International Journal of Engineering & Technology, 7 (2.7) (2018) 936-940

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research Paper

A survey overview: on wireless body area network and its various applications

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Abstract

With the remarkable change of mobile radio communication over the past years in the wireless communication technologies, makes the Wireless Body Area Network (WBAN) services to be adopted by most of the people around the world. Wireless body area network is such a special purpose sensor network that was made for continues monitoring the health parameters in real time with the different wireless sensors by implanting internally or externally of a human body. This wireless sensed information from the vital organs of the human body may be in the form of data, voice, video signals are communicated wirelessly through WBAN. This survey article presents an overview on- the WBAN communication architecture, comparison of WBAN and Wireless Sensor Networks (WSN), WBAN operating protocols- those are intended for short range wireless communication, and its applications in the medical and non- medical field have been out lined.

Keywords: *Bluetooth; Sensors; WBAN; WBAN Applications; Wi-Fi; ZigBee.*

1. Introduction

The WBAN is such a booming technology in the world that fits to improve the quality of human life with the support of various E-Health products. In retrospect to the present in the electronic communication system the wireless communication technology brings the world close to each other, in order to share the information effectively, instantly at any time, from any place, and in any condition (like bad weather in the atmosphere, earthquakes, etc). With the prosperous advancements in the wireless communication networking system such as the mobile communication network, WiFi, WLAN, etc., all are makes the people to be easily communicate in any sector namely- educational organization (in order to share the technical information to anywhere), in the entertainment field (in home or out of the home), in industries / offices(to communicate the data from top to bottom and vice versa), and in the health careservice (for continuous/real time monitoring the health status of patient or any others persons) in order to improve the quality of the life for their enrichment life standards. This wireless communication networking system ennobled with the Wireless Body Area Network (WBAN) in the modern world to provide service for the people in various ways such as real time monitoring the health status of a patient (to reduce the death rate of heart attacked patients in case of emergency) [2], or a commuter to check the health condition or a senile people who are in their home or any other physically disabled person assistance and at last athletics, gaming zone etc [1].

From the above it is no doubt that this WBAN technology supports the people in early disease detection diagnosis of the vital heath parameters (namely heart beat, blood pressure, brain activities, glucose level etc.,) and makes the people to reduce the cost of the heath care services, and death rates of the cardiovascular disease that may be the effectively reduce with the right time diagnosis and proper prescription by the remote monitoring doctor [2] [3] [16] at early stage only. The ennobled WBAN simply differed with traditional wireless sensors (WSN).In this paper we exposed the WBAN communication architecture, and discussed the major differences between the WBAN and traditional WSN, WBAN communication technology standard protocols, and over view of WBAN applications in the medical and non-medical sector.

2. Wireless BAN communication architecture

The WBAN is a special type of new emerging technology that provides E-heath care services in real time by, remotely monitoring the heath status of the patient with the implantation of an autonomously operated tiny sensors inside and outside of human body and instantly send recorded data through wireless communication with lot of security and privacy to an external server for the medical supervision immediately [4]. Means the WBAN performs like Virtual Doctor Server, by keeping the different responsibilities like- maintain the history of the patient, giving advices to the patient in general/emergency(first aid help from second person) case etc. To understand the communication approach of this emerging WBAN technology, we first need to know the conceptual structure of WBAN so that, one can easily know the flow of communication within the system and to the outside world, this has been achieved by the demonstration of a simple WBAN communication architecture. Where this architecture is mainly comprised with three different layers namely a) Tier 1 b) Tier 2 c) Tier3 and these are further described better in the given figure 1 as:

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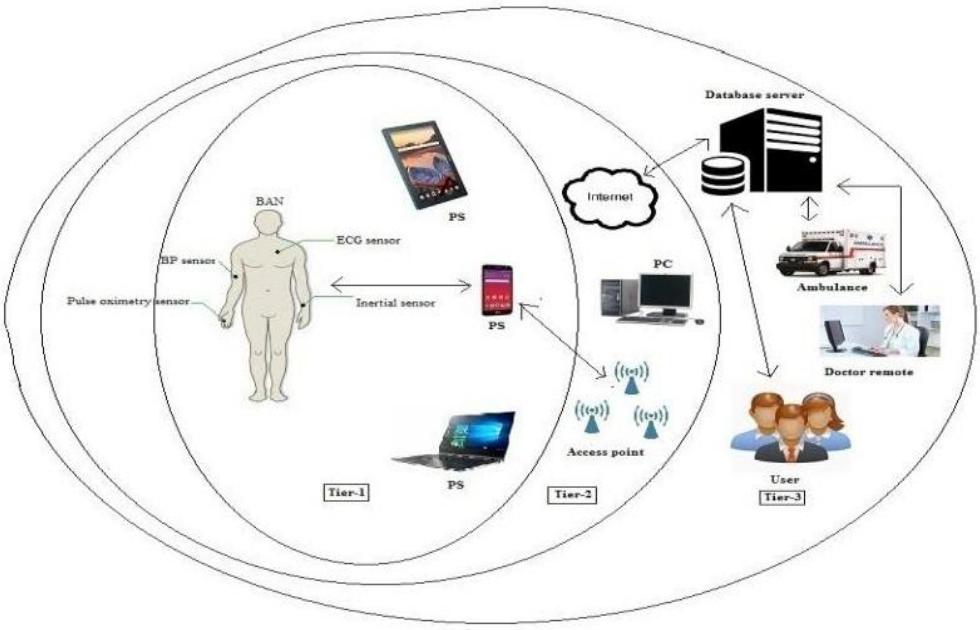


Fig. 1: Architecture of Wireless BAN Communication.

a) Tier -1: Intra-WBAN communication layer: This layer comprised with sensors nodes. These sensor nodes are strategically placed internally or externally on the human body, by that it pro-vides continuous monitoring the vital health parameters such as electrocardiogram (ECG), electroencephalography (EEG), electromyography (EMG), heart rate, body temperature, physical activities, and blood pressure [3][4]. This remote monitoring feature of the WBAN makes the person free to restrict his or her mobility. This intra-BAN layer functioned well, only when there exist: i) a proper communication between the different body sensors those are implanted in or out of the body ii) there should be a proper communication between body sensors and personal server(or personal device assistance (PS /PDA)). This PDA was used to transfer the information to the next level (Tier-2).

b) Tier-2: Inter- WBAN communication layer: This layer is acts like bridge between tier -1 and tier-3 with two or more access points (e.g.: laptops, robots, etc,). This layer is functioned as central control unit, that strives to deliver the collected information from the various sensor nodes to the Beyond-BAN communication, by using the internet or by various cellular networks(GSM, Bluetooth, WLAN, etc.). This model is further categorized as i) Infrastructure based architecture: It provides larger bandwidth with centralized control and management with the limited space, like hospital, home, office, etc. By the illustration in the fig. 2 the access points(APs) can able to do job like a database server based on applications such as SMART, Care Net [4] [12]. ii) Ad-Hoc based architecture: This architecture consist of more APS and able to cover large area of about 2 to 100 m .This architecture helps us when there was any dynamic changes in the environment taken place such as medical emergency care response sites, or disaster site for dynamic communication without centralized unit [3] [4] [21].

c) Tier-3: Beyond-WBAN communication: This communication layers is acts like a gate way to transfer the information to the destination and in this tier-3 electronic gadgets plays a crucial In the following way as a) a mobile node can be act like gate way from the patient to the remote station (tier-3) to send mobile mes-sage to a cellular network using GSM /3G/4G. b) Or a general router or PC can be remote nodes to communicate via email or by any other services using Ethernet to the data base server. So that finally medical supervision is provided to the tier-1 patient in case of emergency or not at but least to save the medical tracking record for further requisitions [3] [4] [12].

