Real Time Wireless Data Collection using Xbee Radios and Arduino

R.K. Dhammi, K.M. Soni, S. Selvam, Shubham Thakur

Abstract: Wireless Sensor Networks (WSNs) are used in several applications such as data acquisition, monitoring and controlling various parameters. In wired system of sensing the parameters, there is a complexity of installation, problem of space, weight and huge power requirement. Measurement of temperature parameter becomes critically important because of increasing controllable compliance needs in Thermal Plants. Wired system of measuring the temperature parameter of remote places is not that much efficient as the wireless system. Main purpose is to create a system that can autonomously administer the correct data of temperature of different remote places simultaneously in real time. Basically, this paper is written for the measurement of the ambient temperature using wireless technique, which will be a prototype set up for future high temperature measurement. Due to invention of Micro-Electro Mechanical systems (MEMS) technology tiny Wireless modules are nowadays employed at remote places for measurement of temperature parameter. This paper establishes the use of wireless sensor network (WSN) technology for measuring, monitoring and data storing of temperature using Arduino microcontroller, Xbee pro, LM35 temperature sensor and PC. Real time temperature is recorded.

Index Terms: Arduino, MEMS, Temperature, Thermal Plant, Wireless Sensor Network (WSN), Xbee

I. INTRODUCTION

Wireless monitoring system basically means an automated system that simultaneously and continuously records one or more physical parameters such as temperature, relative humidity, wind flow, light intensity, soil moisture etc., at many different predefined places. Such type of wireless monitoring system is deployed where the wired system is quite complex and inefficient to be applied. Wireless monitoring of any remote sensitive environment helps to avoid accident and on the other hand helps to increase safety and security. Monitoring temperature is an important parameter of a wide range of quality assurance applications. Detection by monitoring would provide an early warning of initial problems, helping for the planning and scheduling of maintenance programs, hence minimizing relevant costs. Wireless sensor network (WSN) has revolutionized the field of monitoring and remote sensing. In this paper temperature sensor (LM35) is used to sense the environmental

temperature. Arduino microcontroller is used to make complex computation of the parameters and then to receive the data wirelessly by using Xbee pro module connected together with shield at the receiver end. At transmitter section Xbee pro module connected with temperature sensor LM35, is used to transmit the temperature data [Fig. 1(a)]. At the receiving end temperature data is received, monitored and stored in real time using Xbee radio and Arduino board [Fig. 1(b)].
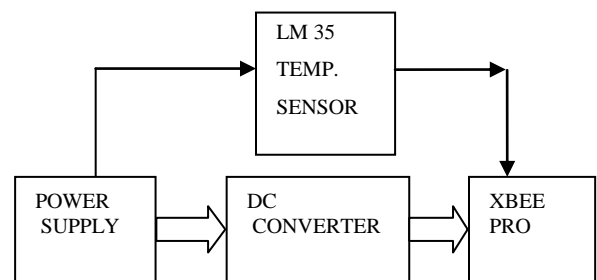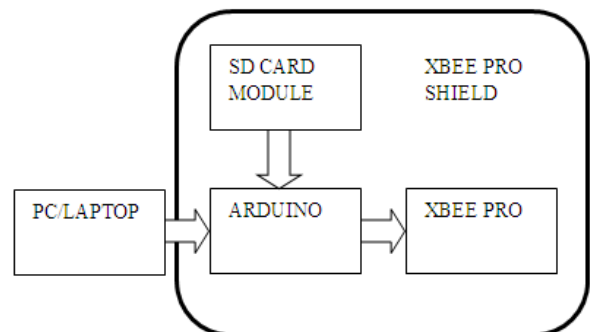

Fig. 1(a). Transmitting end: Router end

Fig. 1(b). Receiving end: Coordinator end

II. RELATED WORK

Poornendu K et al [1] presented a paper on Data Acquisition and Controlling in Thermal Power Plants using a Wireless Sensor Network and LabVIEW. The system consists of both hardware and software platform. The hardware platform consists of a PIC microcontroller and a wireless transceiver. The controller gathers the data and processes it. Software part consists of LabVIEW which receives the data through the serial port and Virtual Instrument System Architecture (VISA). Sriram kagitha et al [2] described in their paper that how to control and monitor the temperature, pressure and flow of steam etc. in thermal plants. For this they have used Wireless sensors along with ZigBee network and GSM technology. Sensor data is communicated in work

