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ZIGBEE Based Wireless Weather Monitoring System Using LabVIEW

Shiji M*[1], Dr. Azha Periasamy[2], Nisha M[3]

*[1] Department of Electronics & Instrumentation, Bharathiar University/ Bharathiar University, Coimbatore, Tamilnadu, India
[2] Department of Electronics & Instrumentation, Bharathiar University/ Bharathiar University, Coimbatore, Tamilnadu, India
[3]Department of Electronics & Instrumentation, Madurai kamaraj University/ Madurai Kamaraj University, Madurai, Tamilnadu, India

ABSTRACT

The environmental factors monitoring is very important over the last few decades. In an industry, certain hazards are very difficult to monitor that parameter by wires and analog devices such as transducers. To overcome this problem we use wireless device to monitor such parameters. In this paper, ZIGBEE based wireless weather monitoring system has been implemented for monitoring the environmental parameters like air temperature, relative humidity and atmospheric pressure. This system displays these readings in real time by using LabVIEW.
Keywords: Zigbee, Temperature, Humidity, Atmospheric Pressure

I. INTRODUCTION

ZIGBEE is an IEEE 802.15.4 Standard that defines a set of communication protocols for low -data rate with short range wireless network protocol. ZigBee-based wireless devices operate with 868MHz, 915MHz and 2.4GHz frequency bands. The maximum data rate is 250Kbps. ZigBee is directed mainly for battery-powered applications which influences low data rate, low cost, and long battery life. In many ZigBee applications, the total time the wireless device is engaged in any type of activity has very limited that device spends most of its time in a power saving mode, also known as sleep mode.

A. Weather Measurement

In few years back, the wireless device usages has very less, but due to the rapid development in technology maximum amount of data can be transferred through the wireless like Wi-Fi, Bluetooth, WI-Max and etc. The paper has designed a ZIGBEE based wireless weather monitoring system to measure parameters like air temperature, relative humidity and atmospheric pressure using LabVIEW.

B. Weather Monitoring System Design

The Weather Monitoring system consists of Measuring Node and Monitoring Node. Measuring Node consists of Temperature Sensor, Humidity Sensor and Pressure Sensor for sensing environmental parameters and a ZIGBEE transceiver to send the measured data to the monitoring node. Monitoring node consists of a ZIGBEE transceiver, which receives the measured data sent by measuring node and a host PC. A LabVIEW program running on the PC gets the actual measurement data save to text pad and displays the data through the waveform graphs.

C. Objective of Wireless Weather Monitoring System

To design a ZIGBEE based Wireless Weather Monitoring System (WWMS) using LabVIEW. The system measured parameters like temperature, humidity and pressure. ZIGBEE is a hardware and software platform for wireless network high secure RF technology device. Because it has low cost, low power, low data rate and highly reliable device.

II. WIRELESS WEATHER MONITORING SYSTEM

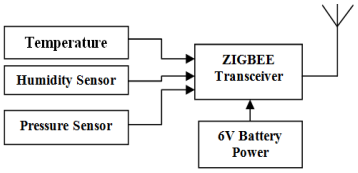


Figure 1. Block diagram of Measuring Node for WWMS

In Figure 1 shows the block diagram of the Measuring Node of Wireless Weather Monitoring System (WWMS), it consists of sensors and digi ZIBEE modules for detecting input signals and it sends to the receiving node.

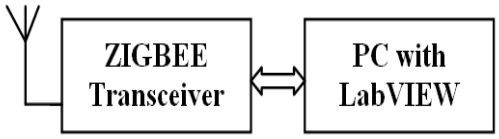


Figure 2. Monitoring Node for WWMS

In Figure 2 shows the block diagram of Monitoring Node of WWMS and it receives the measuring signal from monitoring node then displays the measured signal in the given platform automatically.

