



A Survey on Recent Research Applications of Zigbee Technology

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Abstract: *Wireless personal area network (WPAN) and wireless sensor area network (WSN) are taking important place. Zigbee is an enabling technology of WPAN targeted for applications of WSN. The low cost of Zigbee allows it to be used in wireless control and monitoring applications, the low power consumption allows longer life with smaller batteries. It has various applications like ultra violet detection, green house monitoring, air pollution sensor which save environment, various applications of automation like smart home, street lightening control which saves energy and time. Zigbee network is also contributing in healthcare applications. This paper surveys the various proposed applications of Zigbee and states the current status and future scope of these applications.*

I. Introduction

Zigbee is a set of specifications of WPAN. It consumes less power and has long battery life. Zigbee is an enabling technology of WPAN targeted for various applications of WSN. IEEE802.15.4 specified physical layer and medium access control layer. Zigbee alliance specified the network layer and application layer by making base of IEEE 802.15.4 layers. Due to its powerful features like low power consumption, long battery life and low data rate, it is used in various applications of automation and monitoring. Zigbee network can create a fully automated smart home. It consumes mostly 1mW power which is very less as compared to other standards of communication like wi-fi and Bluetooth [1]. Zigbee specifies operations in three frequency bands: unlicensed 2.4 GHz (worldwide), 915 MHz (Americas and Australia) and 868 MHz (Europe) ISM bands. 2.4 GHz band offered 16 channels; 902-928 MHz band offered 10 channels and 868-870 MHz band offered 1 channel. 2.4 GHz provide maximum data rate 250kbps, 915 MHz provide maximum data rate 40 kbps and 868 MHz band provide maximum data rate 20kbps. It supports upto 64000 nodes at a time having distance 50 m in between nodes. Long battery life is an important feature of Zigbee network. As compared to other WPAN standard which support very short battery life, it support 100 to 1000 days of battery life. Mostly it use 1mW power but still it is capable of providing range up to 150 meters in outdoor by using direct spread spectrum (DSSS) [2][3].

The rest of the paper is organized as follows: After the introduction of Zigbee in section I, section II applications of Zigbee network and Future scope has been described in section III before the conclusion of paper in last section.

II. Recent Research Application

Considering the importance Zigbee technology various researchers have suggested the applications based on Zigbee are mentioned below:

A. Smart home energy management system

Dae-Man Han and Jae-Hyun Lim [4] in 2011 proposed a smart home energy management system using Zigbee technology. Using a WSN with actuator functionality, proposed system can gather physical intelligence information and direct various end user home devices. The system can hand out various responsibilities related to home network to related components and implement actual home services via smart sensors and controller deployed in home areas. A smart home control system can supply significant cost savings in a home environment, as well as the building manager has full power over control of building and great comfort for the residents. Two most effective ways to reduce lighting energy consumption is to turn them off or turn them low according to need. An automated control system can do both these based on sensing factors like occupancy, available daylight and time of day. There is no need of wires, provide great flexibility of control. The whole system reduces the expense of installation and consumption.

B. Industrial automation

Archana R. Raut and L.G. Malik [5] in 2011 proposed Zigbee based sensor system to automate industrial equipments. This system monitors power related parameters and enable remote switching devices for proper power management systems. It is a digital system for circumstances monitoring, diagnosis, and supervisory direction for electric systems parameters like voltage and current using wireless sensor networks (WSNs) based

on Zigbee. Its main feature is its use of the Zigbee protocol as the exchange communication between the transmitter and receiver modules. Results show that the ZigBee standard performs well for industrial environments. It provide easy way for communication without wires and very useful at such places where wired infrastructure can't available.

C. Ultra violet detection

Pedro Cheong, Ka-Fai Chang, Ying-Hoi Lai, Sut-Kam Ho, Iam-Keong Sou, and Kam-Weng Tam [6] in 2011 proposed ZigBee based wireless sensor network node for ultra violet detection. There are other fire detection systems which detect smoke but are very costly and there are very much chances of false alarms. But this is a low-cost and low-power Zigbee based WSN and give accurate information with fast speed. This UV detector can contribute a lot in the fire safety protection industry. The sensor node consumes power only 2.3 mW from a 3.3-V supply in average. This is as fast as 70 ms. Proposed model can be easily integrated with facility management systems and other buildings at low cost. It is efficiently contributing to the fire safety protection industry.

