# Smart Building Automation through Wireless Sensor Networks Using Zigbee

S. Anju[1], N. Lakshmi Prabha[2], Dr. N. Stalin [3]

*M.E(Communication Systems), Dhanalakshmi Srinivasan Engineering College [1],*
*Research Scholar, Anna University, Chennai[2],*
*Department of Petrochemical Technology, Anna University of Tech, BIT Campus, Trichy [3]*

## Abstract

*Building automation systems can also be used to control lighting; however, high initial and maintenance costs, the apparent complexity of these systems, and concerns about the interoperability of lighting systems and other building systems have limited such applications. Benefits of using building automation systems to control lighting include the ability to track occupancy and energy use, the ability to monitor and control lighting throughout a large facility, and the ability to minimize peak demand. The potential for energy savings has made the use of automated lighting controls such as sensors common in modern buildings. In the proposed system, building automation can be done by using Zigbee to effectively deliver solutions for a variety of areas by the design of a multi-sensing, heating and air conditioning systems.*



## 1. Introduction

Moving towards the smart energy management will require changes not only in the way energy supplied, but in the way it is used, and reducing the amount of energy required to deliver various goods or services is essential. A building automation (BA) system (BAS) deals with monitoring and control of building services, such as heating, ventilation and air conditioning (HVAC), lighting, alarms, etc. Not only is it the system bound to operate in HVAC appliances and lamps, but HVAC and lighting control can also be obtained by more natural and efficient ways, e.g. starting a motor to open blinds.

ZigBee is a typical wireless communication technology, which is widely used in wireless sensing networks. ZigBee wireless sensor network is widely used in military security, environment monitoring, and home automation. Various progressive wireless communication standards were developed and implemented into practice during the last decade [6]. GSM, WiFi and Bluetooth are well known amongst people in the modern society. The whole task of the network will be divided into two parts; one is about the network building, node joining, and data collecting; the other one is about data processing, network information conservation, and communicate with the host computer. The first part will be finished by the coordinator and the other one by another processor, which is connected with the coordinator by RS-232 interface.

### 2. Zigbee Overview

*A. ZigBee applications, markets and forecasts*

Although ZigBee standard development is still under progress, the ZigBee market is opened for many various applications. The most promising are:

- *Home Control:* Security, Heating, Ventilation ,and Air-Conditioning (HVAC), Lighting control,
- Access control, Irrigation, *Personal health care:* Patient monitoring, Fitness monitoring,
- *Industrial control:* Asset management, Process control, Energy management, Environmental,
- *Building automation:* Automatic Meter Reading *(*AMR), Security, HVAC, Lighting control, Access control,
- *Consumer electronics:* Remote control,
- *PC & peripherals:* Mouse, keyboard, joystick,
- *Environment:* Environment monitoring.

*B. Zigbee Standard Architecture*

*1) Network reference model*

Network devices, whether wired or wireless, are commonly described by the Open Systems Interconnection (OSI) reference model. This abstraction model was developed by the International Standards Organization (ISO), starting in the 1980 description of communication-related protocols and services. The generic seven-layer model is applied to all network and media types. The adaptation ISO-OSI network reference model for ZigBee purposes is illustrated in the Fig.1.

ZigBee network model does not use presentation, session or transport layer and user application is directly tied into Application layer (APL). This figure shows also IEEE, ZigBee Alliance, and ZigBee product end manufacturer particular responsibility for ZigBee certified product as well as hardware and software proportion in ZigBee.

*2) IEEE 802.15.4 Standard*

The IEEE standard [3] brings the ability to identify uniquely every radio in a network as well as the method and format of communications between these radios, but does not specify beyond a peer-to peer communications link, a network topology, routing schemes or network growth and repair mechanisms.