III. HARDWARE DESCRIPTION FOR WWMS

A. Prototype Model for WWMS

Figure 3 shows the prototype model for the monitoring node of wireless weather monitoring system. It consists of digi ZIGBEE transreceiver and RS232 cable which is for serial interfacing with LabVIEW Platform.

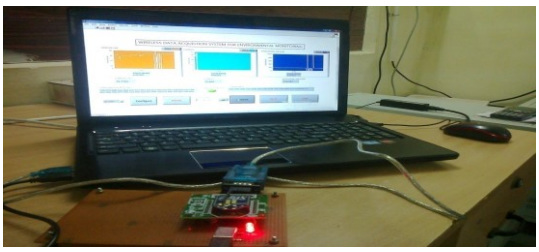


Figure 3. Prototype Model for Monitoring Node of WWMS

IV SOFTWARE DESCRIPTION FOR WWMS

A. X_CTU (Configuration & Test Utility Software)

X-CTU is Windows-based application software provided by Digi. This program was designed to interact with the firmware that files found on Digi's RF products then it's provide a simple to user interface to them.

B. **Application Programming Interface** (API)

API (Application Programming Interface) is an alternative to the default Transparent Operation. The frame-based API extends based on that level of a host application should interact with the networking capabilities of the module. An RF module contains the following firmware versions which will support API operation: 1.1xx (coordinator) and 1.3xx (router/end device). In API mode, all entering and leaving data contain the frames that define operations or events within the module.

Transmitted Data Frames has been received through the DIN pin (pin 3) includes:

- RF Transmit Data Frame
- Command Frame has equivalent to AT commands.

Received Data Frames has sent to the DOUT pin (pin 2) includes:

- RF-received data frame
- Command response
- Event notifications as reset, associate, disassociate, etc.

The API provides the configuring modules and routing data at the host application layer. A host application sends the data frames to the module that contain address and payload information instead of using command mode to modify addresses. The configuring module will send data frames to the application containing status packets as well as source, and payload information from received data packets.

C. To configure an I/O pin as an analog input on a remote radio

7E 00 10 17 05 00 13 A2 00 40 A2 42 97 FF FE 02 44 30

Figure 4. Structure of a typical API command for XBEE.

Fig 4 shows the general structure of API commands for the design and figure 4.1.2 shows the structure for detecting node of Zigbee based wireless weather monitoring system.

Start of API command – Every API begins with 0x7E.

Command length – The next two bytes contain the length of the rest of the command with excluding the checksum.

Command body – Rest of the bytes contain a specific API command with excluding the checksum

Checksum – The sum of all the bytes after the command length, including the checksum, should be 0xFF. The checksum bytes can be calculated by sum all of the bytes after the command length, keep only the least significant 8 bits has subtract from 0xFF. And the diagram shows the structure of the **"Remote AT command request"** below the command begin with 0x17.

Frame ID – Frame ID in an API command has non-zero, then the response will contain the ID.
64-bit address – XBee module address
16-bit address – XBee module address. By default address is not used, but it can be set using the MY command.

Apply changes flag – If this byte is 0x02, then changes take effect immediately on the remote XBEE module and for the byte is 0x00, then you must send an AC command for changes to take effect.

AT command – This is the AT command you are sending to the remote XBee module.

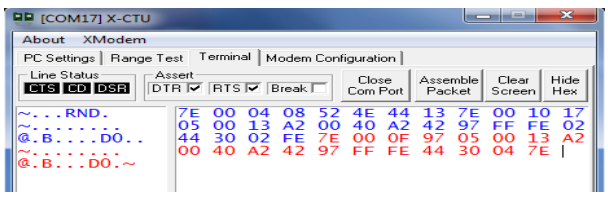
To Detect Node

7E 00 04 08 52 4E 44 13

Figure 5. Structure for detecting node

D. How to configure an I/O pin as an analog input on a remote radio

The XBee RF module has 7 pins it can be used for analog inputs. To configure DIO0 as an analog input on the remote RF module from the base RF module using an API command and its shown in the Figure 5 and Figures 6,7,8 shows input command format of to configure DI1,DI2,DI3 as a analog input.



