

# A brief review: ECG based Health Monitoring System through Zigbee Sensor Networks

Bimaljeet Kaur<sup>1</sup> & Anantdeep Kaur<sup>2</sup>

<sup>1</sup>M.tech student, Department of computer Engineering, Punjabi University, Patiala

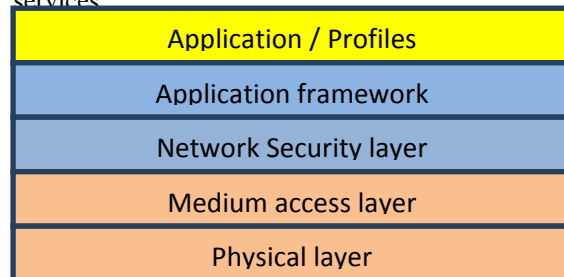
<sup>2</sup>Assistant Professor, Department of computer Engineering, Punjabi University, Patiala

**Abstract:** Recently, there has been increasing interest from researchers, system designers, and application developers on a new type of network architecture generally known as Wireless Body Area Network (WBAN). A WBAN is a collection of low-power, miniaturized, lightweight wireless sensor nodes that continuously monitor human's physiological activities and actions, such as health status and motion patterns. The real time vital signals are transmitted to a nearby body node coordinator (BNC) via ultra-low-power short-haul radios (e.g., ZigBee, Bluetooth), and then to a remote terminal (e.g., a hospital) via the Internet. One of the most important signals for monitoring and analyzing in WBANs is the electrocardiography (ECG) signal. In this paper, existing work has been surveyed using Zigbee technology to communicate ECG signals in an intra-hospital environment. The main work done in these research works is to enhance design and implement an electrocardiogram monitoring system using wireless ZigBee topologies that can be used for remote ECG monitoring, analysis and diagnosis. Using wireless network topologies (mesh, star etc.) transmission as the main design, a number of important issues have been considered in them i.e. network creation, network robustness, route maintenance, data throughput, data loss, and in particular power consumption and node status indication. It has been found that compressed sensing is a subject much needed to explore in zigbee based ECG transmission as compressed signal helps in reduction the number of bits for sending the same signal and hence improves power efficiency of wireless networks.

## 1. Introduction

Wireless body area networks have been designed to create a typical supply chain with the help of sensors. It is the best solution to easily deploy and help to improve the supply chain management and reduce the system cost. In present days, wireless body area networks gain an attention at very extreme level. This network consists of small sensors and very limited resources and power. This paper gives a brief

review on zigbee sensor networks which is used in the health monitoring systems for diagnosis. Zigbee is the distinctive technology used in wireless sensor networks, like Bluetooth. It is the requirement for a group of high level communication protocols. Zigbee uses low power and low rate radios based on IEEE 802 standard. Zigbee is the simpler and less expensive technology than others. Zigbee is established by IEEE. The IEEE standard describes the physical and medium access layer. Zigbee constructs upon IEEE standard and describes the network layer, application layer and security services



ZigBee is a low cost, low complexity and low power technology that exhibits the following characteristics which makes it more beneficial to use in the industry applications [9]. Some are mentioned below along with some Zigbee characteristics.

1. It has great advantages over high fault tolerance, flexibility, and autonomy.
2. ZigBee is the simple technology that was designed with a cost less than other wireless personal networks.
3. ZigBee is freely available for all non-commercial purposes.
4. ZigBee is designed with low power which makes smaller batteries last longer.
5. ZigBee can be very responsive particularly when it is compared to other technologies like Bluetooth.
6. ZigBee uses a variety of power-saving modes to guarantee.

7. Zigbee has self-organizing features that one node can sense other ones without any human interventions, and connect with each other automatically to create a completed network.
8. ZigBee is a wireless mesh network which provides a larger range and high consistency.