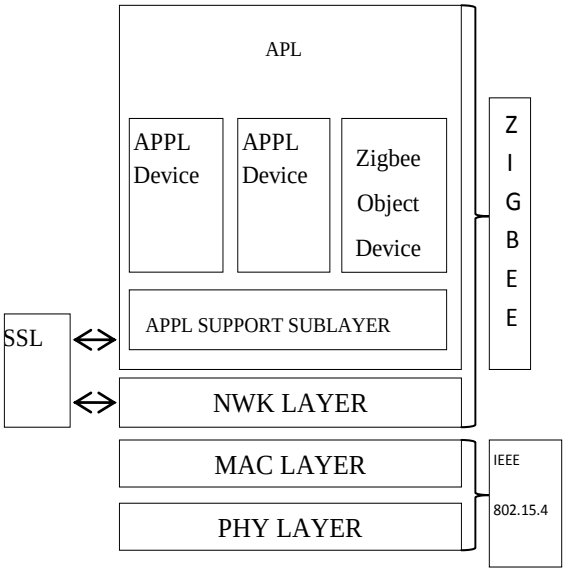


Fig.1 Adaptation ISO/OSI to Zigbee Standard

The ZigBee Alliance selected the IEEE 802.15.4 standard, released in May 2003, as the wheels and chassis upon which ZigBee networking and applications have to be constructed. IEEE 802.15.4 defines three frequencies to employ a standard over the world. The 2.45 GHz platform is used the most frequently thanks to worldwide availability and 250 kbps bit-rate. Physical layer (PHY) of an IEEE 802.15.4 uses Direct-Sequence. Spread Spectrum (DSSS) mechanism for data transmitting and Offset Quadrature Phase-Shift Keying (OQPSK) method of modulation what ensures high level of robustness for ZigBee.

Except frequency bands, modulation and spreading methods IEEE 802.15.4 also define relatively simple protocol, based on CSMA/CA (Carrier Sense Multiple Access/Collision Avoidance) access method to the medium.

ZigBee does not use all abilities of this protocol. Overview of available bands, modulation method and other properties of each is resumed in Tab. 1.

TABLE 1

AVAILABLE FREQUENCY BANDS WITHIN IEEE 802.15.4.

| | 868 MHz | 916 MHz | 2.45GHz |
|---|---|---|---|
| Frequency band | ISM | ISM | ISM |
| Area | Europe | USA | World |
| Bit-Rate | 20Kbps | 40Kbps | 250Kbps |
| Modulation | BPSK | BPSK | O-QPSK |

*3) Networking Overview*

Zigbee network uses three device types: Network Coordinator, Full Function Device and Reduced Function device. Various network topologies used by Zigbee are shown in figure 2.

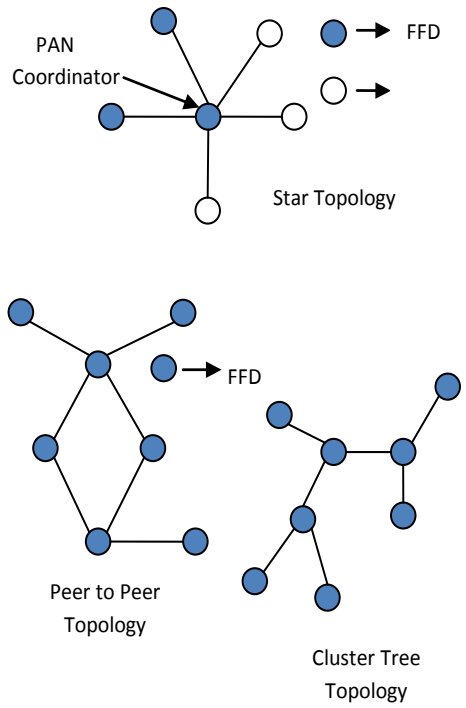


Fig.2 Various networking topologies used by Zigbee

*4) Network Coordinator*

It maintains overall network knowledge. It's the most sophisticated of the three types and requires the most memory and computing power.

*5) Full Function Device*

It can function as network coordinator. Additional memory and computing power make it ideal for network router functions or it could be used in network –edge devices (where the network touches the real world).

*6) Reduced Function Device*

It carries limited functionality to lower the cost and complexity .It is generally found in network edge devices.

