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# Wireless Remote Temperature Sensing and Controlling Using ZigBee

Vaseem Ahmed Qureshi[1], P. Bhagyalakshmir[2]
[1]*Associate Professor, Ece Department, CMR Engineering College, Hyderabad, India*
[2]*Assistant Professor, Ece Department, CMR Engineering College, Hyderabad, India*

**Abstract:-** WSN (Wireless Sensor Networks) has become an emerging area of research in recent years. In this paper a wireless remote sensing and controlling system for real time dynamics has been proposed. Variation in the temperature is recorded in the GUI window and proper controlling action is taken accordingly. The choice of automatic as well as manual control has been added to the des ign. An 8-bit AVR microcontroller has been used to interface the temperature sensor using the IEEE 802.15.4 standard, ZigBee protocol. ZigBee has the characteristics of low power consumption, low cost and self organizing features.

**Keywords:-** Microcontroller , Wireless Sensor Networks, ZigBee

## I. INTRODUCTION

The vast potential of Wireless Sensor Networks is an emerging area of research in recent years. WSN consists of spatially distributed autonomous sensors to monitor physical or environmental conditions like temperature, sound, pressure and to cooperatively pass their data through the network to a main location. The advantage of wireless sensor network is that they can be used with ease in the environment where wired system cannot be used or if used, are to be treated with caution, for example, in medical treatment. The WSN is built of nodes - it may vary from few to several thousands. Each sensor node has typically several parts radio transceiver with internal or external antenna, a microcontroller for interfacing with the sensors, energy source or battery. Different types of WSN are Wi-Fi, Bluetooth, PAN (Personal Area Network), smart transducers, ZigBee.

ZigBee is one of the latest and upcoming technologies in the field WSN. ZigBee is low cost, low power, wireless network standard. Low power usage allows longer life with smaller battery. ZigBee supports mesh, star, hybrid and tree topologies. ZigBee has been developed to meet the growing demand for capable wireless networking between numerous low power devices. So it is widely deployed for wireless monitoring and control applications [1] - [4]. ZigBee is a protocol specification and industry standard for a type of wireless communications technology generically known as Low-Rate Wireless Personal Area Networks (LR-WPAN) based on IEEE 802.15.4 standard [4]. The emergence of LR-WPA N technology and ZigBee standardization is appealing because of its potential for relatively fast, low cost, and simplified implementations compared to more traditional wired network installations used for industrial and process automation applications.

## II. MAIN OBJECTIVES

The main aim of this paper is to design a low cost re mote sensing and controlling wireless system with 8-bit RISC microcontroller and ZigBee transceiver. ZigBee has been used in the field of biomedicine to monitor the various signs like temperature, ECG of patients [5], [6] Some of the research work has been implemented in monitoring green house environment [7], home automation [8], distributed solar panels [9], high voltage switch gears in substations [10]. Temperature is one of the main and common parameter which needs to be monitor in various application areas.
The main objectives of this research are:

- Continuous monitoring as well as controlling of temperature.
- Providing the feature of automatic and manual control.
- Designing of GUI window.
- To transmit the real time data serially on the PC in the form of graph.

## III. HARDWARE IMPLEMENTATION

Hardware implementation can be divided in to two parts transmitting side and receiving side which are explained in its sub-section.

**Transmitting side or sensing node**

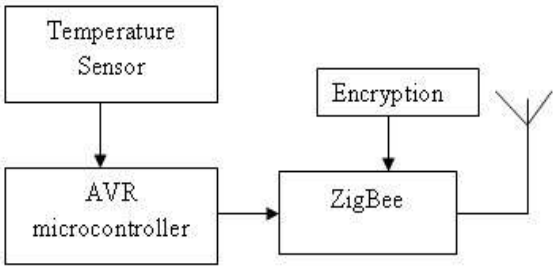



**Figure 1:** Block diagramam of transmitting node

Transmitting node is responsible for sensing and processing of data. Block diagram of transmitting node is as shown in the figure1. The temperature sensor will sense the analog value of temperature and send it to the AVR microcontroller. AVR microcontroller will make use of 10 bit in-built ADC and convert the analog value of temperature in to digital form. Implemented hardware of transmitting or sensing node is shown in the figure 2. The main components used for transmitting node are as follow:

- AVR microcontroller
- Temperature sensor
- ZigBee module
- Power supply
- Relays for controlling devices

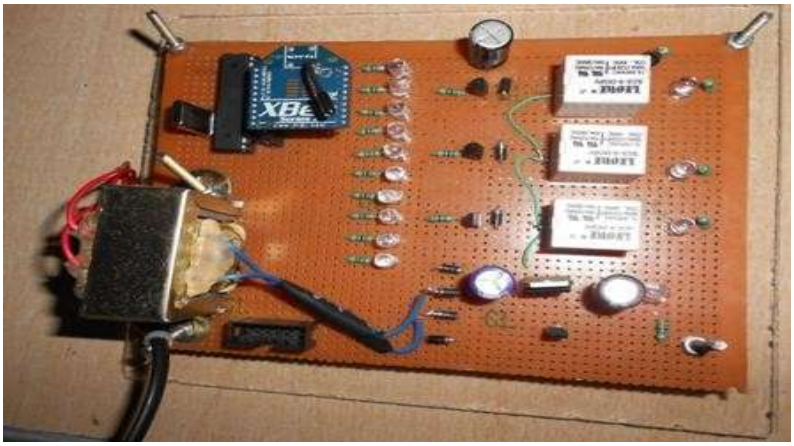


**Figure 2: Implemented hardware of transmitter node**

In our implemented hardware, Atmega 8L microcontroller is used. Atmega 8L is an 8bit microcontroller of Atmel Company. Acronym for AVR is Advance Virtual RISC (Reduced Instruction Set Computing). It is based on CMOS technology. AVR core combines a rich instruction set with 32 general purpose registers. It is featured by:

- Thirty two 8- bit general purpose registers.
- 8K bytes of in-system programmable flash memory, 512 bytes of EEPROM and 1 bytes of internal SRAM.
- 10 bit in–built analog to digital converter (ADC).
- On chip analog comparator.
- Six channel ADC.
- Programmable serial USART.

Temperature sensor used is thermistor. A thermistor is a type of resistor whose resistance varies significantly with temperature. It is having high precision in the temperature range of -90 ° C to 130° C. The Digi International ZigBee/ XBee RF modules are used for wireless communication. It has the desired characteristics of wireless communication. It is having a feature of 128 bit AES. It is designed to operate at 3.3V supply. So to get 3.3V of regulated supply for the ZigBee module LM-2590 IC is used. It needs to be configured

through XCTU software. In the presenters each work, XBee-Pro RF modules had been used to cover a good range for wide application areas. XBee-Pro is having the indoor rang e of 90m and outdoor line of site up to 1 mile. 5 pin sugar cube relays are used to control the different devices connected at the transmitting or sensing node.

**Receiving side or Coordinator side**

The receiving or coordinator node is responsible for gathering the processed data and to display it as required by the application or user. The block diagram of receiving node is as shown in the figure3.

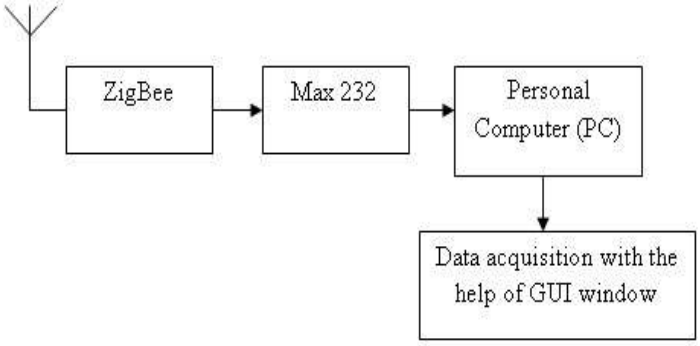



**Figure3:** Block diagramam of receiving node

Remote controlling of devices for temperature control and data acquisition is done with the help of GUI window designed in Matlab code. Implemented hardware of receiving node is shown in figure4. The main components of coordinator node are:

- ZigBee module
- Personal Computer (PC)
- MAX-232
- DB9 connector


**Figure4:** Implemented hardware of receiving node

PC can be used as processor in place of microcontroller. So in the proposed work, microcontroller is not being used at receiver node; PC performs the functionality of processor and is used to receive the data from the transmitting node. The PC uses software drivers to communicate with the devices. MAX-232 and DB9 connector are used to set up serial communication between PC and ZigBee module.

