International Journal of Computer Sciences and Engineering Open Access
Review Paper Volume-4, Special Issue-7, Dec 2016 ISSN: 2347-2693

Design of a Microcontroller Based Wireless Measurement and Monitoring of Temperature and Relative Humidity using Zigbee

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Available online at: www.ijcseonline.org

Abstract— **This paper proposes an advanced remote monitoring system for the farmers to monitor the various environmental parameters required for the growth of crops. This method is cost effective and an improvisation of old techniques. It mainly measures the ambient temperature and relative humidity, using temperature and humidity sensor DHT11 and sends the data wirelessly to remote location using Zigbee based Wireless sensor network and is also displayed on LCD. An application is developed in LABVIEW to acquire the data corresponding to temperature and relative humidity graphically in real time.**

Keywords — *Embedded System, AT89S52 Microcontroller, LCD, DHT11, Zigbee WSN, Graphical user interface(GUI), LABVIEW (Laboratory Virtual Instruments Engineering Workbench)* .

I. INTRODUCTION

Agriculture plays a vital role in the growth of economy of Assam. The Government has, therefore, assigned very high priority to agriculture. Modern agriculture techniques offers a wide range of benefits, including greater production and higher incomes for farmers in both developed and developing countries. Technical advancement in the wireless network have made possible to remotely monitor the parameters required for the growth of crops thus improving the efficiency. Thus the proposed system gives a review of remote monitoring of temperature and humidity for the growth of agricultural crops using GSM-ZigBee based remote control. The system is low cost and consumes less power.

The data corresponding to temperature and relative humidity is displayed on the LCD and also transmitted to a remote receiver i.e, a laptop connected to ZigBee transceiver. An application in LABVIEW is developed that is used to display the data on the PC's monitor. A graphical user interface (GUI) is implemented in LABVIEW (Laboratory Virtual Instrument Engineering Workbench) where the two parameters are displayed on real time and thus monitored continuously

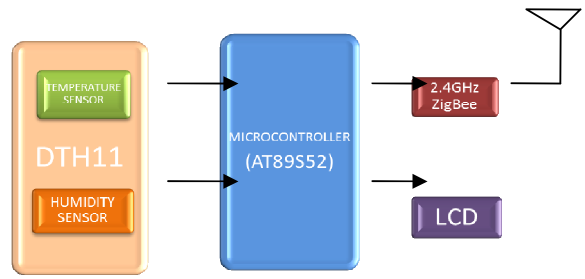
II. HARDWARE ARCHITECTURE

A. System Block Diagram

The building blocks of the system comprises of the temperature and humidity sensor (DHT11), microcontroller AT89S52, USB-to-Serial converter and the WSN base station.

The Block diagram consists of two units: UNIT1(Transmitting unit) and UNIT 2(Receiving unit).

UNIT 1:



UNIT 2:

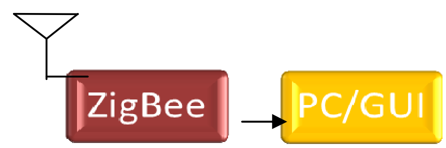


Figure 1: System Block Diagram

- We have DHT11 Humidity and Temperature sensor complex with a caliberated digital signal output. This sensor includes a resistive type humidity measurement component and an NTC temperature measurement component. DHT11 measure both the temperature and humidity of the ambient and express the Relative Humidity as a percentage of the ratio of the moisture in the air to the maximum amount that can be held in the air at the current temperature. The temperature measurement is done using the principle of thermistor. The size of DHT11 is small and its power consumption is low . The component is 4-pin single row pin package.The microcontroller then converts back the corresponding temperature value and displays on the LCD .

- LCD: LCD is a Liquid Crystal Display used in devices and circuits to display the data. The module used here is 16x2 meaning two rows andf 16 columns. It has two registers. One is Command registers and the other is Data register. Command register is used to store the data related to different commands, such as Clear Screen, Initialisation, etc. Data register stores data to be displayed on LCD.

- ZigBee: It is based on IEEE 802.15.4 standards. ZigBee is well known Wireless Communication protocol. It consumes very less power and is reliable for wireless personal area network. There are three types of device in ZigBee network. These are Co-ordinator, router and end device. A network may consist of a Co-ordinator node and multiple router and end devices. The configuration of ZigBee modules is done through X-CTU software. ZigBee operates in the industrial, scientific and medical (ISM) radio bands: 915 MHz in the USA and Australia, 868MHz in Europe and 2.4 GHz in world wide.

B. Working

To monitor the relative humidity and ambient temperature continuous measurement is required. The proposed system provides wireless monitoring from a remote place. The code is written to display the equivalent moisture level of the corresponding voltage. The voltage corresponding to the sensed temperature is converted back to the equivalent temperature by the microcontroller and displayed using embedded C. Compiler used here is Kiel compiler. It is the software which is used to compile the hex file before downloading to the microcontroller.The sensor used here senses humidity level and the temperature present in the surrounding environment and gives a digital voltage thus eliminating the use of ADC. This data is sent to the microcontroller and this is converted back into the corresponding humidity level and temperature and displayed on the LCD. Thus the two parameter values are displayed on the LCD by the microcontroller . To communicate wirelessly a 2.4GHz RF Transciever modem used that communicate with the microcontroller through serial communication.

