

BODY AREA NETWORK

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by

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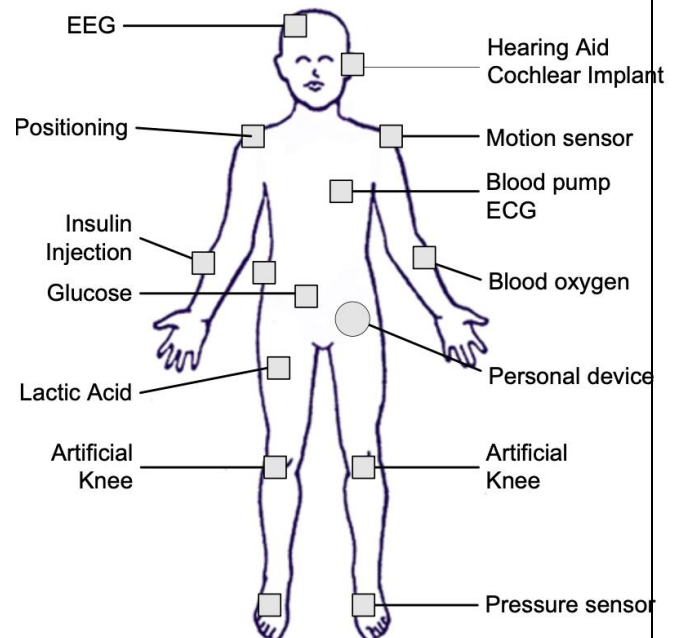
1. Abstract

The blooming industry of electronic and miniaturisation of electronics, electrical equipment and new communication lead to the development of Body Area Networks(BAN).BAN are also referred as Wireless Body Area Network(WBAN)as they have more application in BAN.They are used to increase the life quality of human being's by monitoring the patient's in and out of hospitals, the activities of athletes, military applications.WBANs consist of micro or nano sensors capable of measuring, processing, sending the signals.In this report we will be discussing about BAN, its applications, its architecture have been discussed and finally some of important challenges and some possible solutions are discussed.

2. Introduction

The rapid growth of electronics in the medical industry like physiological sensors, made the first step towards the E-health, in which the patient's are continuous

monitor under the doctor without going to the hospital in low cost. this step and the electronics of low power, less cost, wireless communication enabled the Body Area Network technology. **Body Area Networks (BANs)** are a type of network comprising tiny sensors placed either inside or around a person's body. These sensors are used to monitor various physiological activities, such as ECG, heart rate, and the amount of calories burned, etc... these body area networks use the sensors and collect the data and send it to the specialist through various types of communication. these devices monitor the assigned part or signals like ECG, accelerometer sends the signals to analyse and give the report. There are basically two types of body area networks depending on the placement. first one is wearable body sensors like smart watches to measure the BP and SPO2. the other are implantable one example pacemaker, body position sensor etc.. these detected signals are analysed and were given the possible further problems and solutions. Also, these are used when there is an Emergency situation also by, sending a distress signal to the hospital. [1]



3.Application

WBAN has ample numbers of effective applications. Broadly these applications can be characterised into two categories. They are medical and non-medical applications.

3.1Medical application

WBAN has dominated medical industry in applications. WBAN technology increases the effectiveness of doctor-patient interactions by enabling remote patient monitoring, rapid health status updates, alerting, and emergency calling etc...

Examples: temperature, heart rate, blood pressure, ECG signal for monitoring heart activity, movement sensor to monitor patient movement etc..

3.2Non-Medical Applications

3.2.1Sports

WBAN in sport industry monitor activities like heart rate, temperature, respiration rate, blood pressure, activity, and posture of any athlete in sports. timer, distance can be also measured by using WBAN sensors.

3.2.2 Military

In a battlefield WBANs can be used to communicate between soldiers and send their activities like attacking, running and retreating. WBAN sensors are also helpful to monitor health condition, location, and temperature and hydration level of soldiers in the battlefield. Those sensors like camera, GPS, monitoring sensors. So this WBAN can provide more accuracy, survivability and connectivity.

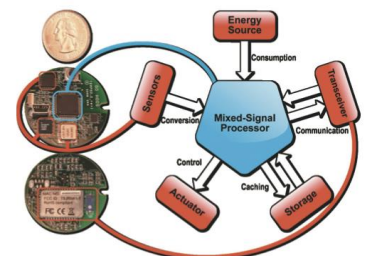
4. Architecture of BAN

The Architecture or main working of BAN is divided into four parts

- 1) sensor nodes
- 2) CCU
- 3) WBAN communication
- 4) control center



1) sensor nodes basically reads the analog signals and transmits then to CCU. these sensor nodes generally consists of 5 different parts sensors, a mixed-signal processor, storage, a transceiver unit, an energy source, and an actuator unit. sensors capture the analog data from the environment. they produce a measurable response to a change in a physical condition like temperature or pressure. these responses are sent to mixed signal processor/micro controller. this controller basically processes the data, also controls the functionality of other components. Transceiver has both properties of transmitter and receiver, it uses different communication frequency to communicate with CCU and other sensor nodes. storage stores the data if there is a delay in communication. energy source gives the power to run all these functions. actuator is not present in all BANs but it is an action to the response received in the Transceiver.



2) sensor nodes will directly connected with a coordination node known as Central Control Unit (CCU). CCU takes the responsibility to collect information from the sensor nodes and to deliver to the next section. these sensor nodes are connected to the CCU in different topologies like star topology, tree topology, mesh topology etc... There is no fixed technology for this transfer of data mostly used technologies are ZIGBEE, BLUETOOTH, WIFI, etc...