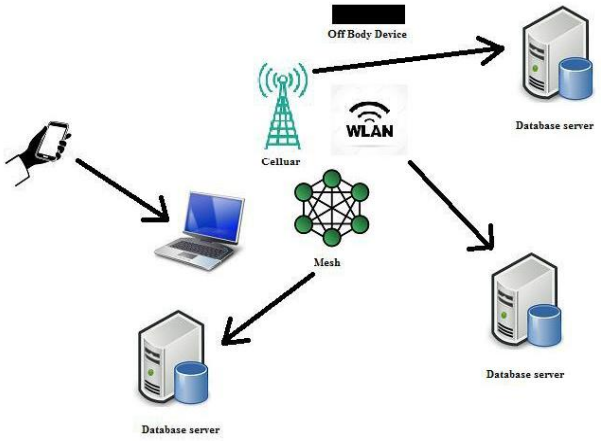


Fig. 2: Infrastructure Based Inter-WBAN Communication.

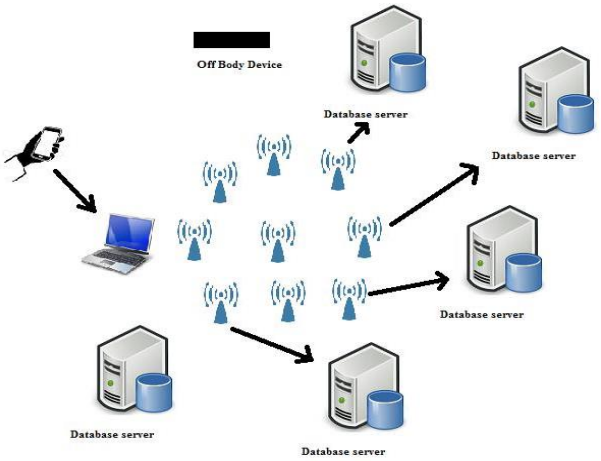


Fig. 3: Ad-Hoc Based Inter-WBAN Communication.

3. The traditional WSN and WBAN comparison

The wireless BAN is treated as a special type of WSN, with its own premises. However to build both WBAN, WSN networks shows the similarities, but the way of tackling WBAN nodes are

differed with the WSN, going through that the deployment of WBAN nodes are restricted to limited area with limited number, whereas WSN are able to deploy its nodes up to several kilometers for environment monitoring, this seems that there is a lot of difference between WBAN and WSN even though both shows similarities in terms of the nodes [1] [2] [14] [18].The table.

Table 1: Comparison of WSN & WBAN

Parameters	WSN	WBAN
1. Bandwidth	More	Limited bandwidth
2.Cost	Costlier than WBAN	Cheaper
3.Accuracy	Compensated by redundancy	All the nodes must send accurate data
4.Failure	Nodes often disposable	Difficult in replacement of implanted nodes
5.Nodes replacement	Easy	Difficult
6.Mobility	Nodes are stationary	Can move as the wearer moves
7.Size	Small in size preferred but it is not an obligation	Small size is mandatory
8. Security	Is not an important concern	Most crucial, otherwise its leads to medical malpractice
9.Energy scavenging power	Solar and wind power	Body motion or body heat
10.Nodes biocompatibility	No need to be consider	Mandatory especially for implants
11. Privacy	Not required	Must required as it is sensitive issue
12. Network topology	Already in existence	Little research taken place for the optimal network architecture
13. Network latency	More	Very less

4. Short range wireless RADIO technologies of WBAN

There are so many wireless RADIO technologies were developed for short range wireless communication, where some of them are discussed well below as follows:

4.1. IEEE 802.15.4 and ZigBee

Both IEEE 802.15.4 and ZigBee radio technologies are widely used in WBAN applications. The IEEE 802.15.4 standard provides the physical (PHY) and medium access control (MAC) layer protocols for low data rate and medium range wireless communication. With the little difference to the IEEE802.15.4, the ZigBee standard provides additional layer protocols, namely-network layer and application layer (where security is a prime concern to both). Therefore in ZigBee protocol with respect to the security concerns authentication processes and key exchange mechanisms and its supplementary are defined in the network layer. The ZigBee network is shown well in fig. 4.The preferred encryption algorithm to enhance the security system in ZigBee is advance encryption standard (AES), which is having 128-bit key length. Including that other features of ZigBee are data integrity (provided by message integrity code (MIC)), long battery life, etc.
The recent development in ZigBee is Personal Health and Hospital Care (PHHC), and this was aimed to provide reliable, secure moni-toring of non-invasive, non-critical healthcare applications-like physical fitness, chronic disease and aging. Addition to that this PHHC ZigBee advancement is also able to supports ISO/IEEE 11073 standard in order to exchange the medical information. The network topology of ZigBee is comprised with coordinator router and end device in order to do continuous /remote monitoring,
Where the coordinator & router are always in active state only, the mesh topology of ZigBee is simple & easy to deploy in any field [1] [3] [4] [5] [19] [22].

4.2. Bluetooth

Bluetooth is one of the simple radio technology designed for short range wireless communication depicted in fig. 5 the Bluetooth network comprised with two piconet (formed with two or more(up to eight)Bluetooth devices) and these are used to form a scatter net, In each piconet one is master & remaining are behaves as slaves, The basic features of Bluetooth are low cost, low power consumption, small in size, Bluetooth devices are operate in license-free environment with 2.4GHz ISM band frequency, By using frequency hopping spread spectrum technique the data is exchanged in terms of piconet between the Bluetooth devices with a nominal rate of 1600 hops/sec in order to reduce interference The various security protocols are provided by the Bluetooth namely- base-band, link manager protocols & logical link control and adaption (L2CAP),. The major task of security is encryption and authentication, by all these security concerns the Bluetooth enhances the quality of service [4] and make to be useful in different applications such as a provider for wireless communication between mo-bile phone & hands free headset, live video streaming to the visual cortical implant device by noble Fattah in new castle university 2017, short-range transmission of health sensor data from medical device to mobile phase, used as tele-health device. [1] [2] [23].

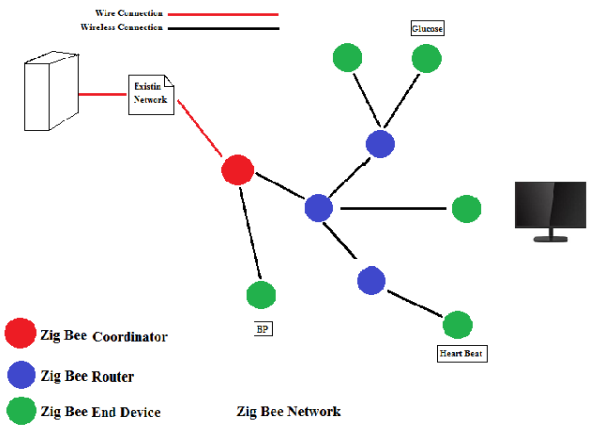


Fig. 4: ZigBee Network.

4.3. Wi-Fi

Wi-Fi is a booming technology in wireless local area networks and this Wi-Fi is based on the IEEE 802.11 standard, using 2.4GHz (12cm) UHF & 4.5GHz (5cm) SHF ISM radio bands. The fig. 6 depicts the Wi-Fi network, where users can transfer large amount of data with high speed wireless connectivity. The important feature of this Wi-Fi is by using the smart phones, tablets, laptops, users can happy to make their conversations like internet video streaming, video conference, voice calls, this feature not only helps for general conversation, it is best suited for medical supervision on live streaming , which helps easy diagnosis easy it is best suited for medical supervision on live streaming , which helps easy diagnosis, easy prevention methods in health related issues, fast recovery in the E-health, etc., are being taking place in case of emergency [1] [5] [24].

4.4. IEEE 802.15.6 WBAN

One of the latest international standards that were added in WPAN is IEEE 802.15.6 and is technically called as WBAN. The main aim of this was to provide reliable wireless communications to inside & outside (not only limited to humans) of the human body and to enhance the E-health care service some of the extra features are added, these are pointed as: a) extremely low power operation b) low data rate up to 10Mbps, without any interference c) portability in antenna design (varying with male /female skin) d) ensuring security & privacy to the health information e) long term con-

tinuous monitoring to provide health assistive of a chronic condition f) able to monitor all important health parameters [4] [5] [9] [10] [12].