C. Microcontroller Firmware Architecture

1. Small Embedded Operating System

The Microcontroller used here is AT89S52 from ATMEL. It is a 40 pin IC of 8052 family microcontroller with 8K of Flash Memory, 32 I/O pins, 256 Bytes RAM , Flexible ISP programming with fast programming time and one serial port. By combining a versatile 8-bit CPU with in-system programmable Flash on a Monolithic chip, the ATMEL AT89S52 is a powerful microcontroller which provides a highly flexible and cost-effective soulution to many embedded applications.

2. Serial Port Driver

The PC sends a command to read the temperature, humidity and soil moistureto the microcontroller through the serial port. The data transmission speed via the serial port is 9600 bps. The microcontroller is programmed to read the sensor values and transmit the corresponding parameter values on receiving the read command from the PC. A memory buffer holds the data to be transmitted through UART. The scheduler that executes the serial port functions checks the buffer if it holds any character to be transmitted and if it does then the character is transmitted.\

III. DATA ACQUISITION AND GRAPHICAL USER INTERFACE

The application used here to build a graphical user interface with the microcontroller based system is LABVIEW. The PC is connected through a USB interface to the system via a USB-serial converter. The LABVIEW application gives a read temperature and read relative humidity command through the virtual serial port to the measurement system. The microcontroller receivs this command and reads the sensors and transmits the corresponding temperature and relative humidity to the PC through the serial port. These datas are received by the LABVIEW application and is displayed graphically in real time.

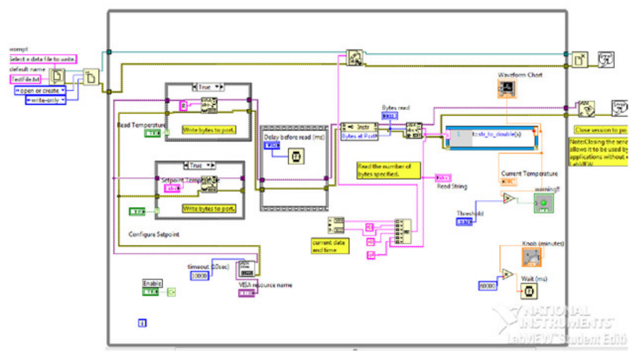


Figure 2: LABVIEW block diagram

IV. EXPERIMENTAL RESULTS:

OBSERVATIONS AND MEASUREMENTS FOR:

A. TEMPERATURE MEASUREMENT

Table-1 OBSERVATIONS FOR TEMPERATURE MEASUREMENT

Temperature range in degree Celsius	Temperature sensor output(Vout)
10 ^{0}C	0.1V
10 ^{0}C to 10.3 ^{0}C	0.1- 0.103V
10.3 ^{0}C to 10.6 ^{0}C	0.103- 0.106V
10.6 ^{0}C to 10.9 ^{0}C	0.106- 0.109V
10.9 ^{0}C to 11.2 ^{0}C	0.109- 0.112V
99.7 ^{0}C to 100 ^{0}C	0.997- 1.0V

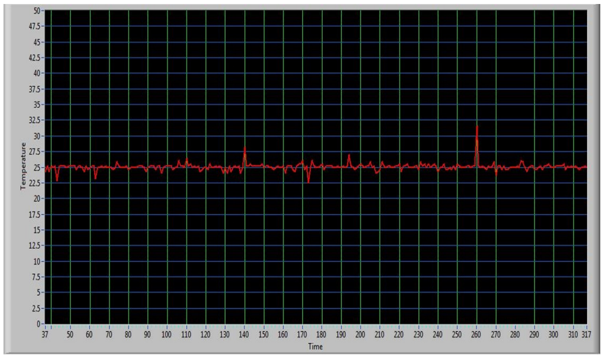


Figure 3: Rise of temperature from 10ºC to 100ºC

Figure 3 shows a Graphical representation of temperature variation ranging from 10 ^{0}C to 100 ^{0}C.

B. RELATIVE HUMIDITY

Table-2: Observations for Relative Humidity

Dry	Wet	Difference	Humidity
90	74	16	47
88	73	15	48
86	72	14	50
84	71	13	52
82	70	12	55
80	70	10	61
78	69	9	63
76	68	8	66
74	68	6	74
72	66	6	73
70	66	4	81

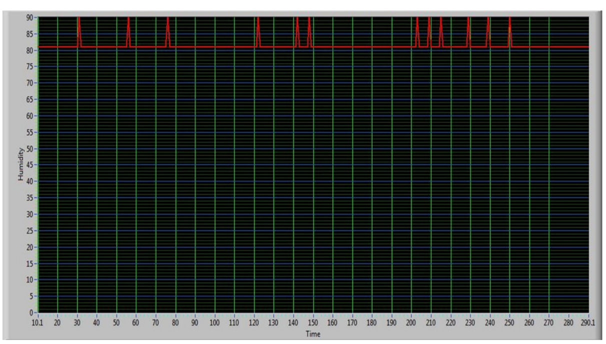


Figure 4: Humidity measurement

Figure 4 shows a Graphical representation of relative humidity ranges from 47 to 81.

IV. CONCLUSION

The system is fully functional with the advantage of being possible monitoring from remote without carrying the whole setup to the field . The system finds its application in the agricultural field but it could be further used for medical and industrial area by using high sensitivity sensors for more accuracy. We can also design for controlling the parameters

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