D is the Dew point temperature, RH is measured relative humidity and T is the atmospheric temperature.

The measured value of relative humidity is 47.00 % at a temperature of 35°C. So by putting these values in the above formula we find:

$$T_D = \left(\frac{47}{100}\right)^{1/8} (112 + 0.9 * 35) + 0.1 * 35 - 112$$

$$T_D = 22.07^\circ\text{C}$$

Also, the measured values of atmospheric pressure can be utilized to forecast the future weather conditions. . Very simply put, cold air is denser than warm air - thus as air of differing temperature passes over the sensor, the pressure will change. The arrival of warm air will cause the pressure to fall and as warm air holds more moisture than cold air a falling pressure will herald the arrival of rain. Conversely, if the pressure rises this will indicate some nice sunny days to come. Further, if the pressure falls (or rises) fast, then there are likely to be strong winds. The wind anemometer is used to measure the intensity of winds.



Whenever the wind speed crosses the comfortable range which is generally around 40 kmph it may cause loss or lives or property. So it is also of utmost importance to measure wind speed. The output of the LDR i.e. the light intensity is used to predict the part of day. Highest light intensities occur during the daytime and lowest during night.

Technical University U.K., India and is pursuing M.Tech. in Instrumentation and Control Engineering from Graphic Era University Dehradun, Uttarakhand, India.

Sanjeev Gaba holds M.Tech Degree and is presently working as Assistant Professor, Department of Instrumentation and Control Engineering. He has also Published/ Presented many papers in international journals and conferences.

VIII. CONCLUSION

The Weather monitoring system is comprehensively derived according to the natural phenomenon of weather like temperature, air velocity, humidity, day/night stage etc in living-kind. In this project work the designing and implementation of a weather monitoring system using radio frequency wireless communication is successfully done. The system is tested which concludes that the implemented system can provide the desired results. The system is robust, cheap and handy so that it can be used at any feasible location. This system can be successfully used for the weather monitoring process even at places where the user is at distant location. This work has a great potential to be extended to incorporate more functionality. Firstly, it can be extended to include more environmental variables to be monitored for agricultural or industrial applications. Secondly, some more sophisticated wireless technologies can be employed to increase the distance between the user and the system. Also some automatic actions can be triggered as for example glowing of a electric bulb on the detection of poor lighting conditions. Some of the possible future applications of the system include local weather monitoring, emergency warning for environmental disasters, shipboard weather monitoring, and defense, agricultural and industrial applications. Further some warning mechanism can also be employed which can give a warning signal whenever the atmospheric parameters deviates from the desired values which are in comfortable range of humans as well as plants and animals.

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Dushyant Pande received his B.Tech. Degree in Electrical Engineering from Dehradun Institute of Technology, Dehradun affiliated to Uttarakhand