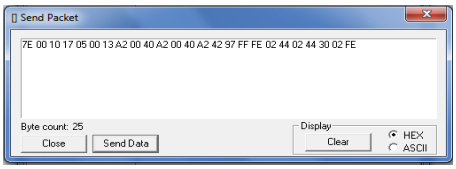


Figure 6. Configuration of DI0 as an analog input

To configure DI1 as a analog input

7E 00 10 17 05 00 13 A2 00 40 A2 00 40 A2 42 97 FF FE 02 44 02 44 31 02 FD

Figure 7. configuration of DI1 as an analog input

To configure DI2 as a analog input

7E 00 10 17 05 00 13 A2 00 40 A2 00 40 A2 42 97 FF FE 02 44 02 44 32 02 FC

Figure 8. Configuration of DI2 as an analog input

To configure DI3 as a analog input

7E 00 10 17 05 00 13 A2 00 40 A2 00 40 A2 42 97 FF FE 02 44 02 44 33 02 FB

Figure 9. Configuration of DI3 as an analog input

E. Configuration and Response of Four Channels via DI0, DI1, DI2, DI3

In the following figure 4.1.2 shows the configuration commands and response of four channels via DI0, DI1, DI2, DI3 in the XBee module on X-CTU.

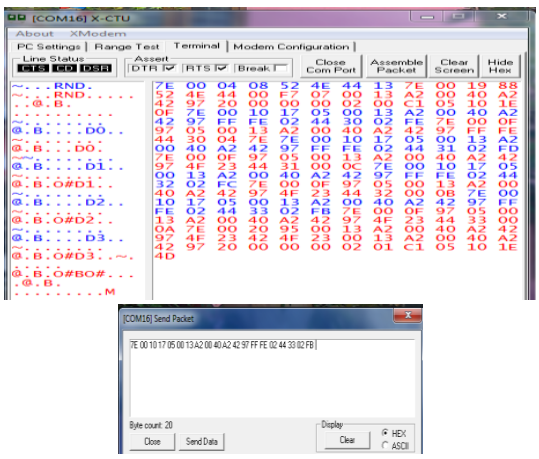


Figure 10. Configuration and response of four channels

V LABVIEW BASED WWMS

To establish the communication between the XBee modules the API commands has been provided by Digi. An application program (VI) developed by National Instruments, LabVIEW platform to send the API commands to the wireless sensor node to gets response. A SubVI 'SerWr&Rd.vi' has developed to send and receive strings through the virtual COM port and then SubVI converts API commands into strings, then it writes the string of characters to the virtual COM port, it waits a second and reads the response data from the virtual COM port.

A. Configuration of wireless sensor node

The VI selects the 64-bit address in the wireless sensor node to enable the four analog channels, AIN0-AIN3, by sending API commands 'D0' to 'D3' in sequence with its. The VI sends the 'Apply Changes' (AC) command each time the channel has configured, the wireless sensor node has reinitialized for the changes has been made. Figure 4.2.1.1 shows the configuration operation of the VI which for interfacing the XBEE modules.

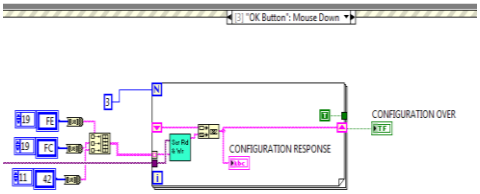


Figure 11. Configuration Response of SubVI for Wireless Data Acquasition System

B. Data acquisition

The 'Force Sample' API command has send it to read all the enabled analog channels. The corresponding conversion formula are applied to the received data and computes the measurement parameter values. The VI plots the parameter values on a waveform chart.