## IV. EXPERIMENT AND RESULT

The software implementation of this research work can be divided in to two main parts. At transmitter side the software implementation is done on AVR microcontroller. The software used for AVR microcontroller is AVR studio5. The whole programming at transmitter side is written in assembly language. At receiver side, software implementation is based on MATLAB.

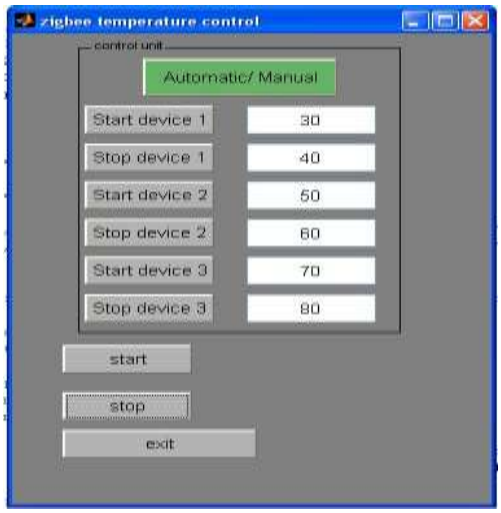
**Following steps are implemented in the programming section:**

- Sensed value is converted in to digital value by using ADC of AVR controller.

- Serial communication at 9600 baud rate is done and data is passed to ZigBee router.
- ZigBee router passed the data to ZigBee coordinator.
- ZigBee coordinator received the data.
- Serially interfaced with PC at 9600 bps.
- Controlling feature is added in the GUI window des ignored in Matlab to control various devices. Automatic and manual feature of controlling is added in this GUI window.
- Data acquisition and conversion of raw data in to temperature is done in Matlab.

The GUI window des ignored for s electing automatic and manual control of devices attached at the transmitter end to control the temperature is as shown in the figure5. Device1 will start automatically if the temperature sensed is between 30°C - 40°C and similar is with device2 and device3. They will start automatically if the temperature is between 50°C - 60°C and 70°C - 80°C respectively. If we go for manual controlling then any of the devices can be started or stopped from GUI window. By pressing "Start device1" will start the device1 at the transmitter side and by pressing "Stop device1" will stop the device1. Similarly other two devices can be manually controlled from the GUI window.

In this work three devices are used to control the temperature of the transmitting side. Relays are being used for this purpose. In the automatic controlling of temperature, each device can start and stop according to the temperature range set for them. While in manual controlling, one can start and stop any device according to the need. Figure6 is showing variation in the temperature at real time plotted in the form of graph.



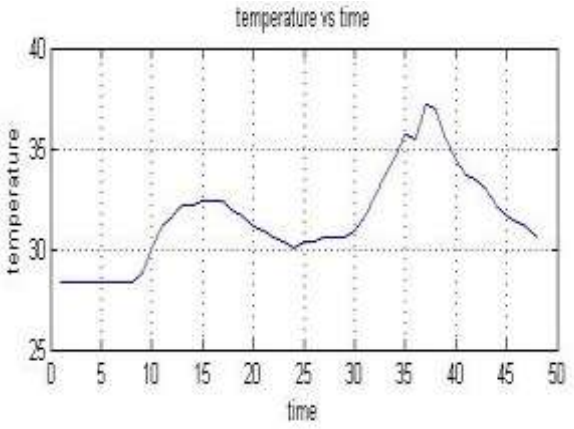




**Figure5:** GUI window designed for controlling devices Figure6: Graph showing temperature variation in real time

## V. CONCLUSION

The proposed research work can be used in various application areas. Due to long battery life, it can be used in the remote areas where battery consumption is a major issue. Various application areas include industrial monitoring, nuclear power plant monitoring. In these application areas, a little variation in temperature can cause serious accidents. So temperature needs to be controlled timely. Other application areas can be green house monitoring, defense and bio medical applications.

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