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place and to remote place using ZigBee network and GSM technology respectively. Vongsagon Boonsawat et al [3] presented a paper on embedded wireless sensor network prototype system for monitoring of temperature in a building. In this system present and past temperature readings of different rooms are taken. In each room there is one WSN node. Each WSN node consists of a microcontroller on Arduino board and an Xbee wireless communication module based on the IEEE 802.15.4/Zigbee standards. Vijay S. Kale et al [4] presented a paper which describes how to collect and monitor the temperature data using Arduino microcontroller, Xbee S2 and temperature sensor. They have used the Arduino board, Xbee radio and temperature sensor at remote place and one Xbee radio at coordinator end which is connected to PC where data is collected. Madhukar S. Chavan et al [5] implemented ARM based temperature controlling and monitoring system using LPC2148 kit and temperature sensor LM35. To control the temperature wirelessly they used a pair of Xbee radios. Anil.H.Sonune et al [6] developed an air pollution monitoring system using WSN based on ZigBee network. Suresh Y. Sankpal et al [7] presented a paper in which they used two Xbee wireless modules and microcontroller to monitor different data points of the capacitor as microfarad rating and different temperature. PM Korake and M.K. Bhanarkar [8] proposed a monitoring system for grapes environmental condition WSN technology. It has been observed that in most of the papers the data collection technique used was not promising. Microcontroller along with Xbee was used at remote place (Router end) [which increases the complexity at remote end] while Xbee is used as Coordinator connected with PC where we can not store the data in real time. In such type of approach there is no flexibility in modifying the code of software.

In this paper, this problem has been overcome by using Xbee radio at remote place along with sensor module. Data monitoring and storing is being done with the help of microcontroller and Xbee radio at Coordinator end. Arduino board is connected to PC where we have the flexibility to modify the coding in software. Range tested in this set up was pretty high. It was possible to measure the remote temperature data up to a distance of 200 meters under obstacles.

III.   HARDWARE COMPONENTS

(A) Arduino UNO

Fig. 2. Arduino UNO

ATmega328P microcontroller is used in Arduino/Genuino Uno board. [9].There are 14 digital input/output pins as shown in Fig. 2. Xbee along with shield is fitted in the Arduino Board. Arduino UNO has 6 analog pins labeled as A0 through A5 having 10 bits resolution.

(B) Xbee

Xbee is a brand of radio that supports a variety of communication protocols. XBee is a feature-rich RF module which makes it a very good solution for WSN designers [10]. It has Capability to communicate with microcontroller through UART serial communication; Digital input on one Xbee can be reflected on the digital output of another, thus controlling the output of the second Xbee.

In this set up we have used Xbee Pro S2 radio module. This module offers the capability for long distance communication. The Xbee modules offer simple AT or an API mode of operation. Xbee modules function in the license-free 2.4 GHz ISM band. Due to this technology users can quickly set up a network [11]. Pin diagram of Xbee module is shown in Fig. 3.

Fig. 3. Xbee Pro Pin diagram

(C) Xbee shield

The Xbee Shield gives our Arduino a seamless interface to Xbee-one of the most popular wireless platforms [12]. By using Xbee pro shield what we are trying to do is to join all fragmented parts of setup at coordinate end such as arduino, Xbee pro and adjoining connections together in the shield and connecting it with a single RS232(USB port) data cable with pc for monitoring.

Fig. 4. Xbee Shield/Xbee adapter board

(D) Micro SD card module

In our setup we are using micro SD card module to store the real time temperature data which is compatible with arduino.The temperature data is stored as a text document on the computer to analyze further.
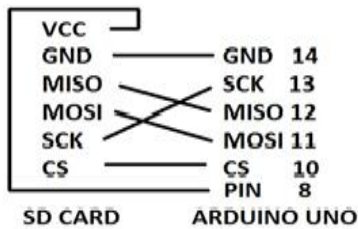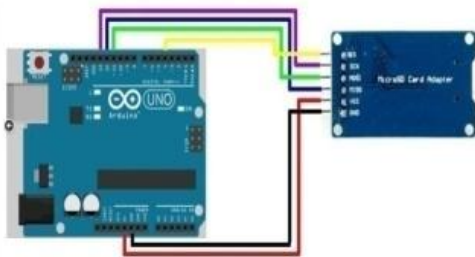