C. Time stamping

The parameter values has converted by using in-built function in LabVIEW 'array to spread sheet string1.vi' and adds the timestamp to the string by reading the system time using the in-built function 'Get Date and Time String.vi'. The data acquisition and time stamping operations are repeated at a regular interval of 1 minute for 130 times. Figure 11 shows the data acquisition and time stamping operations of the VI.

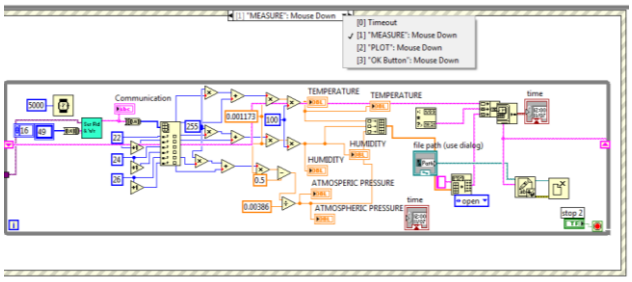


Figure 11. Data acquisition and time stamping operations of the VI.

D. File save

The appended string writes a data file using in-built functions 'open/create/replace file.vi' and 'write to file.vi'. Figure 12 shows the file save operation of the VI.

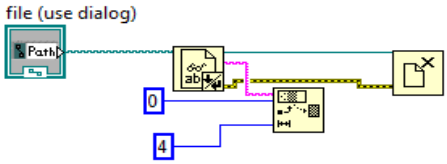


Figure 12. File Save Operation of the VI

E. Block Diagram and Front Panel of Wireless Data Acquisition system based WWMS

Figure 13 and 14 shows the block diagram and front panel of the given system of wireless data acquisition system for environmental weather monitoring system using LABVIEW.

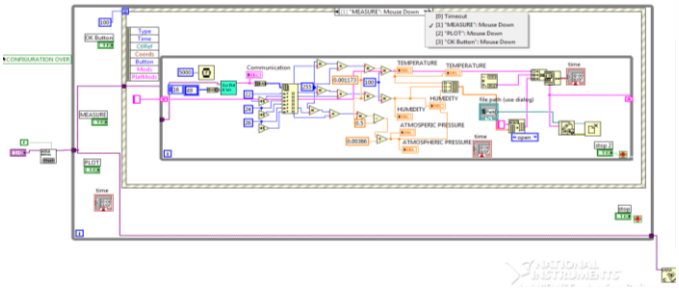


Figure 13. Block diagram of Wireless Data Acquisition System based Weather Monitoring System

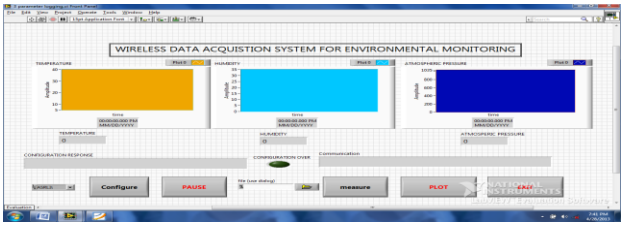


Figure 14. Front Panel of Wireless Data Acquisition System based Weather Monitoring System

VI RESULTS AND DISCUSSION

A. Measuring Data Response in Labview Platform

The front panel displays the measured values and it is shown in Figure 15 and its represented as time versus amplitude and the outputs of the given system also displayed in the required form.

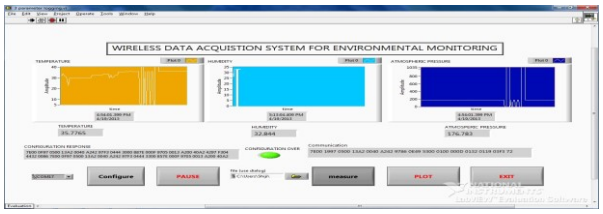


Figure 15. Front Panel diagram of Measuring Node for Wireless Weather Monitoring System

Thus the measurements of weather parameters sensors data versus certain time periods were montoring and saving in a text document.