D. Power management system based on ZigBee

Chiung-Hsing Chen, Hung-Wei Lin, Yen-Sou Huang and Jwu Jenq Chen [7] in 2012 proposed power management system. As now a day's energy is consuming in big amount. Lots of big buildings exists which consume power in huge amount. Zigbee based power management system is the solution of this problem. This system comprises intelligent plug and light control. In intelligent plug user set the maximal current, if current load exceed from maximal load then intelligent plug cut-off the extra load. Zigbee end-devices network are developed with light switch. User can operate it from smart phone or computer to control the light from anywhere. There is no need of long wires. The building or school administrators only require using their smart phone turned off the lights. The system can attain energy saving effect.

E. Fingerprint system

Mukesh Kumar Thakur, Ravi Shankar Kumar, Mohit Kumar and Raju Kumar [8] in 2013 proposed a Zigbee based fingerprint system. Now a day's security is playing vital role. It may be for application, network, home, information, data, financial etc. Mainly CCTV, barcode, identity cards are in use for maintaining security. But these are slow, highly expensive; these are much chances of hacking thus not efficient easy for security. But fingerprint system based on Zigbee technology overcomes these problems. This system is based on the concept that it takes finger impression of a user with a fingerprint sensor module and compares it with the pre-recorded database details corresponding to the user fingerprint and displays it on the computer screen. Experiment of this system is performed by taking impression of 251 authorized and 10 un-authorized persons. Results show that in case of authorized system gives 99.6% accuracy and in case of un-authorized access system gives 100% accuracy. Thus security system has a better percentage of security with respect to other already available security systems. Along with this, it is fast processing, better portability and a little bit chance of hacking, and less expensive.

F. Water environment monitoring system

Lie Guo Wu, Ling cheng Kong and Zhihua Zhang [9] in 2013 proposed Zigbee based water monitoring system. Zigbee sensor network is deployed on water. This network can monitor temperature, pressure, pH (potential of hydrogen) level, oxygen and other pollutant. In this application star topology is used because it is easy to configure and adding/removing of devices are easy. Using this application two type of experiment: temperature data collection and pH data collection. For temperature collection, its temperature measurement range is between 0 to 100o C. it uses the warm cp of water and monitors the changes in temperature. For pH data collection temperature range is 4 and 200 C and experiential change in pH value in the lake of Tai Hu. In both cases, it evaluates different value on different time. It is very helpful in monitoring water pollution.

G. Air pollution sensor

Darshana N. Tamba¹ and Nekita A. Chavhan [10] in 2013 proposed air pollution sensor based on Zigbee network. The air pollution is damaging to human life, vegetable, and animal. Air contains dusts, paper hashes, smokes, gases, poisonous chemical products and many polluted materials. Some polluted materials react with each other and produces other pollutants. Carbon dioxide (CO₂) and nitrogen dioxide (NO₂) produced by automobiles motors, lead to the development of ozone. It is the main reason of respiratory harms. It also contributes in the acid rain and depletion of ozone layer. Earlier GPRS, GSM detect pollution but this is very costly. Then air pollution sensing device based on Zigbee has been introduced. In this system there are four transmitters (Node1, Node 2, Node 3, Node 4) which transmit the different levels of pollutant substance such as CO₂, SO₂, and NO₂ to the receiver node in real time. It contributes to monitor the pollution, alert to human about it, maintain clean air that is safe for everyone to breathe and it is stable due to low cost and low power consumption.