Fig. 5. Connecting SD Card with Arduino UNO

(E) LM35 Temperature Sensor

LM35 is a linear sensor with scale factor as +10 mV/°C and accuracy as 0.5°C at 25°C. It works between temperature range rated as −55°C to 150°C. It is suited for remote applications. In our setup we have connected LM35 directly with remote Xbee pro module; hence sensor senses temperature and sends it to remote Xbee radio which sends data to coordinator end for monitoring.
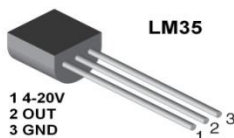

Fig. 6: Temperature Sensor LM 35

(F) LM2936S DC to DC converter:

The LM2936 is an ultra-low quiescent current regulator having low dropout voltage and low current in the standby mode. In our setup we have used LM2936S at remote end to give desired 3.3 V supply to Xbee module. The input of

LM2936S is 12 V DC coming through external battery and the   output is 3.3 V which is given to remote Xbee module.

Fig. 7. DC to DC Converter: LM 2936

IV. TRANSMITTER SETUP

Fig. 8 shows the diagram for transmitting end of Experiment set up. Basically, at the transmitting or remote end the circuit consists with one Xbee pro module, temperature sensor (i.e. LM35), 12 V power supply, and LM2936S DC to DC converter to provide 3.3 V to Xbee pro by taking 12 V DC as an input from the battery. Therefore, under working condition (when power is ON) the temperature sensor LM35 senses the temperature of its surrounding and provides its reading at its output pin. This output of the temperature sensor is fed on to the pin no 17 (we can choose any of digital I/O) of the remote Xbee module. Hence, that temperature data in the form of packets is transmitted to receiver end.
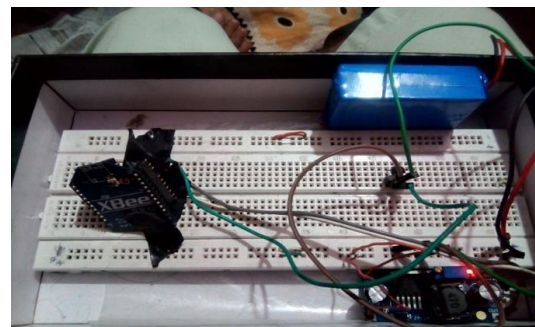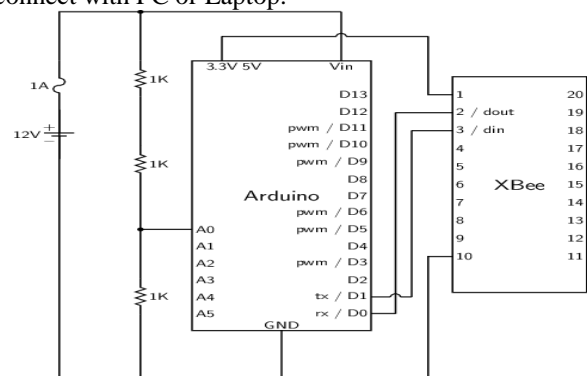

Fig. 8: Transmitting end

V.   RECEIVER SETUP

Fig. 9 shows the diagram of the receiver end. Basically, at the receiving or coordinator end the circuit consists with one arduino Uno, Xbee pro module, SD card module to store the data, Xbee shield to connect altogether, RS232 cable to connect with PC or Laptop.
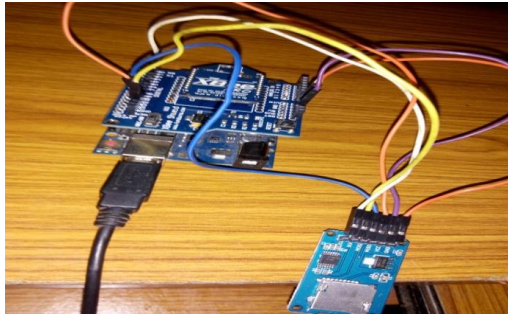
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Fig. 9. Receiving end

Therefore, under working condition(when power is ON) the temperature data is wirelessly received in the form of data packet on the coordinator Xbee and that Xbee transmits the serial data on the receiver pin Rx of the arduino UNO microcontroller. Therefore the required data can directly be monitored on the serial monitor platform of arduino IDE. Then Micro SD card module is added to store all the data to SD card as a text file which can easily be read and analyzed on computer.