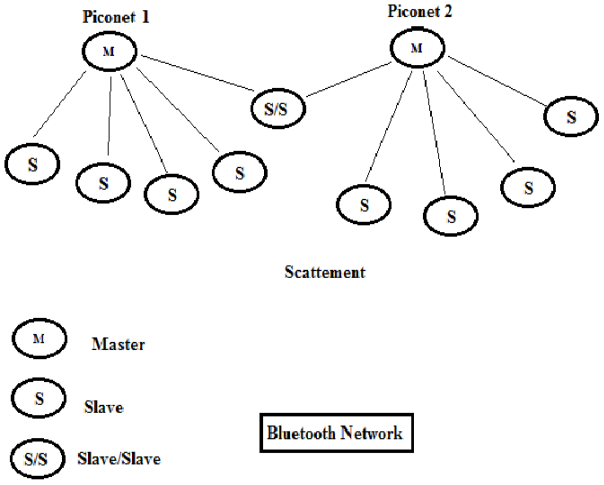


Fig. 5: Bluetooth Network.

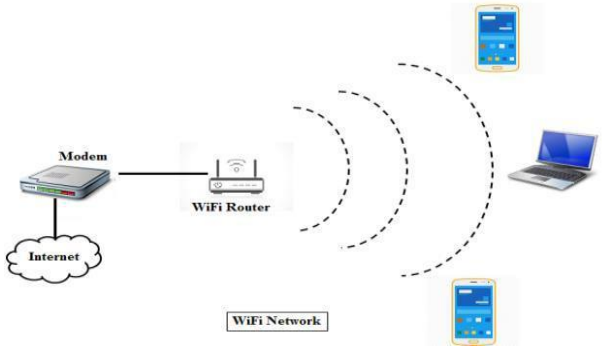


Fig. 6: Wi-Fi Network.

5. Application of WBAN in health-care

WBAN application can be categorized as medical applications, non-medical applications and these are discussed in simple methods in the following tables(table 2 and table 3) [1] Including the above Wireless BANs are sophisticatedly applicable to monitor the health information of the children in terms of their emotional, behavioral or mental health conditions in order to encourage the children to acquire good nutritional habits with the help of parents or teachers, to reduce the adverse drug reaction of a person who is effected by taking single or more drugs with the help of pharmaceutical intelligence and continuous monitoring the health record by sensors, able to work like virtual hospital for the community healthcare [6], etc.

5.1. Medical applications

Table 2: Medical Applications

1.Remote health care monitoring	2. Assisted Living	3. Tele medicine
Health data is collected by different sensors and information is stored, provides remote monitoring and controlling the health status effectively in emergency situations [12].	Simply it gives medical assistance at home instead of staying at hospital, so medical expenditure turns to reduced [11].	It is used for E-prescription to the patient by using the mobile [8][13].

5.2. Non-Medical Applications

Table 3: Non- Medical Applications

1.Sports	2.Military	3.Lifestyle, Entertainment
With the wearable device-physical parameters like heart rate, respiration rate, temperature, BP, the posture of the athlete, and their navigation, distance can be easily measured.	Including to the physical parameters of the body, it is used to provide communication between soldiers, etc.	Navigations support is provided when the person is walking that to used in health parameters monitoring, Used for making video call, audio & video system entertainment is possible with portable devices.

6. Conclusion

In this survey we discussed the architecture of WBAN, a deep comparison of WSN and WBAN, also discussed wireless short range technologies and in short the application of WBAN in medical and non-medical sectors. This survey projects that WBAN was responsible for a revolution in the E-health care era to take care about the people (the ennobled WBAN is not only restricted people it can also supports other living organisms), but its design is a challenging task to provide security and privacy to the patients who need secrecy. In the next step we are addressing the security and privacy issues in WBAN technology.

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