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Zigbee Based Temperature Monitoring and Controlling in Matlab

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Abstract – **Efficient design and implementation of wireless sensor network has become an emerging area of research in recent years, due to vast potential of sensor network enables application that connect the physical world to the virtual world. By networking large numbers of Zigbee sensor nodes, it is possible to obtain data about physical phenomena that was difficult or impossible to obtain in conventional ways. In this paper a wireless temperature 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. An 8-bit Atmega16 [1] 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: **Atmega16 Microcontroller, Temperature Sensor, MATLAB, IEEE 802.15.4 standard-Zigbee Protocol.**

I. Introduction

Wireless Sensor Networks are found to be useful when we talk about the surveillance. It may be surveillance for military application, home appliances, building-automation controls like intruder/fire alarms, solar panel fields, structures monitoring, environment monitoring etc. The advantage of wireless sensor network is that we can use them with ease in the environment where wired system cannot be used or if used we have to be very cautious for example in medical treatment. The protocols used in wireless sensor network are Bluetooth, Zigbee, Home RF, 802.11a, 802.11b, and HyperLan etc. Zigbee is one of the latest and upcoming technologies in the field of 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 [2] - [5]. 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-WPAN 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. Objectives of The Study

The main aim of this paper is to design a low cost temperature sensing and controlling wireless system with the Atmega16 [1] microcontroller and Zigbee transceiver. Zigbee has been used in the field of biomedicine to monitor the various signs like - temperature, ECG of patients [7]. Some of the research work has been implemented in monitoring green-house environment [8], home automation [9], distributed solar panels [10],high voltage switch gears in substations[11]. 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. Designing of GUI window and to transmit the real time data serially on the PC in the form of graph.

III. Hardware Implementation

Hardware implementation can be divided into two parts-transmitting side and receiving side which are explained in its subsection.

A. Transmitting Side or Sensing Node

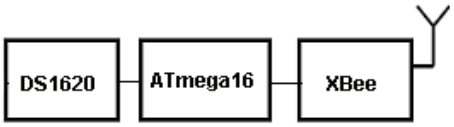

Fig. 1 Block diagram of transmitting node

Transmitting node is responsible for sensing and processing of data. Block diagram of transmitting node is shown in the figure1. The main components used for transmitting node are as follow:

- Microcontroller
- Temperature sensor
- Zigbee module
- Power supply

To get the temperature reading we use the Dallas DS1620 integrated circuit. It is an 8-pin chip, as shown in figure 2, which has a built in system that measures the temperature and converts the reading into a 9 bit binary value. The DS1620 is connected directly to the I/O port on Atmega16 microcontroller and low-level software drivers handle the 3-wire handshaking and temperature readings. The temperature is received in the microcontroller as 2 bytes. The second byte only contains a sign bit to signify whether the temperature is above or below 0 degrees Celsius.

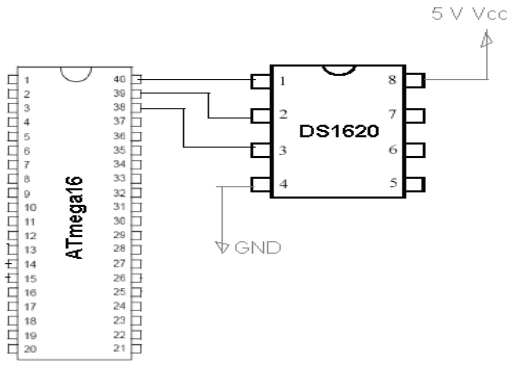

Fig. 2 Interfacing DS1620 with Microcontroller

The interfacing of Zigbee transceiver with the Atmega16 [1] microcontroller as shown in figure 3, can be achieved by connecting the required pins. Their interface can be accomplished quite easily because both communicate with a serial UART interface There are some considerations that must be taken into account to accommodate the needs of the Zigbee. Zigbee is designed to operate at 3.3V, whereas Atmega16 microcontrollers run at higher voltages. Voltage regulation can be easily accounted for by using a LM317 voltage regulator [12].

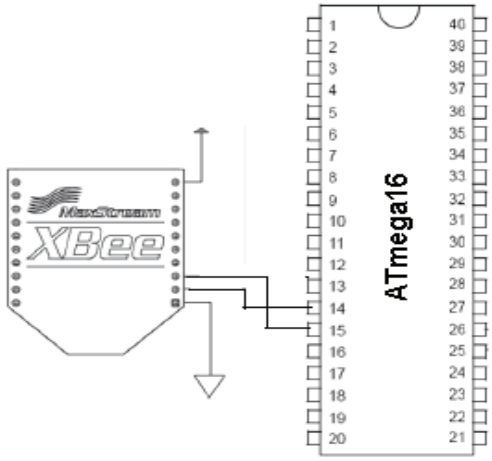

Fig. 3 Interfacing of Xbee with Microcontroller

The Atmega16 microcontroller is low power CMOS 8-bit RISC microcontroller. The on-chip ISP Flash allows the program memory to be reprogrammed in-system through an SPI serial interface and can operate with operating voltage levels from 2.0V to 5.0V. The Atmega16 delivers four ports with 8 pins each, a total of 32 I/ O pins. The MaxStream's Zigbee/ XBee RF modules [13] have many characteristics that are desired in wireless communication. Transmit power output is rated at 1mW with an operating frequency of 2.4 GHz with operating current running around 45-50 mA and RF data rate of 250 kbps. It needs to be configured through XCTU software. Figure 4 shows the physical hardware structure of transmitting node.