VI. ALGORITHM
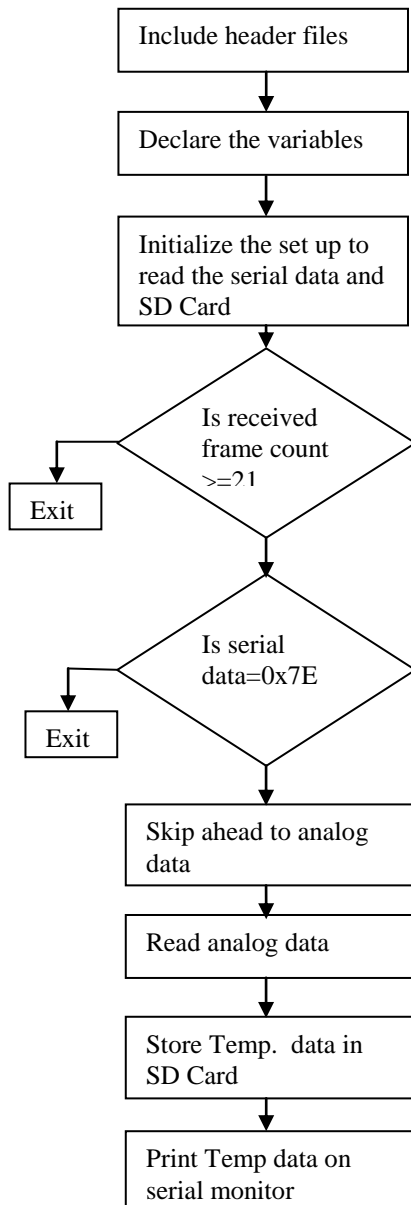
VII. XCTU SOFTWARE

XCTU is free, multi-platform application software which is compatible with Windows, MacOS and Linux operating systems. This software is used to configure the Xbee radios. Developers Eyes can interact with Digi RF modules using this software through a simple-to-use graphical interface. It includes new tools that make it easy to set-up, configure and test Xbee RF modules [13]. Fig. 10(a) and 10(b) show the configuration of Xbee parameters and the basic change in the configuration of Xbee parameters in XCTU software respectively.

Fig. 10(a). Configuration of Xbee parameters
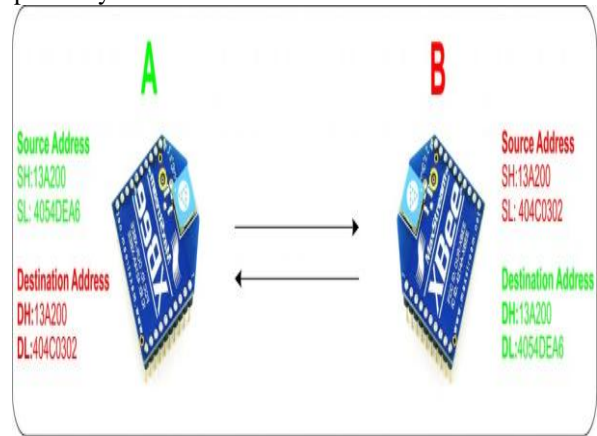
The basic requirement to configure the two Xbee pro modems (one at coordinator end and other at receiver end) is that
(i) PAN ID of both should be same.
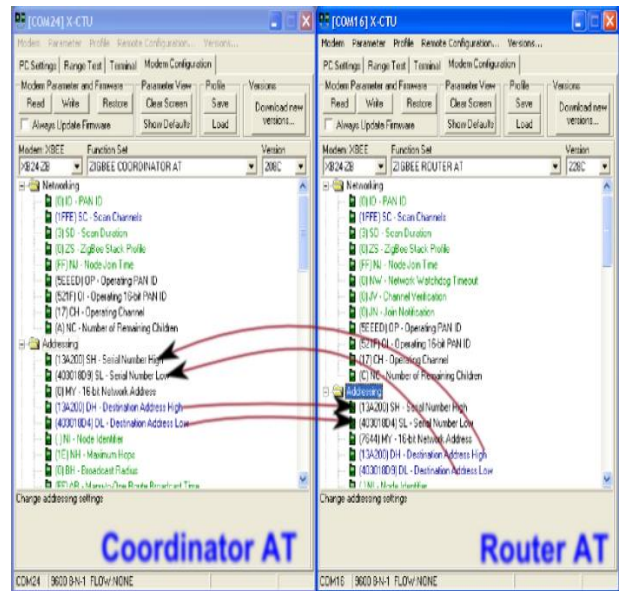(ii) Both should be in AT/API command mode.

