Proceedings of the
International Conference on Mechanical Engineering and Renewable Energy 2015
(ICMERE2015) 26 – 29 November, 2015, Chittagong, Bangladesh

ICMERE2015-PI-054

IMPLEMENTATION AND PERFORMANCE ANALYSIS OF REAL TIME HOME AUTOMATION SYSTEM USING ZIGBEE PROTOCOL

Nafize Ishtiaque Hossain[1,*] and Sakib Reza[2]

[1,2]Department of Electrical and Electronic Engineering, Chittagong University of Engineering and Technology, Chittagong -4349, Bangladesh
[1,*]nfz.istq.hsn@gmail.com, [2]skb.rza@gmail.com.

Abstract- *For the sake of sustainable development and amelioration of our current life style, home automation is one of our top concerns. Home automation will be useful not only for the elderly person but also for visually impaired, physically handicapped and remote patients. Though home automation can be done by using Bluetooth or RF technology; reliability, cost effectiveness must be taken into consideration before the implementation of these technologies. The goal of our project is to setup a reliable, secured, cost effective and user friendly home automation system for patient, elderly and physically handicapped people. Here arduino as processing unit and zigbee 2mW wire antenna (zigbee mesh) are chosen for this project. This project is implemented by using three node providing the provision of further node integration. Though this system is developed for residential environment, because of zigbee's high noise immunity this system can be implemented for industrial environment by modifying its configuration.*

Keywords: Zigbee, Noise immunity, Node integration.

1. INTRODUCTION

Rapid growth of technology in recent years has given rise to automation and the smart home concept becoming a new buzz word in the leading tech communities. The researchers of different fields are trying to widen the concept of smart home relentlessly. Though in most of the cases smart home is out of range for the middle class people, the amelioration of smart home is significant. This research aims at bringing smart home to everyone.

2. LITERATURE REVIEW

In [1], GSM based load control system using interactive voice response is used. Zigbee based voice controlled home automation is applied in literature [4]. Literature [3] offers slightly improved voice recognition for automation of home loads using Zigbee. All these system are voice enabled or voice automated. This concept is partially erroneous in the sense that they fail to meet the demand either when two or more people are chatting in a room or most severe case when the operator is unable to talk or when they are ill. A web based automation is proposed in [5]. Since the maintenance and security of web server is difficult, it makes the system more complex for the user and also cause high installation cost. This system also fails when the user is away from internet. Though the system proposed in [2] is very user friendly, the use of this system requires personal computer or laptop causing barrier to remote patient to use this systems.

Now our proposed system includes 2 nodes which is controlled by coordinator keeping the provision of further node integration. The coordinator part is kept to the patient or human who controls the various loads connected to the node.

3. FEATURES OF THE DEVELOPED SYSTEM

The superiority of the developed system over the other system discussed above can be characterized as follows:

a. Design consists of different modules, which is helpful for troubleshooting.
b. Low power consumption & high battery life.
c. Development of Wireless Mesh Network.
d. User friendly.
e. Low initial and maintenance cost.
f. Noise immunity for wide bandwidth and secured automation due to specific PAN ID.

4. SYSTEM ARCHITECTURE

The system architecture can be described by various means. But the most convenient way is the block diagram. The dedicated block diagram is given in Fig. 1.

5. SELECTION OF TRANSCEIVER

As earlier stated in this paper, for the features of low power consumption and secured automation Zigbee is one of the perfect choices. IEEE 802.15.4 otherwise known as Zigbee protocol. Though different transceivers are available as nRF24L01+, bluetooth, GSM; Zigbee has chosen as it fulfills the required features.

