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## A Survey Paper on Body Area Network in Healthcare System

### Abstract

Body Area Network (BAN) is widely used in medical healthcare systems. Under WSN (Wireless Sensor Network) technology many applications are developed in Body Area Network (BAN). In medical applications the sensor network is widely used now days. Applications like Healthcare Monitoring System, Smart Hospitality, and Continuous patient monitoring system are under Body Area Network (BAN) technology. Sensors are attached on the body of patient by which values are to be taken, analyzed for healthcare system. WBAN offers wide variety for evaluation of healthcare in medical systems. Various sensors can be connected to the on clothing or on-body and also implanted under skin. There sensors are used to calculate the parameters from the body of patient. And the values are taken from sensors is given to the analyzing device or hardware by the wired or wireless devices such as Bluetooth, Zigbee etc. BAN gives wide availability of healthcare devices all the time. Projects are done in Body Area Network (BAN) from 1976. A wearable computer, sensor network based medical monitoring system, European Mobihealth etc. are some of the examples of project in WBAN. Wireless Body area network is now often used in Mobile Health Application and it is emerging technology which gives facilities for human health applications.

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**Keywords:** *Body Area Network (BAN), Wireless Sensor Network (WSN), Mobile Health Application, Smart Hospitality, Wireless Body Area Network (WBAN), Body Sensor Network(BSN), Electrocardiogram(ECG).*

## 1. INTRODUCTION

BAN is also called as BSN. BSN is becoming very important aspect in the human's life. As the technologies based on BSN are increasing day by day. These technologies are used in mainly healthcare system. In medical healthcare system it is used as patient monitoring system. For medical monitoring system it requires some kind of hardware resources, sensors etc. also the network will be formed of sensors and hardware for solving the problems in healthcare system. BAN is built from sensor, battery and processor.

Various IEEE standards are available for BAN. IEEE 802.15.6 standard is for BAN [1]. Various advantages are taken for other wireless communication standards from IEEE 802.16 Group 6 [2]. IEEE 802.15 standard for short range, low complexity, low cost and also very low power consumption. Three aspects are presented by IEEE 802.15.6 standard which are physical layer(PHY), medium access layer(MAC), and security aspects.

BAN is used for sensing the values from the body of patient. The sensors are attached on the body of patient. Those can be ECG sensor, motion sensor, heart rate sensor, pressure sensor, positioning sensor etc. To make the connection between the sensors and hardware device the wireless sensors are used.

The wireless technologies are the next step for improving the mobile health applications. Mobile health is also referred as mHealth and electronics health is referred as eHealth. A Wireless Body Area Network contains small and intelligent systems or devices attached to the body of the patient which is to be continuously monitored by the mobile health application over a wireless communication device which can be Zigbee or Bluetooth.

WBAN gives the continuous data and monitoring and real time graphs and feedback to the user, patient or to the doctor allocated for that patient. Next the values taken are used for analyzing purpose. The analyzed values are used to check that any kind of disease will occur. The data is recorded for the long period of time.

## **2. BODY AREA NETWORK (BAN)**

Body Area Network now also called as IEEE 802.15.6. In May 2010 research group released the first draft and in April 2011 latest draft of new standard which is third version was released. BAN is actually a network which contains sensors nodes in close proximity on a person's body, which monitors continuously vital signal of the human body and even more intelligent node is capable to handle advanced signal processing.

A Body Area Network is also defined as a standard for short range and wireless communication in the vicinity of a human body which provides real time monitoring.

Body Area Network now-a-days not only used in medical application but also for nonmedical field. BAN is used in Healthcare sensor network applications, Assistance to people with disabilities and in entertainment.

BAN is used in healthcare network for continuously monitoring of the patient in where various sensors are attached to the patient's body. Values are taken by various sensors and then analyzed. It is very easy for patient to make physical movement.

In entertainment applications such as 3D games, video streaming, 3D video are also applications where movement of body is great concern.

For the people having physical disabilities BAN or BSN is very useful. For the disabilities many inventions are made such as artificial hands, muscle tension monitoring, and speech disability and even some inventions are made for blind people.

There was a project named Code Blue Project by Astang Coupe in 1967. The wearable computer is made which was attached to the patient's wrist. In this off-the-shelf wireless sensors are used to design a prototype such as Tmote sky platform. It form an ad hoc network with portable tablet PC. Sensors used in this project are wireless two-lead ECG, a wireless pulse oximeter sensor & a wireless electromyogram[6].

