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Survey on WBAN Methodology and its Challenges

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Abstract: It has been observed from the last decade that IoT has gained the market. The main enablers of IoT technology being the wireless communication, cloud computing and embedded system has gained attraction in many different areas. The major sector for IoT applications had been military sector, aerospace industry, manufacturing sector, home and automation and not at a neglected one that is the healthcare. Healthcare sector is the place where major requirement of IoT is there. Wireless Body Sensor Network (WBSN) innovations are viewed as one of pulling in look into regions in software engineering. At the point when joined with the medicinal services application, it gives high worth innovation of exhaustive medicinal services checking arrangement in extraordinary circumstances including high height or hazardous situation empowering the ground controller to screen remote pilots or seismic tremor unfortunate casualties progressively by a mix of remote sensors and sensor systems. In previous decades, cell phones have steadily become irreplaceable electronic items in individuals' day by day life. A cell phone has an assortment of implicit sensors, for example, Wi-Fi, GPS, amplifier, magnetometer, and inertial sensors. This paper focuses on WBAN methodology and its challenges. The 3 layer WBAN schematic tells about the WBAN to be thought for in three different sections viz. intra BAN, extra BAN and storage and analysis.

Keywords: Body sensor node, IoT, WBAN, WBSN.

I. Introduction

The chronic diseases like blood pressure, allergies, seizures, epilepsy, diabetes etc. requires continues body monitoring. WBAN is like a boon for such diseases. A WBAN system nowadays mostly focuses on sensor-based series of applications sensing various body vital parameters like heart rate, body temperature, blood pressure etc. [1]. WBSN once paired with a healthcare application, it provides high-quality software for comprehensive healthcare monitoring systems in extreme situations, including high altitude or disaster areas, allowing the ground controller to track remote pilots or earthquake victims in real-time.

The progress in network technology and hardware in conjunction with the Internet-of-Things (IoT) has provided the comfort ability for an easier human life at present. Apart from the so-called "smart" environments, including smart homes, smart city, smart agriculture, IoT have been included recently in e-healthcare systems as well for real-time diagnosis and medical consultancy. Communication and sensing devices, as well as their respective software, have become versatile for Information Technology (IT) solutions in different contexts.

Various methods are proposed for WBAN in the form of wearable technology like clothing, bracelets, glasses, rings etc. [2] [3] [4] [5] [6] [7]. A human body phantom has been proposed where wearable clothing is made out of plexiglass. Here tap water having permittivity and conductivity is used for sensing body [8].

A glass frame antenna is proposed in this article. The dielectric permittivity of different body structure items is mentioned which shows skin and muscle have good dielectric permittivity. The antenna is structured so as to access the body values using skin and muscles [9].

Different wearable sensors to find the performance of athlete have been proposed. Wearable technology companies with their product details and sensors used for categories like Position and motion of the athlete, Impact monitoring, Heart rate and muscle oxygen saturation, Monitoring sleep [10] [11].

Thus WBAN is gaining attention for many new medical sectors. Various methods are applicable for implementation of an application. But the main schema of WBAN remains to be the same. Though the architecture may vary from various literatures but the main application of WBAN is same.

II. WBAN Methodology

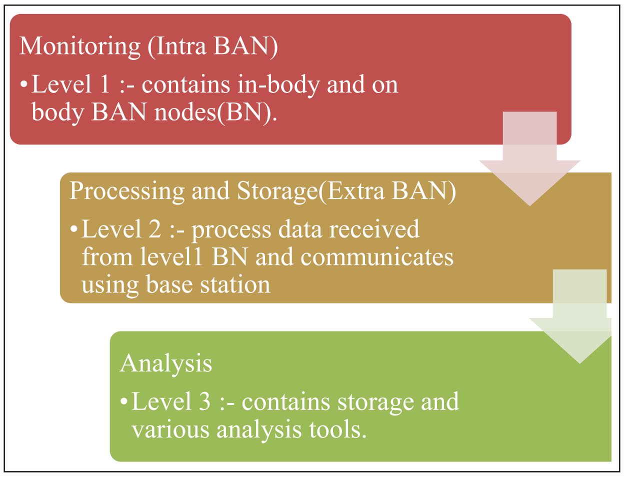

Fig. 1: WBAN Methodology Layered Schematic

The above figure (Fig. 1) shows a layered schematic of WBAN, where the WBAN implementation can be thought for in 3 different steps intra BAN, extra BAN and storage and analysis. Level 1 - Intra BAN, Level 2 - Extra BAN and Level 3 - Storage and Analysis. The details of Level 1, Level 2 and Level 3 are given below.