F. Air Temperature

The following figure 16 shows the measurements of air temperature in certain periods of time.

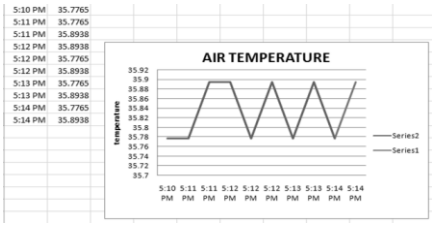


Figure 16 . Measurements of Air Temperature in Certain Periods of Time

G. Relative humidity

The following figure 17 shows the measurements of relative humidity in certain periods of time.

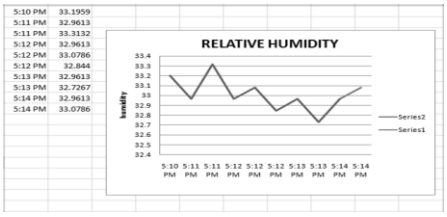


Figure 17. Measurements of relative humidity in certain periods of time

H. Atmospheric Pressure

The following figure 18 shows the measurements of Atmospheric pressure in certain periods of time.

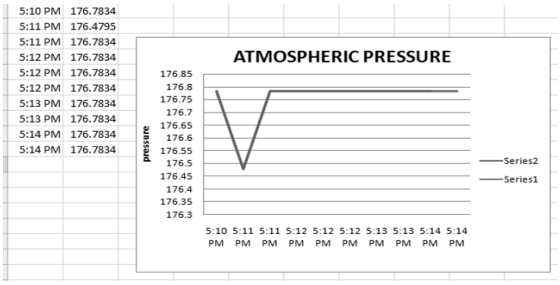


Figure 18. Measurements of Atmospheric pressurein certain periods of time

I. Measured data for three channels from the measuring node

Figure 19 shows the file path of the output of the parameters is displayed by using of file from the LabVIEW platform format periods of time versus certain measurements like Air temperature,relative humidity,Atmospheric Pressure.

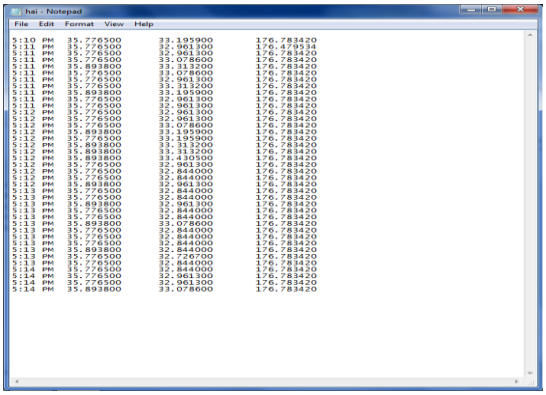


Figure 19. File Path of the Output of the Parameters

Figure 20 shows the command window of Enable API moode of the Zibee transreceivers in X-CTU.

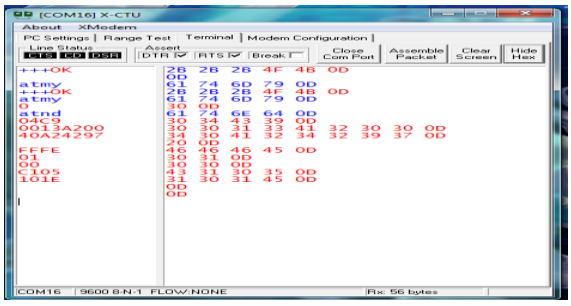


Figure 20. Commands and Reponse Window of Enable API mode

J. Read The Zigbee Modem

Figure 21 shows Communication Response of XBEE MODEM Read using of given specifications.It has some configurations for communicate the given MODEM like, setting baud rate,databits,port selection,etc.