H. Patient monitoring system

H. C. Tung, Veselin Rakocevic, and K.F. Tsang, L. L. Lai [11] in 2013 proposed a Multipurpose Patient Monitoring system embedded with a Zigbee mobile application profile is proposed. This system specifies the concept of mobility in Zigbee devices. It saves patient by tarcking the location when patient press the panic button. It use tree network and support upto 3000 patients with 200 nodes. This application provide healthcare for

patients. MPMS system provides three main services: Real time medical parameter monitoring, Patient location tracking and Paging patient. Real time monitoring collect medical data such blood pressure, ECG (Electrocardiogram) which tell heart condition, body temperature etc. from patients regularly and saves the data in database. Doctor can access the data later. If collected data signify any danger then it informs doctor at that time. Patient location tracking paging serves in and out patients. In patient can press panic button and call doctor for help when they feel any suffer, MPMS tell the location of patient. Similar function serves out patients by control central of the clinic. MPMS also decide which patient should serve first.

I. Wireless medical system

Shu-Cheng Gu, Hsien Lung Chuan, Shu-Hua Wang [12] in 2013 proposed wireless medical system using Zigbee Network. In this system CC2530 integrate with Medical System based on ZigBee network technology. It collects the bio-signal data of patient and display on screen. It use cluster tree Zigbee network. This system is divided into three categories: client, medical server, and Zigbee network. In client bio-signal data such as ECG which tell heart condition, heart rate variability collected from person's body. Then Zigbee network transmit the data to medical server. Multiple devices act as intermediate router. Finally medical server process and analyze the patients health according to data received and show result and provide the efficient mobility for moving patients.

J. Intelligent bus query system

Cui Shiyao, Xing Yunyang, Lu Baihui, and Wang Hui [13] in 2014 proposed an intelligent bus query system. As in modern world traffic is increasing drastically so it becomes difficult to choose the right route. But by using proposed system route of the bus, current position can be easily identified. It can help the passengers to change line easily. Researchers experiment in a school by applying the proposed system in 5 school buses. System includes Zigbee network, GPS and internet for query. In experiment 5 collecting nodes are placed in 5 school buses and there are stations so 3 routing nodes are placed at stations and finally coordinator in campus. System make mesh network. When bus passes from any station, server collect data by using longitude and latitude according to predefine setting. User can login from mobile phone and check the status of bus.

K. Intelligent street lighting system

Sagar Deo, Sachin Prakash and Asha Patil [14] in 2014 proposed intelligent street lightening system. This system operates the street lights. Zigbee network of street lights can be monitored from base stations. There are two ways of operating it: manual and automatic. In manual human can manually on/off the street light from the base station of Zigbee network or switches provided at respective nodes according to information given by the system and in automatic network automatically toggle the on/off state according to the sensed conditions. Small model of proposal shows the accurate and successful results. This system is very useful for energy saving, and less expensive. It overcomes the human errors in operating the system. Zigbee provide a convenient way to maintain the proposed mode.

L. Real time monitoring and control system for green house

Jaypal Baviskar, Afshan Mulla, Amol Baviskar, Shweta Ashtekar and Amruta Chintawar [15] in 2014 proposed Real time Monitoring and Control System for Green House Based Zigbee (802.15.4) WSN. This system analyzes the temperature, humidity, soil moisture level, light intensity. It also analyzes the power consumption of all appliances and check if there is malfunctioning of appliance. It doesn't need any wire. Zigbee provide suitable data rate for controlling and monitoring and provide scalability. It uses the star and mesh topology in Zigbee network. This application is well contributing in green house management.

By considering the above application, advantages and remarks for future work of Zigbee applications are summarized in Table I.

Table I Zigbee Recent Applications

Author	Publication Year	Application Name	Advantages	Remarks
Dae-Man Han and Jae-Hyun Lim [4]	2011	Smart Home Energy Management System	It make home very much intelligent and automatic. It saves money on installation without wires and saves energy to encourage "green house"	Location services can be added.
Archana R. Raut, L.G. Malik [5]	2011	Industrial automation profile for power monitoring system	It is a digital system for circumstances monitoring, diagnosis, and supervisory direction for electric systems parameters like voltage and current using WSN.	Zigbee can be widely used to improve the controlling and monitoring operations in power management system
Pedro Cheong, Ka-Fai Chang, Ying-Hoi Lai, Sut-KamHo, Iam-Keong Sou, and Kam-Weng Tam [6]	2011	Ultraviolet Detection of Flame System	This low-power and less cost ZigBee-based, contributing to the fire safety protection industry.	The presented flame detection can be easily integrated with building or facility management systems at low cost.