## III.SYSTEM OVERVIEW

### *A. System Overview Framework*

The improved ZigBee wireless sensor network is composed of various sensors, ZigBee nodes, host computer. In the network, the sensor collects the information and uploads it to the ZigBee node.

The ZigBee node sends this information to the control section .Then it will monitor the status of each device and also will control can be done by sending command signal to those devices. The lighting can be control by implementing DALI(Digital Addressable Lighting Interface).DALI with general purpose sensors in order to have a single network for lighting, HVAC and environmental monitoring [1].

### *B. Design*

The design of the ZigBee wireless sensor network includes two parts: ZigBee sensor and Zigbee control section. The ZigBee sensor node consists of multiple sensors used to sense the status of the devices and transmits the sensed data to the control section. Zigbee control device will receive the data and displayed in PC. The control command will be send through Zigbee to the node then it will be transferred to the intended destination.

### *C. Transmission Section*

Using Zigbee technology the building automation like lighting, temperature checking and air conditioning is done by using wireless sensor network.

Here the system with sensors are interfaced with the Microcontroller which is used to monitor the light source, temperature and moisture content of a room are gathered and transmitted to the monitoring section using Zigbee wireless communication.

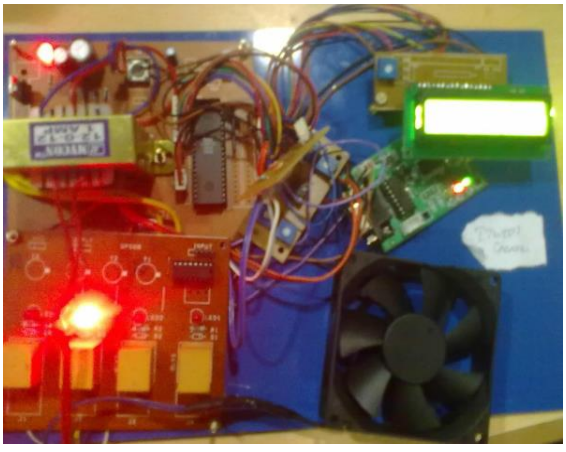

Fig. 3 Block diagram of Transmission Section

Liquid Crystal Display which is used to display the status of the devices which are interfaced with the controller. The control and monitoring of those electrical devices can be done through Zigbee, in which the transmitter and the control section which are enabled with Zigbee trans receiver.

*D. Monitoring Section*

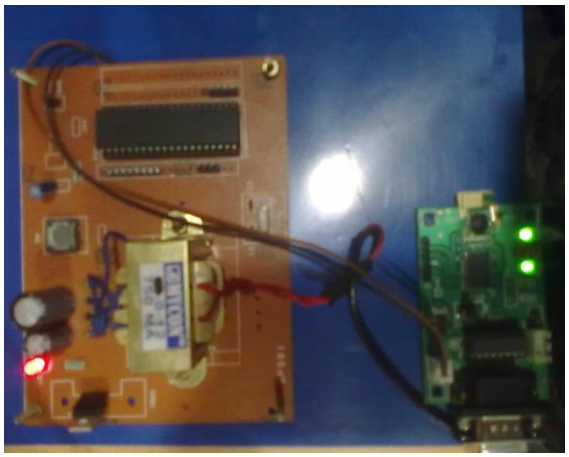

Fig.4 Block diagram of Monitoring Section

The data from the transmitter section will be received by the receiver end they can control the system with separate address. So the control data will reach the proper node and after receiving the data the controller will controls the devices. A LCD display is used in every section for displaying the status.

*E. Simulated Result*

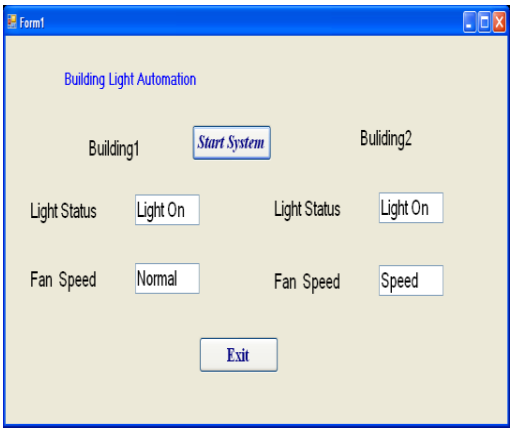


Fig.5 Simulated Result at Monitoring section

When the input is given to temperature sensor and LDR, the output of those devices are in analog form so ADC is used to convert the analog signal in to digital form.