### 3. Zigbee Devices

Zigbee devices are of three types [1]:

- 1) ZigBee coordinator (ZC): The most capable device, the coordinator forms the root of the network tree and might bridge to other networks. There is exactly one ZigBee coordinator in each network since it is the device that started the network originally. It stores information about the network, including acting as the Trust Centre & repository for security keys.
- 2) ZigBee Router (ZR): As well as running an application function, a router can act as an intermediate router, passing on data from other devices.
- 3) ZigBee End Device (ZED): Contains just enough functionality to talk to the parent node (either the coordinator or a router); it cannot relay data from other devices. This relationship allows the node to be asleep a significant amount of the time thereby giving long battery life. A ZED requires the least amount of memory, and therefore can be less expensive to manufacture than ZR or ZC.

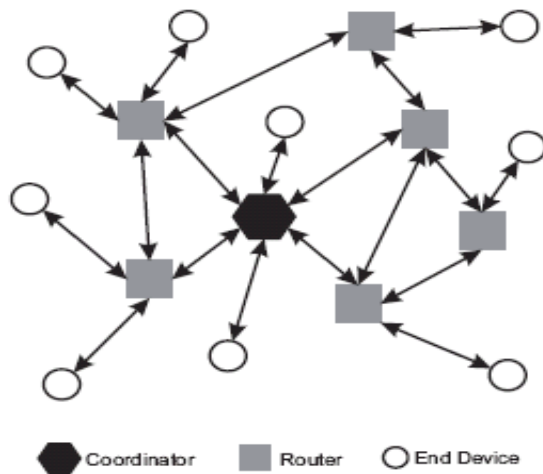


Figure2:- Zigbee coordinator, Router, End device [1]

### 4. Network Topologies in Zigbee

- a) Star Topology is where a coordinator is surrounded by a group of end devices or routers.
- b) Tree topology, a coordinator initializes the network and is the root of the tree.

- c) Mesh topology is the most flexible topology because message can take multiple paths from source to destination.

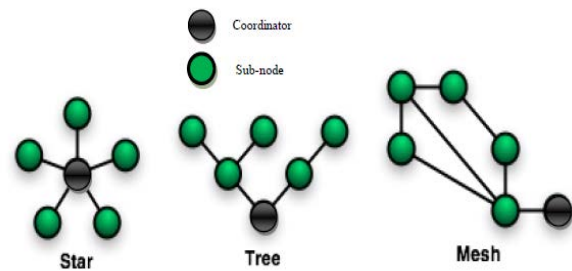


Figure3:- Network Topologies in Zigbee [8]

### 5. Electrocardiogram Monitor System

Because of ageing of population, the pressure of workload increases the cardiac deaths. Heart diseases increases day by day. To prevent these diseases we need real time detection of ECG for long time. Therefore medical monitoring system is widely used in hospitals, clinics. Sensors are mostly used for testing the physiological parameters. Zigbee sensors networks are the best example used in the health monitoring system. It provides route maintenance and self-healing. The parameters of ECG signals can be used for diagnosis of heart diseases. ECG telemonitoring system relieves patients from the need of visiting hospitals frequently. ECG telemonitoring system requires new algorithms and scheme for implementations.

#### 5.1 Intra hospital patient monitoring scenario

[10] proposes a tele-cardiac patient monitoring in which ECG of cardiac patients is being monitored in an intra-hospital scenario consisting of 4 wards. Each ward consists of 10 patients each. Their ECG signal is assumed to be measured by ECG sensors placed on their body which are battery operated. Each sensor sends data to a main nurse's Personal Digital Assistant (PDA). Further it is being sent to Doctor's PDA for monitoring in case of emergency. Connection in between sensors and nurse PDA is ZigBee for the sake of fast connection and high scalability of this short range communication standard. Doctor's PDA is connected to nurse's PDA by ZigBee connection. Here assumption is being made 3 point measurement of ECG signal with typical sampling rate requirement of 500 samples per second with a assumed bit resolution of 10 bits which amounts to a data rate of 15kbps. As per the QoS requirements, average end to end delay should be less than 350 ms for the efficient transmission of ECG signal from the patient node to the doctors PDA. Now in a typical 200m\*200m hospital scenario the ECG sensors are connected to the FFD device called the nurse's PDA which takes the data from the RFD device or ECG sensors which are planted on patients. The sink node or the PDA are connected to a central node which receives all the data from the

nurse PDA is doctor's PDA. The parameters being monitored in this proposed scenario is Super frame duty cycle which is being varied with change in macSuperframeorder(SO) and macBeaconOrder (BO). Here a search for optimum duty cycle is being carried out by varying load by inducing varied packet rates. To route the packet from source to destination Bellman Ford routing protocol is selected.