In 2008 a project is made by V. Annamalai & S.Gupta named as Project Ayushman. It is a real time project which is sensor network based medical monitoring system which collect and analyze health information. In this project a wireless ECG, gait monitoring & environment monitoring was developed by using off-the-shelf components with a Mica2 wireless

transceiver. ATMEGA 128L microcontroller is used. Chipcon 868/916 MHz transceiver is used It has 4 KB RAM program and data memory & also 128 KB flash external memory[6].

The project European Mobihealth by Katarzyna Wac in 2009 which works as WBAN. It provides a complete end-to-end mHealth platform for patient monitoring. For this UMTS & GPRS networks are used. Blood pressure, heart rate and electrocardiogram sensors are used. Communication between sensors & the device is through Bluetooth or ZigBee. But it has some major issues; they are security and reliability of communication resource [6].

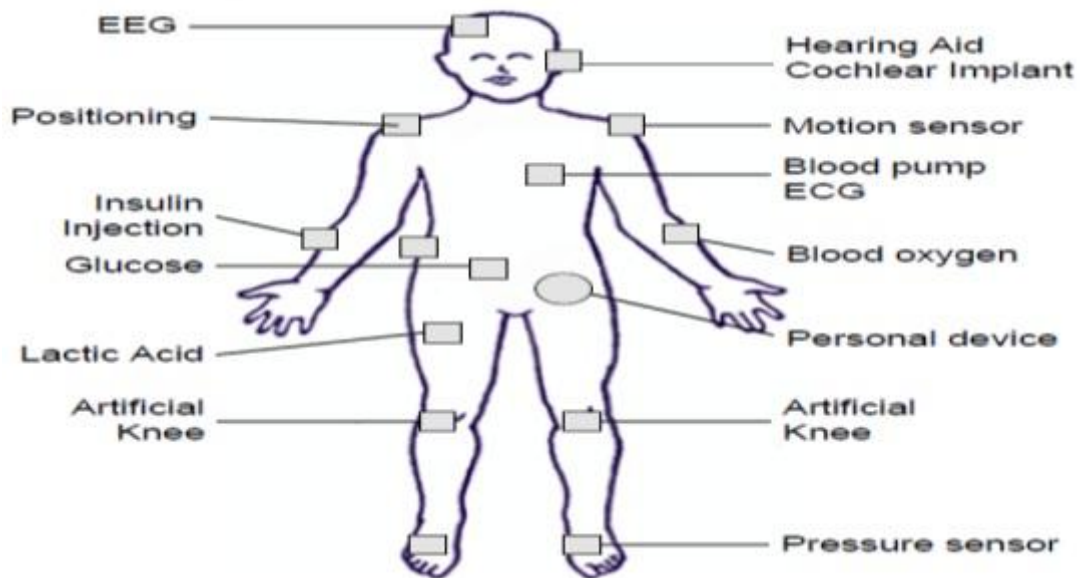


Fig.1. Example of patient monitoring in Wireless Body Area

### 2.1 Network requirements:

Requirement specification for BAN depends on range, interference, network density, sensors per network, quick time of transmission, in body environment, security or encryption, Quality of services and reliability, enabling priority, support for different data rates, compatibility with other PANs [3].

Range for sensing depends on devices used in BSN. For Bluetooth it is up to 10 meters, for ZigBee device it is 100 meters etc. Network density of BAN is 2-4 networks per meter square. Sensors used per network are 256 devices per network as per BAN standardization group.

### 2.2 Hardware Requirements:

Hardware requirements specification depends on applications of the sensor network. Those are ultra-low power consumption, suitable sensors, lifetime of sensors, low cost, low complexity [3].

By using ultra low power consumption battery backup is improved so there is no need of changing batteries. Suitable sensors should be used for purpose of mobility and monitoring should be possibly transparent. Sensors or hardware to be used should be of low cost as the purpose is to provide a technology to the people to get cheaper rate monitoring and also includes low complexity of hardware for the people who do not like technology because they think it is difficult to use.

Body areas sensors are composed by 1.Sensor/actor which is used for measuring the necessary parameters from body. 2. Battery which is used to provide energy to sensors. 3. Processor which is used for analysis of data and system management. 4. Antenna which is used for formatting and sending radio frequency signal.

Body sensors used in BAN are in-body sensors which are implanted under skin which allows system to measure temperature, glucose etc. and on-body sensors are integrated onto the cloths to measure ECG, heart rate etc.

### **3. WIRELESS BODY AREA NETWORK (WBAN)**

Wireless body area network is also part of BAN or Wireless Body Sensor Network (WBSN).It is composed of one or more Body Sensor Units (BSU), one Body Central Unit (BCU) and work with long range network such as ZigBee or Bluetooth etc. [3].