Then the digitized output is given to controller and will be transmitted to the monitoring section. The transmitted data will be displayed in PC. If the temperature is high then the speed of the fan will be increased and if the place is dark light will gets turned on automatically.

## IV. CONCLUSION

The building automation can be done by using Zigbee standard with wireless sensor networks. It is used for managing energy usage is a crucial factor in addressing the home's growing energy concerns. This will be implemented in hardware to empower consumers with near real-time information of their energy usage through an array of products and services; the intent is to help consumers.

In a proposed system, this building automation can be done to extend to other standards or technologies to control and monitor the atmospheric conditions, for energy saving and also per suing the improvement of user experience.

## REFERENCES

[1] Akildiz .I .F, Su .W, Sankarasubramaniam .Y, Cayirci .E, "Wireless Sensor Networks : Survey", Computer Networks, Published by Elsevier Science, pp. 393-422,Dec 2002.
[2] Bellido –Outeirino .J .F, Jose Maria Flores-Arias, Francisco Domingo-Perez, Aurora Gil-de-Castro and Antonio Moreno-Munoz, "Building Lighting Automation through the Integration of DALI with Wireless Sensor Networks", IEEE Transaction on Consumer Electronics, vol. 58, Feb 2012.
[3] Buratti C, Conti.A, D. Dardari, and R. Verdone, "An overview on wireless sensor networks technology and evolution," Sensors, vol. 9, no.9, pp. 6869-6896, Sep 2009.
[4] Bellido-Outeirino .F .J, M. Flores-Arias .J, Domingo-Perez .F, Gil-de-Castro .A and Moreno-Munoz .A, "In-Building Lighting Management System with Wireless Communications", Proc. International Conference on Consumer Electronics ICCE Las Vegas, January 2012.
[5] Chengbo YU, Yanfei LIU, Cheng WANG, "Research on ZigBee Wireless Sensors Network Based on Mod Bus Protocol", Int. Journal on WSN, pp. 1-60,April 2009.

[6] Christian Reinisch, Wolfgang Kasner, GeogNeugschwandtner, "Wireless Technologies in home and building automation," IEEE trans. on WSN, Feb 2007.
[7] Chunduru .V, Subramanian .N, "Effects on Power lines on performance of home control system," Proc. Int. Conf. on Power Elec., Drives and Energy Systems. Dec. 2006.
[8] Dietrich .D, Bruckne .D, Zucker .G, and Palensky .P, "Communication and computation in buildings: a short introduction and overview", IEEE Trans. Ind. Electron., vol. 57, no. 11, pp. 3577-3584, Nov. 2010.
[9] Domingo-Perez .F, Gil-de-Castro .A, Flores-Arias .J .M, Bellido-Outeirino .F .J, and Moreno-Munoz .A, "Low-rate wireless personal area networks applied to street lighting," Lighting Res. & Technic., pre published Dec. 14, 2011.
[10] Ferreira .F, Osorio .A .L, Calado .J .M .F, and Pedro .C .S, "Building automation interoperability – A review," 17th Int. Conf. on Systems, Signals and Image Process (IWSSIP), Jun. 2010.

## Biography

Mrs. N. Lakshmi Praba doing PhD in Anna University of technology, Trichy. Did her Master of Technology (M.E) in Shanmuga college of Engineering, Tanjore and completed her Bachelor of Engineering (B.E) in Noorul Islam college of Engineering, Kumaracoil, Kanyakumari District.

Miss. S. Anju doing Master of Engineering (M.E), Communication Systems in Dhanalakshmi Srinivasan Engineering college, Perambalur. Completed her Bachelor of Engineering (B.E), Electronics & Communication Engineering in Sengunthar College of Engineering for women, Thiruchengode.