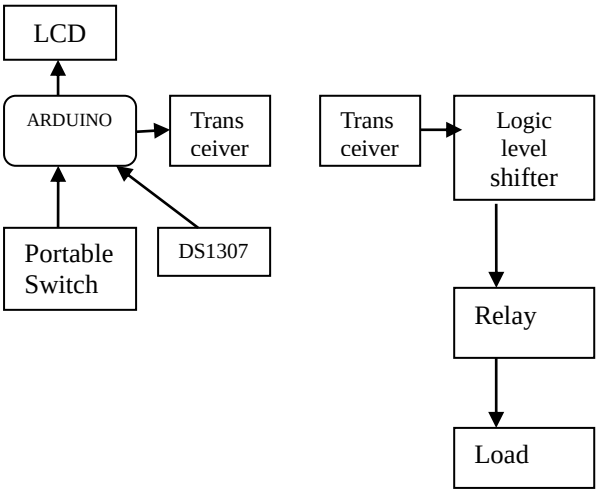

Fig.1: System Architecture

6. ZIGBEE MODE

Zigbee can work in two modes. They are:
Transparent mode–here both modules are set as AT mode
Command mode–here transmitter is set as AT mode and receiver is set as API mode.

This research has implemented the second mode of operation.

Fig.2: Zigbee 2mW wire antenna series 2 module

7. ZIGBEE CONFIGURATION

Zigbee has 11 digital I/O pins and 4 analog pins. In our work digital pins will be used in the router zigbee. On the other hand, data in and data out pins will be used in the coordinator zigbee. To configure zigbee, Zigbee Adapter Kit v1.1 by adafruit and FTDI cable are used. Configuration is divided into two parts – hardware configuration and software configuration.

8. SOFTWARE CONFIGURATION

X-CTU software recommended by Zigbee manufacturer is used. After connecting the Zigbee to the computer and opening the software X-CTU the following window will appear.

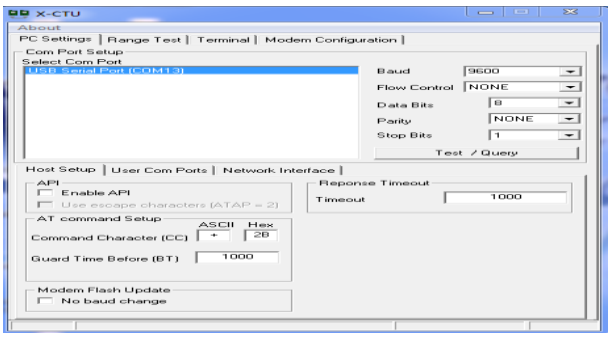

Fig.3: Initialization of X-CTU software

Then we need to switch modem configuration option. The configuration for the router and the coordinator Zigbee is different.

Coordinator Configuration: In the modem configuration option, only networking sub option is needed. Here function is set the coordinator as API and in networking sub option PAN ID is given which is same for all the zigbee in the network.

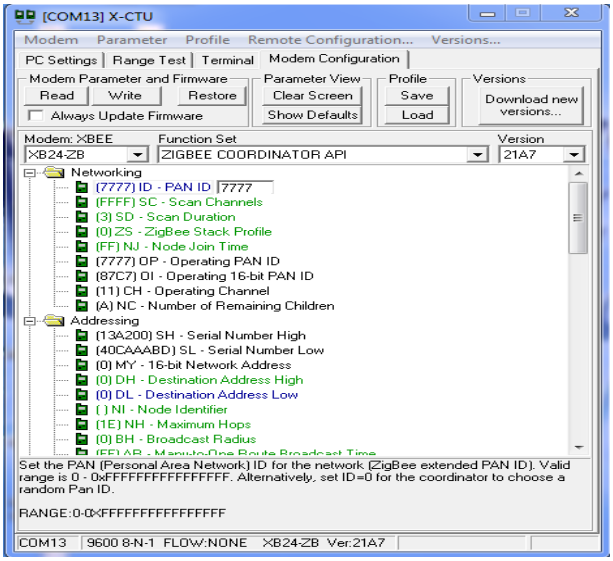

Fig.4: Coordinator configuration

After writing the setting following should be appeared.

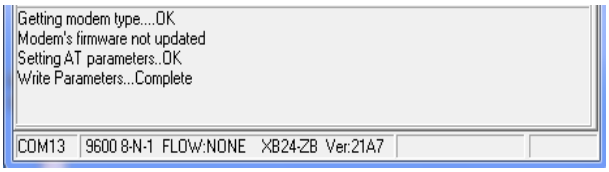

Fig.5: Result of writing setting the coordinator

Router Configuration: In this case only networking sub option is needed. Here function is set the router as AT mode. Same PAN ID is set. Channel verification is also enabled which will help for further integration of node mentioned earlier.