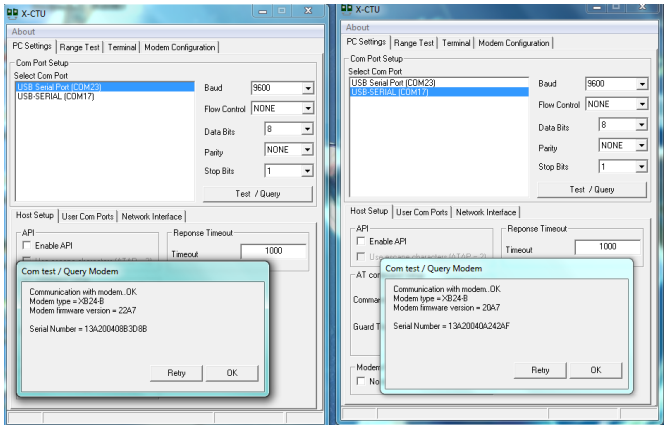


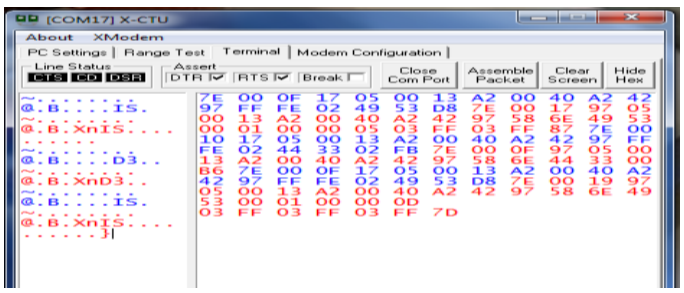
Figure 21. Communication Response of XBEE MODEM Read

J. Channel Configuration

The configuration of channels is important part of the XBee modules for wireless communication. Figure 22 shows the real setup of the system when configuration has been done.

Figure 22. Configuration of Channels

The figure 23 shows the screen shot of configuration response of the MODEM and figure 24 also shows the configuration responses of the four channels via DI0, DI1, DI2, DI3 in the XBee module on X-CTU.



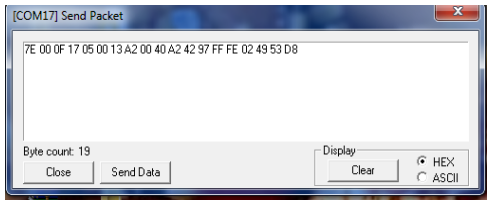


Figure 23. Configuration Response of XBEE Modules of WWMS

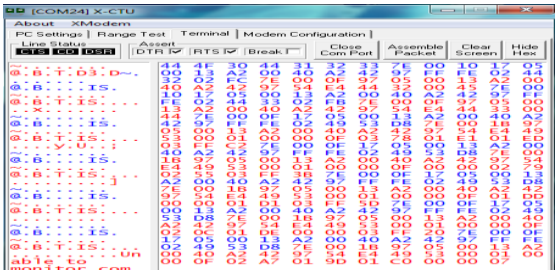


Figure 24. Configuration Response of Four Channels in X-CTU

VII CONCLUSION

ZigBee is leading global standard for implementing low-cost, low-data-rate, short-range wireless networks. The IEEE 802.15 is a WPAN Working Group are the has implemented based on IEEE 802.15.4 wireless networks. However, these lengthy documents can be very great in amount of people with time constraints that are more product-focused. Therefore, there is a need for a wide-ranging resource that not only contains the in-depth technical information but also provides the high-level overviews of fundamental ZigBee wireless networking.

The flat plat collector efficiency has calculated with acquired data which matches the obtained value from the conventional method. The WSN based system is easy to setup,configure and get measurement values. It consumes less power. The WSN based system has better than the conventional measurement method with cost effective, reliability, and portability. The developed ZigBee and LabVIEW based Wireless Wether Monitoring system(WWMS) which eliminates the need for lengthy communication wires and provides networking capabilities. LabVIEW provides the excellent graphical user interface(GUI) and advanced signal processing functions for research and analysis.

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