Fig. 10(b). Configuration of Xbee using XCTU software.

XIII. DATA STORAGE

While monitoring the temperature data on the serial monitor, the data is stored simultaneously on

the micro SD card connected to Arduino module. This data is shown in Table 1 and can easily be seen and analyzed at any time.

IX.   RESULT

The measurement of temperature is carried out and a plot as shown in Fig. 11 is drawn where the parameter value is on Y-axis and time is on X-axis.

Table 1. Observed real time data:

2017/03/12 15:59:27 23.930
2017/03/12 15:59:34 23.930
2017/03/12 15:59:39 23.930
2017/03/12 15:59:46 23.930
2017/03/12 15:59:51 23.930
2017/03/12 15:59:56 23.930
2017/03/12 16:00:01 23.930
2017/03/12 16:00:06 23.930
2017/03/12 16:00:11 23.930
2017/03/12 16:00:17 23.930
2017/03/12 16:00:22 23.930
2017/03/12 16:00:27 23.930
2017/03/12 16:00:34 23.930
2017/03/12 16:00:40 23.930
2017/03/12 16:00:45 23.930
2017/03/12 16:00:52 23.930
2017/03/12 16:00:58 23.930
2017/03/12 16:01:03 23.930
2017/03/12 16:01:08 23.930
2017/03/12 16:01:14 23.930
2017/03/12 16:01:19 23.930
2017/03/12 16:01:24 23.930
2017/03/12 16:01:36 28.270
2017/03/12 16:01:47 28.504
2017/03/12 16:01:52 28.504
2017/03/12 16:01:58 28.739
2017/03/12 16:02:03 28.622
2017/03/12 16:02:08 28.739
2017/03/12 16:02:14 28.739
2017/03/12 16:02:19 28.739
2017/03/12 16:02:27 28.739
2017/03/12 16:02:32 28.739
2017/03/12 16:02:37 28.622
2017/03/12 16:02:43 28.622
2017/03/12 16:02:49 28.622
2017/03/12 16:02:54 28.622
2017/03/12 16:02:59 28.622
2017/03/12 16:03:04 28.739
2017/03/12 16:03:09 28.739
2017/03/12 16:03:14 28.739
2017/03/12 16:03:20 28.739
2017/03/12 16:03:27 28.622
2017/03/12 16:03:32 28.622
2017/03/12 16:03:37 28.622
2017/03/12 16:03:42 28.622
2017/03/12 16:03:48 28.622
2017/03/12 16:03:53 28.739
2017/03/12 16:03:58 28.622
2017/03/12 16:04:03 28.739
2017/03/12 16:04:08 28.739
2017/03/12 16:04:13 28.739
2017/03/12 16:04:21 28.739
2017/03/12 16:04:26 28.739
2017/03/12 16:04:31 28.739
2017/03/12 16:04:38 28.739
2017/03/12 16:04:44 28.739

Table 1. (contd.)