Lets get more detailed into the working of these technologies

ZIGBEE

ZigBee is an IEEE 802.15.4 standardised solution for wireless telecommunications designed for sensors and controls. one the most important advantage of this network is low power consumption. a general Zigbee network consist of three major parts coordinator, router, end-device. In our case there are no router and end device is the sensor nodes. Zigbee generally operate in frequency bands like 868MHz, 915MHz, and 2.4GHz. but the main disadvantage is that it operates at low data rates. another disadvantage is that it interfere with WLAN transmission as it operates at 2.4GHz. But is best for health monitoring and have a range upto 50-70 meters.

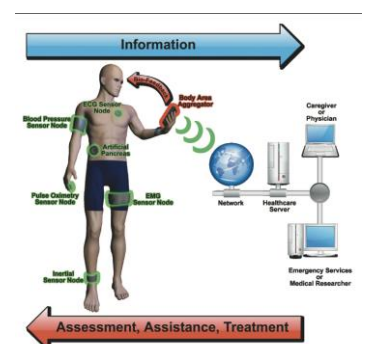
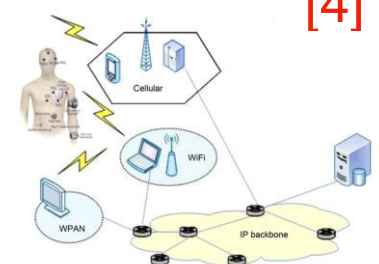
BLUETOOTH

Bluetooth is an IEEE 802.15.1 standard commonly known as WPAN (Wireless Personal Area Network). Bluetooth has both security and low power capability (but more than that of Zigbee). A general bluetooth form a piconet and one acts and master and all other acts as slaves, which makes them to communicate simultaneously. the range also can be increased by forming scatternet by coming two or more Piconet. In general this bluetooth operate in 791MHz frequency at a nominal rate of 1600 hops/sec. This bluetooth has a range of upto 100meters.

There are also other networks we can see the comparison table

3) this where the combination happen between the CCU to final destination (PC, Servers etc..) this communication happens through satellite or mobile towers or by using internet (ethernet) and also several other like GSM/3G/4G.

4) this is there all the data is collected and analysed to give a total report and the place where to respond in case of emergencies.



5.Challenges

The major challenges faced in this network is battery, communication, security.

[5]

5.1.Battery

Mostly all the BANs are wireless. they need battery backup to run, wearable one can easily be recharged but the implantable ones cannot be recharged easily as operate and replace the device costs too much and there is a high risk of damage of tissues on operating again and again. Also there is a trade off between accuracy and battery life. As more accurate the data is there is more need of energy. depending upon the need of accuracy we have adjust.

One of the way to conserve more energy is using low power transmission communication to save more energy. Other way is using a period data transmission and avoid continuous transmission of data. another significant but a temporary solution is energy harvesting using physical or kinetic motion to convert to energy within the body like vibration, solar, kinetic energy, heat etc.. but this solution is not so effective as the amount recharged is very less compared to the discharging.

5.2.Communication

Main Factors that affect the communication in the BAN are Temperature, Mobility..

5.2.1.Temperature

If temperature becomes too high there is problem in communication. two main factors for tissue's overheating, i.e. Radiations produced due to antenna and circuit of the node implanted. equation for rise in temperature is given by

$$\rho C_p (dT/dt) = K \nabla^2 T - b(T - T_b) + \rho SAR + P_c$$

C_p -tissue specific heat

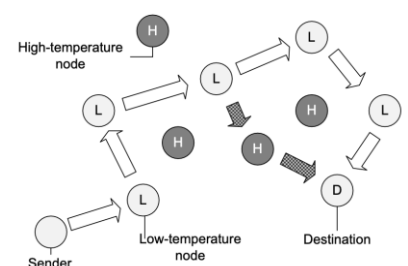
dT/dt - rate of temperature rise

$K \nabla^2 T$ -temperature rise due to thermal conductivity

$b(T - T_b)$ -heat due to blood perfusion

ρSAR -antenna radiation absorption

P_c -the heat caused by the node circuit



[6]

One of the method to solve this problem is thermal-aware routing protocol in this in this the nodes are given priority according to the temperature of the nodes and the signal is transmitted to the other nodes with based on priority to communicate.the disadvantage of this method is high delay of signals, high energy consumption.this problem was some what solved by using cluster routing in which some of the sender nodes are divided into clusters and have a head node and function same as the thermal aware routing but have a less energy problem and less delay.

5.2.2Mobility

The communications gets affected by the movement in the body like running waking, even bending affects the communication.for example a sensor cannot transmit the signals due to some activity ,in normal case these will store the data upto limit and might loss also and trying to communicate with the CCU costs the battery power. Solution to this is posture based routing, many experiments have proved that human body movements have some regularity.on the bases of this pre expecting the posture the necessary devices communicates or stores the data making it more reliable.

5.3.Security

As we are not physically connected to the servers we are using different frequency levels of communication these are visible to attacker. A report from Healthcare IT news in February, 2014, hackers accessed a server from a Texas healthcare system, compromising the protected health information of some 405,000 individuals.These communication is needed to be secured.these security requirements are divided mainly into two parts security requirements in internal communication and security requirement in extra communication.

1)security requirements in Internal communication

- Data authenticity-there is a system need to check whether data is coming from the claimed source only. Solution is by using public key cryptography.
- Data confidentiality-information disclosure to unknown entities. Solution is by using encryption.
- Data availability-the data produced should reach the servers, as Denial of service attack is favourite for hackers(in this the hackers attack the site) makes it inactive.this can be prevented by constant checking.

2)security requirements in external communication

- Increasing app security to prevent Hacking into self monitoring device.
- Making more firewalls to protect the data in the severs and cloud.

- Most these can be avoided by making a check of authenticity of the user every time when he access the data.

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