Chiung-Hsing Chen, Hung-Wei Lin, Yen-Sou Huang and Jwu Jenq Chen [7]	2012	Power Management System Based on ZigBee	There is no need of wires and this can attain energy saving effect by providing the facility to operate switches from smart phones and computers.	Automatic on/off facility can be added according to user requirement.
Mukesh Kumar Thakur, Ravi Shankar Kumar, Mohit Kumar, Raju Kumar [8]	2013	Wireless Fingerprint Based Security System	It is fast processing, better portability and a little bit chance of hacking, and less expensive	This common wireless security system can be extended in future by using several different types of required database that will be very hard to break by the attackers and thus it can provide better security.
Lie Guo Wu, Ling cheng Kong and Zhihua Zhang [9]	2013	Water environment monitoring system based on ZigBee wireless sensor network	This network can monitor temperature, pressure, pH level, oxygen and other pollutant. It is very helpful in monitoring water pollution.	List of pollutant to monitor can be increased.
Darshana N. Tambe1, Nekita A. Chavhan [10]	2013	Air Pollution Detector System	It saves the environment and human health by detecting pollution in air.	List of pollutant to monitor can be increased.
H. C. Tung, Veselin Rakocovic, and K.F. Tsang.L. L. Lai [11]	2013	Multipurpose Patient Monitoring System	This application provide healthcare for patients and provide emergency help.	This application an be extended for more large network and other standards of zigbee can be used
Shu-Cheng Gu, Hsien Lung Chuan, Shu-Hua Wang [12]	2013	Wireless Medical System	It collect the bio-signal data of patient and store the data in database. It is contributing in medical care.	There can be emergency alarm in case of emergency.
Cui Shiyao, Xing Yunyang, Lu Baihui, Wang Hui [13]	2014	Intelligent Bus Query System	This system help user to identify the route of the bus and current position of bus. It can help the passengers to change line easily	More features can be added to this system like vacant seats, estimated reached time.
Sagar Deo, Sachin Prakash and Asha Patil [14]	2014	Intelligent Street Lighting System	This system is very useful for energy saving, and less expensive. It overcomes the human errors in operating the system.	An innovative database management scheme can be added for automatic storage.
Jaypal Baviskar, Afshan Mulla, Amol Baviskar, Shweta Ashtekar and Amruta Chintawar [15]	2014	Real time Monitoring and Control System for Green House	This system analyzes the temperature, humidity, soil moisture level, light intensity. It also analyzes the power consumption of all appliances	List of analysed parameters can be increased.

III. Future Scope

Lot of applications has been reported in previous section. As seen Zigbee Network is contributing a lot in WPAN and WSN. In lot of applications it act as sensor network to sense the required information and in lot of applications it act as communication medium. There are many applications Zigbee. This paper only surveys the recent application of Zigbee. Considering the benefits of Zigbee network, there are lots of applications developed and there is scope of new applications. There is also scope adding new features in previously developed applications to make them more convenient and beneficial. Future scope of various Zigbee applications is given below:

Zigbee network provide the automation in various works. Due to its powerful features like low power consumption, long battery life and useful for application required low data rate intended it to use in many applications. In smart home energy system it provides automation and in future this application can extend by adding location services. MPMS system can be built by using other standards of Zigbee and network can extend by increasing nodes to support more patients. In wireless fingerprint system wireless security system can be extended in future by using several different types of required database that will be very hard to break by the attackers and thus it can provide better security. In intelligent street lightening system an innovative database management scheme can be added for automatic storage. In future performance of proposed system can be check for other standards and topologies, may be proposed will better perform for other standards and topologies of Zigbee.

IV. Conclusion

Zigbee Network provides is an economical way for various application for communicate, monitor, control and for automation. Different application using Zigbee are developed with powerful feature. This paper surveys the features of Zigbee in terms of power, data rate, battery life, frequency bands, channels etc to show the importance of Zigbee Network. This paper highlights the various applications of Zigbee for energy conservation, environment saving, automation in home and surrounding and in health care systems. This paper little contributes in providing the future scope of application. . The whole paper concluded Zigbee Network is very important.

VI. References

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