2017/03/12 16:04:51 29.208
2017/03/12 16:04:56 29.208
2017/03/12 16:05:01 29.208
2017/03/12 16:05:06 29.208
2017/03/12 16:05:11 29.208
2017/03/12 16:05:17 29.208
2017/03/12 16:05:22 29.208
2017/03/12 16:05:27 29.208
2017/03/12 16:05:32 29.208
2017/03/12 16:05:37 29.208
2017/03/12 16:05:43 29.208
2017/03/12 16:05:48 29.208
2017/03/12 16:05:53 29.208
2017/03/12 16:05:59 29.208
2017/03/12 16:06:05 29.208
2017/03/12 16:06:12 29.208
2017/03/12 16:06:17 29.208
2017/03/12 16:06:22 29.208
2017/03/12 16:06:29 29.208
2017/03/12 16:06:34 29.208
2017/03/12 16:06:39 29.208
2017/03/12 16:06:45 29.208
2017/03/12 16:06:50 29.208
2017/03/12 16:06:56 29.208
2017/03/12 16:07:01 29.208
2017/03/12 16:07:06 29.208
2017/03/12 16:07:11 29.208
2017/03/12 16:07:18 29.208
2017/03/12 16:07:23 29.208
2017/03/12 16:07:28 29.208
2017/03/12 16:07:33 29.208
2017/03/12 16:07:39 29.208
2017/03/12 16:07:44 29.208
2017/03/12 16:07:49 29.208
2017/03/12 16:07:54 29.208
2017/03/12 16:08:01 29.208
2017/03/12 16:08:06 29.208
2017/03/12 16:08:11 29.208
2017/03/12 16:08:16 29.091
2017/03/12 16:08:22 29.208
2017/03/12 16:08:29 29.208
2017/03/12 16:08:35 29.208
2017/03/12 16:08:40 29.208
2017/03/12 16:08:45 29.208

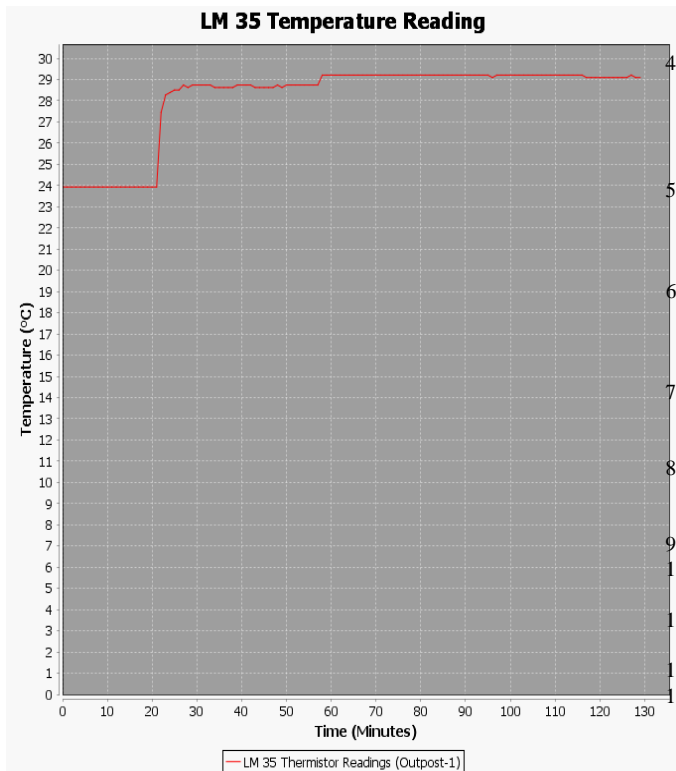|	
2017/03/12 16:08:50 29.208	
2017/03/12 16:08:55 29.208	
2017/03/12 16:09:00 29.208	

Fig. 11. Graph between Temperature and Time

X.   CONCLUSION

In this paper, we have successfully demonstrated the deployment of Xbee module at remote end along with sensor module. While we have kept the Xbee, Arduino on coordinator side where received data were monitored in real time on computer screen and were stored also in a text file. Based on this data a plot was drawn which shows the variation of temperature with time. In this approach there is flexibility in changing the coding in software. A simplified temperature monitoring system with least number of components and less complexity has been developed. Most importantly the temperature monitoring application turned out to be very user – friendly. It is considerably very cheap and simple to measure remote area temperature data compared to a conventional setup. Such wireless system will prove to be revolutionary for Thermal Plants, Agriculture, Health Care, Industries, Storage areas and many more remote and critical areas.Range tested in our set up was pretty high. It was possible to measure the remote temperature data up to a distance of 200 meters under obstacles.

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