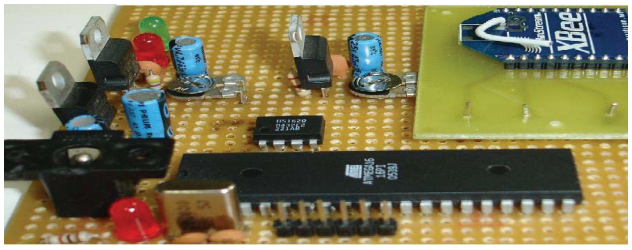

Fig.4 Hardware structure of transmitting node.

B. 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 figure 5.

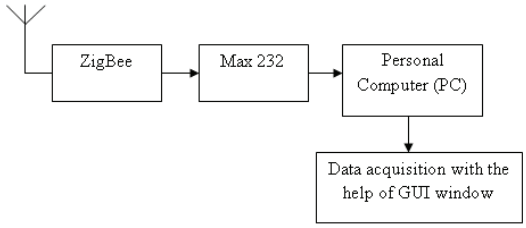

Fig. 5 Black Diagram of receiving node

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 the receiving node is shown in figure 6. The main components of coordinator node are:

- Zigbee module
- Personal Computer (PC)
- MAX-232
- DB 9 connector

The transmitter node design is easy as compared to the receiving node. The idea of not using a microcontroller at the receiving node is that 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 has been used to display temperature data collected by the DS1620 and sent through wirelessly with the help of Zigbee compliant-Zigbee transceiver module from the transmitting node. The Zigbee module on the Receiving node receives these data's and transfers to PC using RS-232 communication. The PC uses the software drivers to communicate with the devices. In order to set the computer side up with the Zigbee module, serial communications needs to be setup. MAX232 [14] and DB9 connector has been used to set up a serial communication between the PC and Zigbee.

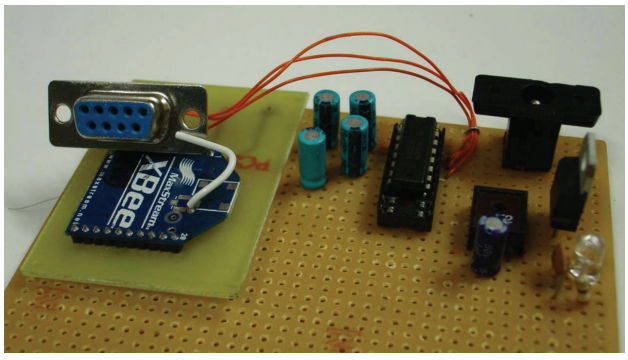

Fig. 6 Hardware structure of receiving node.

IV. Experiment and Result

The software implementation of this research work can be divided into two main parts. At transmitter side the software implementation is done on Atmega16 microcontroller. To program the microcontrollers the WinAVR software development tool [15] to write and compile the source code, which has been written in the C language was used. Although inline assembly was possible, the programming was done strictly in the C language. The source code has been commented to facilitate any occasional future improvement and maintenance. The PonyProg serial device programmer [16] has been used to write this compile code into the microcontroller. At the receiver side, software implementation is based on MATLAB.

Following steps are implemented in the programming section:

- Sensed value is converted into digital value by using ADC of microcontroller.
- 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 which is serially interfaced with PC at 9600 bps.
- Data acquisition and conversion of raw data into temperature is done in MATLAB.
- Controlling feature may be is added in the GUI window designed in MATLAB to control various devices. Automatic and manual feature of controlling may be added in this GUI window.

The graph showing temperature variation in real time in figure 7, is plotted using MATLAB.

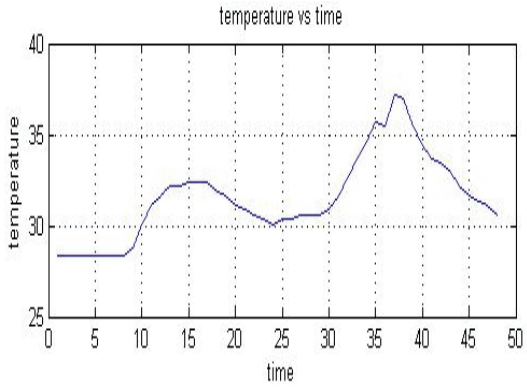

Fig.7 Graph showing temperature variation in real time

V. Conclusion

In this paper we wrote about new learning model developed with ZigBee technology and Matlab environment. The main benefit is that ZigBee technology is fully capable of replacing serial links with the wireless transfer. Matlab provides known environment to students, therefore solving task is easier for them. Due to long battery life, Zigbee can be used in the remote areas where battery consumption is a major issue. The proposed research work can be used in various application areas that 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 greenhouse monitoring, defense and bio medical applications.

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