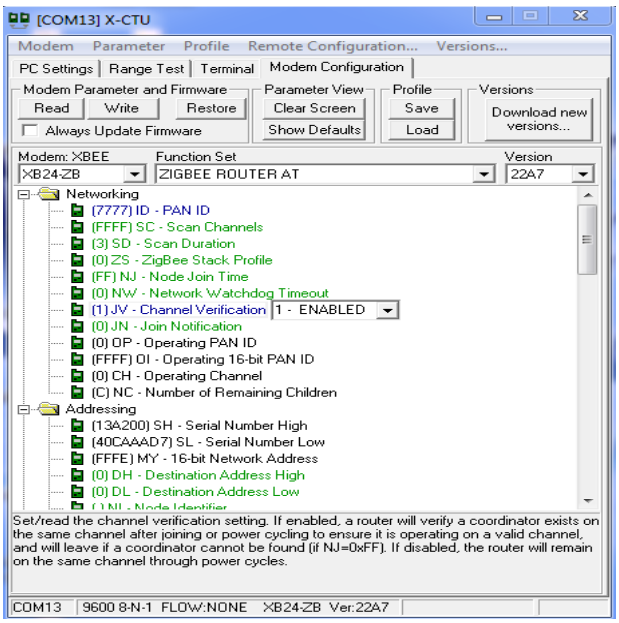

Fig.6: Channel verification enabling of router

In this case both the high and low destination address is kept 0x00 because it will communicate only to the coordinator.

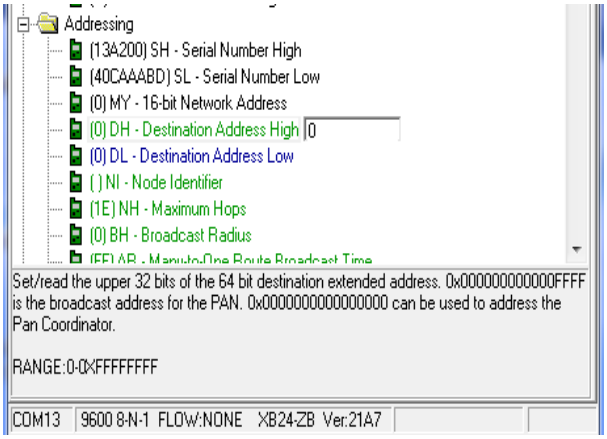

Fig.7: Destination address setup

9. HARDWARE CONFIGURATION

Zigbee is enabled by 3.3V. We have used Sparkfun's XBee Explorar Regulated to take care of it. Here CMOS is used for logic level shifting. It also has 3.3V regulated supply.

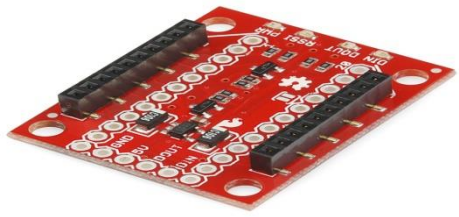

Fig.8: Sparkfun's XBee Explorer Regulated

10. REAL TIME CLOCK CONFIGURATION

We have implemented the real time clock with DS1307. It is an I^2C device and it can be set either as 12hr or 24hr mode. We set it as 24hr mode. The device address is 0x68. One of the problem with this device is that it gives data in BCD format. The data is converted form BCD to decimal. An external micro lithium battery is used so that after resetting the system the time is not erased from the internal memory of the DS1307 chip. The load and the time are displayed on the LCD.

11. DEVELOPED PROTOTYPE

The transmitting end setup is shown in figure below:

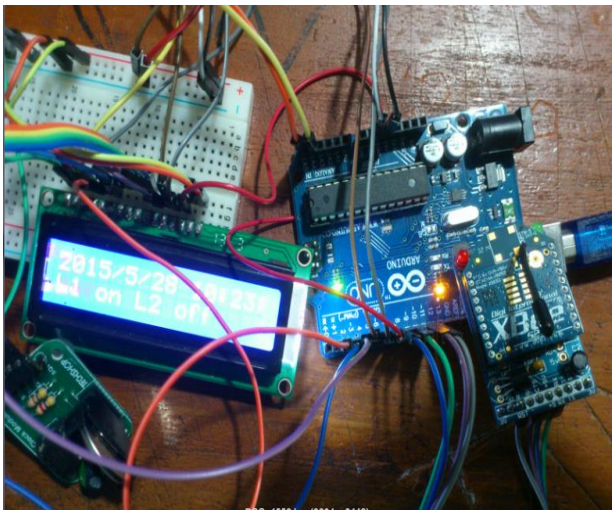

Fig.9: Transmitting end setup

The receiving end circuit when the load is off is shown below:

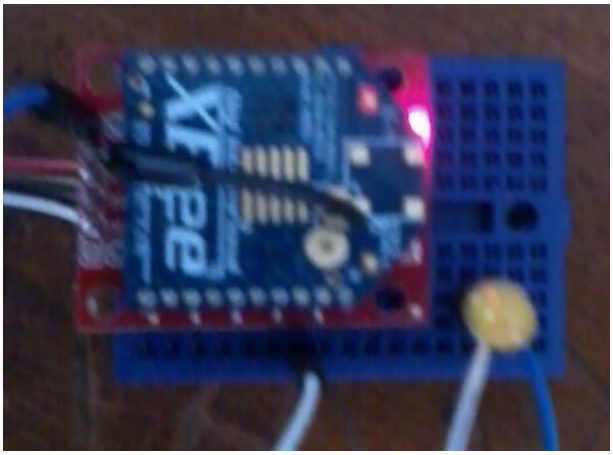

Fig.10: Receiving end setup (load off)

In case of the load is on by the user, we have showed the result by lighting an LED. Instead of using LED the 3.3V output can be passed to a non-directional buffer and shifting the logic level to 5V. Then a relay of 5V can easily be used to connect the large load of common home appliances which run on AC power supply.

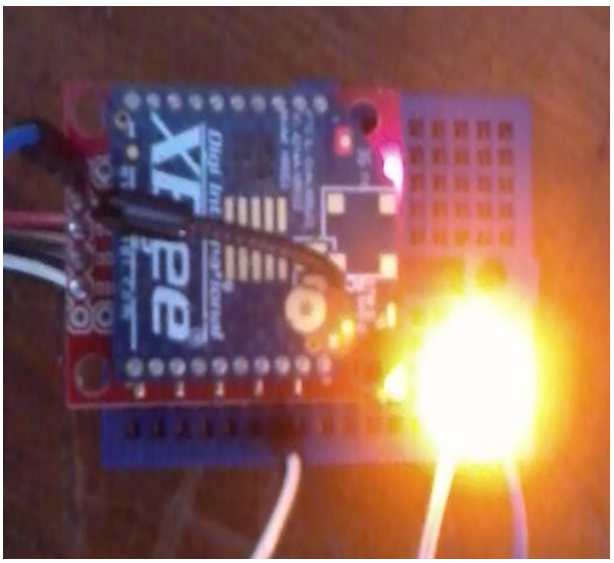

Fig.11: Receiving end setup (load on)

12. PERFORMANCE ANALYSIS

Real time home automation system has been developed with nRF24L01+, Bluetooth and here a comparative study is presented based on experimental result :

Table 1: Comparative analysis with other system

System developed	System Security	System integration capability
Zigbee	High	YES
nRF24L01+	No	NO
Blue tooth	Medium	NO

The following table shows the error rate of different system.

Table 2: Performance analysis with other system

System developed with	System failure(during 50 trials)	% of Error
Zigbee	1	2%
nRF24L01+	7	14%
Blue tooth	4	8%

Since GSM requires much power and cloned SIM makes it easy to hack, it is not given here for comparison.

Since the performance of this research is done with some trial and error, it will be the best if the result is analyzed graphically. The performance of different systems will be visualized simultaneously.