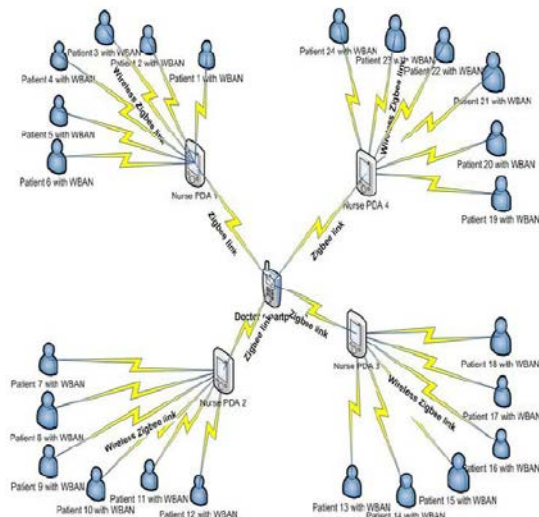


Figure 3: Intra hospital tele-cardiac monitoring simulation scenario [5]

## 6. Related Work

In order to develop effective yet low cost health monitoring system, a number of previous substantial work which are related to health monitoring system have been carried out in this section. Based on the surveyed literature some of the literature work is explained as:

**Prof. Pravin R. Lakhe et al [1]** describes wireless sensor networks using zigbee. An evaluating hardware developed with intention to create a HA network workplace and to test interoperability of various stacks. RF board was designed with on-board F- antenna with the MC13203 chip.

**Wen-Tsai Sung, Kuo-Yi Chang et al [2]** presents multiple physiological signals collection and analysis processing based on neural network methods study proposes a hospital guardianship and remote care medical system based on a wireless sensor network framework using optimal data fusion based on evidence theory. Data will be stored or real-time signal analysis made and the results transmitted via the wireless network device to the central monitoring system network server. The proposed method will greatly improve data fusion process immunity.

**Mohamed FEZARI et al. [3]** propose an improvement of our previous work in this field by developing a heart rate, body temperature and blood pressure monitor system based on new Arduino

Mega micro-system device. The paper focus on: how we implemented algorithms to analyze heart beat rate signals in real-time, how to fusion data of different sensors mainly here temperature and blood pressure and to transmit.

**Satyam Srivastava et al [4]** Presented work which addresses the development and application of artificial olfactory (e-nose) as an efficient Non-destructive handheld system to extract quality attributes of variety of orange cultivars at various cultivated lands. An ARM-9 (S3C2440 controller) based advance embedded electronic nose system has been developed for on-site odour acquisition, processing and ripeness level prediction for various orange cultivars.

**Aamir Hussain et al. [5]** propose people-centric sensing framework for the health care of elderly and disabled people. Such platform is aimed to monitor health of the elderly and disabled person and provide them with a service oriented emergency response in case of abnormal health condition. They focus on three aspects: (a) context manipulation from the mobile device in people-centric environment; (b) emergency response using context base information; and (c) modeling mobile context sources as services. The most distinctive feature of current work is that medical resources are efficiently used to provide them real-time medical services in case of emergency simultaneously extending social network of the elderly people.

**Marco Giammarini1,et al [6]** a low-cost architecture of a wireless sensor network for a structural health monitoring system is proposed. It has been designed. Tests have been carried out in order to understand which are the challenge that has to be solved and the points that can still be improved.