By using new technologies in electronics the small sized and intelligent sensors are used in the biomedical system to improve the performance of the health care system. The sensors are connected to the small sized hardware and the data from the sensors is used to transfer. Also the data is sent to the medical server and it is analyzed over there and stored. Wired connection used for this purpose is time consuming and even much complex. Also it includes more deployment cost and maintenance cost.

Wireless connection used in the WBAN applications is easier and cost efficient. The patient can move anywhere and there is no need to be present in hospital or no need to stay under observation. By using such systems can improve the medical health care and minimizes the cost.

In general, the devices used are of two types such as actuators and sensors. Sensors are used to measure the parameters of the patient’s body such as body temperature, heart rate etc. To make the connection between the sensors and hardware device the wireless devices are used.

The first prototype of Wireless Body Area Network (WBAN) is already started developing by several research groups and commercial vendors. Here we will discuss about the non-exhaustive overview of projects for WBANs as WBAN have unique architecture.

ZigBee and Bluetooth which are networking devices which are mostly used in WBANs as they have low power and simple topology operations.

IEEE 802.15.6 is a very new standard for WBAN, as such there was various wireless communication standards existing up till now.

IEEE 802.11 (WLAN), IEEE 802.15(WPAN), including IEEE 802.15.1(Bluetooth), IEEE 802.15.4(ZigBee) are some commonly used standards. But besides all some existing standards new standards for Body Area Network are required to be established.

	Other IEEE 802.15 Standards	IEEE 802.15.6 Body Area Network
Configuration	15.3,15.4 MAC	MAC with reliable delivery and single scalable.
Power Consumption	Low power consumption	Very low power consumption while communication
Requirements (QoS)	Low Latency	Reliable response and guaranteed to external stimuli.
Frequency Band	ISM	Medical authorized approved bands

Fig 2: IEEE 802.15.6 and IEEE 802.15 comparison [3].

Even ZigBee devices have much lesser joining time for network though it has various advantages but when compares with the requirements of the Body Area Network incompetence is found. Following is the comparison table.

	IEEE 802.15.4	IEEE 802.15.6
Range	10-100m	2-5m

Data Rate	20,40,250 kbps	Kbps-10kbps
Power Consumption	25-35mW	0.01mW

Fig 3: IEEE 802.15.4 and IEEE 802.15.6 comparison [3].

#### 4. HEALTH MONITORING SYSTEM

Population in countries is increasing and the costs for hospitals are also increasing day by day. Even the technology is increasing for health care systems. There are examples of development in the technology as AID-N system which is used for continuous monitoring of the patient [6].

A review presents recent advances in Micro-Electro-Mechanical Systems [MEMS] for WBAN in Medical Applications. WBANs provide unremarkable ambulatory health monitoring for a long period of time and provide real time updates of the patient's status [9].

Monitoring of vital physiological signal now has been proven to be one of the most efficient ways for continuous monitoring of health status of patient. If we take example of Heart Monitoring system, in many medical services centers and hospitals ECG monitors are available to monitor and diagnose person's heart status by measuring their cardiac activity. ECG will monitor and measure the rate and regularity of heartbeats, position of the chambers and investigate the damage and effect of drugs.

#### 5. HEART MONITORING SYSTEM

Monitoring of heart is very essential need of today's life and inventions are to made for it. According to survey it is analyzed that in 2015 almost 20 million people will be die, due to CVD(cardio vascular diseases) that's why ICT research are searching for a system which will reduce the rate of heart failure of people. The death by CVD can be prevented by using new technologies.

In regular life of person there is no such machine which can predict heart attack at any circumstance. Those are available at hospitals only and it is not possible to be present in the hospital for regular so that there is need for Heart Monitoring System which is wireless as well as portable.

#### 6. CONCLUSION

In this survey current research is reviewed on Wireless Body Area Network in Healthcare system. WBAN is being very useful technology with many benefits for medical applications, patients and society by continuous monitoring and early detection of diseases. By using WBAN medical healthcare system will improve their performance and will be useful for reducing death rate. WBAN provide Quality of Service, low power consumption, continuous health monitoring and mobility.

By using key points of survey on BAN in healthcare system we propose a system Android Based Heart Monitoring and Reporting System. In proposed system we are working on heart rate and body temperature parameters by using key features of WBAN. In which values are taken from sensors which are sent on android mobile phone and after analyzing those values heart attack predicted. So that mobility is obtained and telemedicine system is also implemented.

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