The graphical representation of performance analysis is given below:

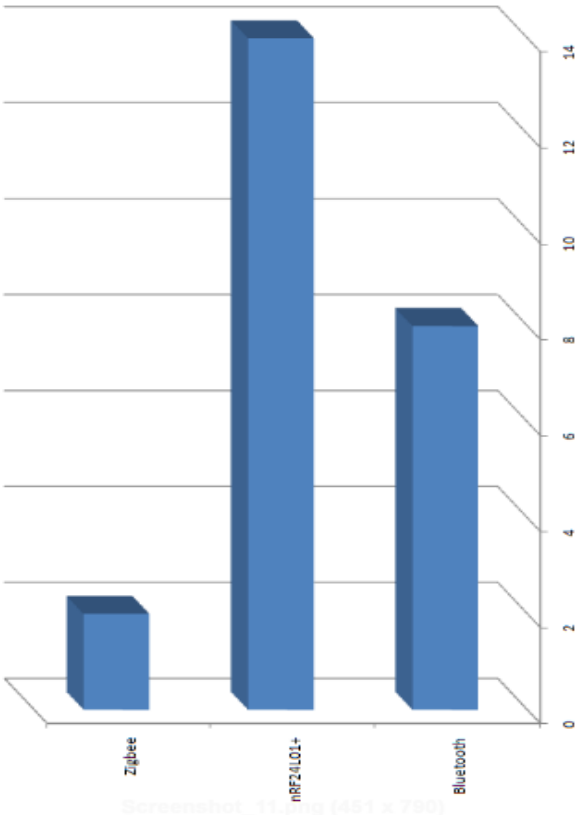

Fig.12: Graphical method for performance analysis

13. ACKNOWLEDGEMENT

We are truly grateful to our honorable teachers of the department of Electrical and Electronic Engineering of CUET. We also like to thank to all the members of Andromeda Space and Robotic Research Organization (ASRRO) for their continuous and constructive technical support.

14. FUTURE DEVELOPMENT

In this paper implementation and performance analysis of Zigbee protocol for home automation is achieved. In future this protocol can be implemented in industrial environment and performance analysis may show better result compared with the existing system.

15. REFERENCES

[1] A. Mulla, J. Baviskar, J. Desai, C. Beral, and A. Jadhav, "GSM Based Interactive Voice Response System for Wireless Load Control and Monitoring ",in *Proc. of IEEE International Conference on Communication, Information & Computing Technology (ICCICT)*, Mumbai, India, 15-17 Jan. 2015,pp. 1 – 6.

[2] A. M. A. H. Al-Kuwari, C. O. Sanchez, A. Sharif, V. Potdar, "User Friendly Smart Home Infrastructure: BeeHouse" ,in *Proc. of 5th IEEE International Conference on Digital Ecosystems and Technologies Conference (DEST)*, Daejeon, South Korea, May 31 2011-June 3 2011,pp. 257 – 262.

[3] A.K.Gnanasekar, P. Jayavelu ,and V. Nagarajan, "Speech Recognition Based Wireless Automation Of Home Loads With Fault Identification For Physically Challenged", in *Proc. of IEEE*

International Conference on Communications and Signal Processing (ICCSP), Chennai, India, 4-5 April 2012, pp. 128 – 132.

[4] J. Zhu, X. Gao , Y. Yang, H. Li, Z. Ai, X. Cui, "Developing a Voice Control System for Zigbee-based Home Automation Networks", in *Proc. of 2nd IEEE International Conference on Network Infrastructure and Digital Content,* Beijing, China, 24-26 Sept. 2010,pp. 737– 741.

[5] A. Z. Alkar, H. S. Geçim, M. Güney, "Web Based ZigBee Enabled Home Automation System", in *Proc. of 13th IEEE International Conference on Network-Based Information Systems (NBiS),* Takayama , Japan, 14-16 Sept. 2010, pp. 290 – 296.

[6] Kamran Javed, "ZigBee suitability for Wireless Sensor Networks in Logistic Telemetry Applications", Halmstad University, Technical Rep. IDE0612, January 2006.

[7] "XBee®/XBee-PRO® RF Modules datasheet", U.S.A, Digi Internatonal, Inc. 2008.

[8] http://examples.digi.com/get-starrted/configuring -xbee-radios-with-x-ctu/ (5 May 2015)

[9] http://ftp1.digi.com/support/documentation/html/ 90001399/90001399_A/Files/XBee-concepts.html (5 May 2015)

[10] http://www.arduino.cc/en/Guide/Arduino WirelessShieldS2 (5 May 2015)