**Aris S. Lalos et al. [7]** In Wireless Body area networks (WBANs) the most important signals for monitoring is the electrocardiography (ECG) signal. The design of an accurate and energy efficient ECG telemonitoring system can be achieved by: i)reducing the amount of data that should be transmitted ii)minimizing the computational operations executed at any transmitter/receiver in a WBAN. In this paper, we propose two novel CS based ECG reconstruction algorithms that minimize the samples that are required to be transmitted for an accurate reconstruction, by exploiting the block structure of the ECG in the time domain (TD) and in an uncorrelated domain (UD). The proposed schemes require the solutions of second-order cone programming (SOCP) problems that are usually tackled by computational demanding interior point (IP) methods.

## 7. Conclusion

As a result of rapid technological progress in information science remote monitoring in medical

services has gradually begun to play an increasingly important role. This theme has led to wireless communications becoming more widespread in the medical environment application arena. Hence ZigBee technology for wireless transmission network system, offers medical hospitals centralized management, personal health care, with Internet telemedicine system implementation. Data will be stored or real-time signal analysis made and the results transmitted via the wireless network device to the central monitoring system network server. In this work, we have reviewed the existing work carried out by using Zigbee technology to communicate ECG signals in an intra-hospital environment. The main work done in these research works is to enhance design and implement an electrocardiogram monitoring system using wireless ZigBee topologies that can be used for remote ECG monitoring, analysis and diagnosis. Using wireless network topologies (mesh, star etc.) transmission as the main design, a number of important issues have been considered in them i.e. network creation, network robustness, route maintenance, data throughput, data loss, and in particular power consumption and node status indication. In our future work, we will explore the compression issues in transmitting signals by zigbee in order to increase battery life time of WSN networks.

## 8. References

- [1] Prof. Pravin R. Lakhe (Department Of Computer Engineering, Vidyavardhini's College Of Engineering and Technology International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622
- [2] Wen-Tsai Sung, Kuo-Yi Chang," Health parameter monitoring via a novel wireless system" published in Applied Soft Computing 22 (2014) 667-680
- [3] Mohamed FEZARI, Rachad Rasrasb and Ibrahim M. M. El Emary," Ambulatory Health Monitoring System Using Wireless Sensors Node" published in Procedia Computer Science 65 ( 2015 ) 86 - 94
- [4] Satyam Srivastava, Shashikant Sadiatp," Development of a low cost optimized handheld embedded odor sensing system (HE-Nose) to assess ripeness of oranges" published in Food Measure (2016) 10:1-15 DOI 10.1007/s11694-015-9270-3
- [5] Aamir Hussain, RaoWenbi, Aristides Lopesda Silva, Muhammad Nadher, Muhammad Mudhish," Health and emergency-care platform for the elderly and disabled people in the Smart City" published in The Journal of Systems and Software 110 (2015) 253-263
- [6] Marco Giammarini<sup>1</sup>, Daniela Isidori, Marco Pieralisi, Cristina Cristalli, Matteo Fioravanti<sup>1</sup> · Enrico Concettoni," Design of a low cost and high performance wireless sensor network for structural health monitoring" published in Microsyst Technol DOI 10.1007/s00542-016-2859-6
- [7] Aris S.Lalos, LuisAlonso, ChristosVerikoukis," Model based compressed sensing reconstruction algorithms for ECG telemonitoring in WBANs" published in Digital Signal Processing 35 (2014)105-116
- [8] Huanjia Yang," Integrated ZigBee RFID Sensor Networks for Resource Tracking and Monitoring in Logistics Management," Loughborough University Institutional Repository 2010
- [9] Kanchan Kaushal;Taranvir Kaur;Jaspinder Kaur," ZigBee based Wireless Sensor Networks." (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 5 (6) , 2014, 7752-7755
- [10] Shashwat Pathaka, Mayur Kumara, Amrita Mohanb, Basant Kumara," Energy Optimization of ZigBee based WBAN for Patient Monitoring," published in Procedia Computer Science 70 ( 2015 ) 414 - 420