A. Level 1

This level deals with only on body and in body sensing and communication between body nodes. The main components of it are sensors and intra body networks.

i. Sensors

WBANs are a variation of Wireless Sensor Networks (WSNs) which comprise of a couple of small sensors embedded inside the body or situated on the body to ordinarily watch physiological signs radiating from various body organs, body movements just as the general condition. A WBAN comprises of differently scaled-down, brilliant and self-controlled sensor gadgets that can be joined, or even embedded into, people to screen their physiological boundaries e.g., temperature sensors, heartbeat rate, and so on, body movement e.g., act, direction, area, and so forth, just as their general condition e.g., poisonous gases, stickiness, heat etc. Sensors can be placed on either knee (legs), wrist, arm, chest or head. These are the most common body locations mostly used for sensor location. The sensor can be accompanied, wearable or implanted. The wearable sensors are more popular as they need not be carried and taken care of. They can be worn and thus easy for use. The accompanied sensor devices need to carried explicitly wherever we go, so less preferred as compared to wearable. Here the user has to be always alert for the device being carried with him/her. While the implanted category deals with sensors which are embodied. The sensor is fitted into human body to have continuous check for eg. Knee lubricant sensing unit. Here there is a risk of sensor compatibility with body. As it is foreign body for human body these categories of sensors are less preferred. The below given figure (Fig. 2) shows the division of sensor category as per the applicability.

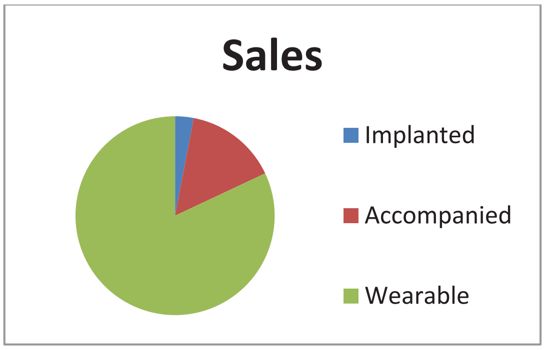

Fig. 2: Sensor Category Wise Division

The Fig. 2 shows the percentage division of sensor devices for WBAN. The wearable is the most preferred category as human becomes hands-free and easy to operate. The accompanied is sometimes preferred especially when continuous monitoring is not required. While the least preferred category is the implanted where the sensor unit is to be inserted or fitted to a body part.

The commonly available sensors for WBAN are temperature, heart rate, pulse, blood pressure, oxygen etc. [12].

ii. Intra Body Network

All the checked boundaries are then sent remotely, utilizing short-go on-body or Intra-WBAN interchanges, from the on/in-body sensors to the WBAN's organizer for additional information handling and investigation. If we talk about the intra body network short-range technologies such Zigbee, Wifi and Bluetooth are preferred as they easily satisfy the intra BAN requirement. Low power consumption and security feature make them more popular [13] [14]. The comparative study of these short range technologies is given in Table I [15].

Table I: Comparison of Zigbee, Wifi and Bluetooth Intra BAN Communication Technologies [15]

Parameters Considered\ Technology used	Zigbee	Wifi	Bluetooth
Range	10-100 mtrs	50-100 mtrs	10-100 mtrs
Operating Frequency	2.4 GHz	2.4 GHz and 5 GHz	2.4 GHz
Power Consumption	Low	High	Medium
Maximum Number of Nodes	>65000	2007	8
Security	128 bit encryption	128 bit encryption	128 bit encryption

B. Level 2

The level 2 of WBAN deals with long-distance communication where the intra body readings are transferred to the desired remote location like cloud or server. If we talk about extra BAN then long-distance technologies like 3G, 4G and 5G are more prominently considered nowadays. The comparative chart is given below in Table II.

Table II: Comparison of 3G, 4G and 5G Extra BAN Communication Technologies [16]

Features	3G	4G	5G
Standard	WCDMA, CDMA2000	OFDMA, MC-CDMA	CDMA, BDMA
Network Architecture	IP and broadband CDMA	Combined IP and broadband like LAN, WAN, WLAN, PAN	Combined IP and broadband like LAN, WAN, WLAN, PAN and WWWW
Data Rate	2 Mbps	2 Mbps to 1 Gbps	1 Gbps and more
Frequency	1.8 to 2.5 GHz	2 to 8 GHz	3 to 300 GHz
Internet Service	Broadband	Ultra-Broadband	Wireless World Wide Web
Bandwidth	25 MHz	100 MHz	30 GHz to 300 GHz

C. Level 3

Once the body nodes sense-data through intra BAN and transfer it through extra BAN, now the main concern is to store the data captured. Level 3 deals with this aspect of WBAN.

The data received can be either stored to a server or cloud. The main step here is the data analytics part which deals with data aggregation and extracting the required information in stipulated time. Once the data is stored various analysis tools like Machine Learning and Deep Learning are gaining importance nowadays [17]. Deep learning is used for various health predictions in advance to the situation becoming worst. Predictive analysis is thus one of the important steps where chronic disease patients can get immediate attention. Various algorithms like Naive Bayes, Support Vector Machine, Decision Tree, K-Nearest Neighbour etc. can be used here. There are several sources of such sensor data flowing into the medical information systems such as contextual sensors, wearable, physiological sensors, and human sensors. The tools and techniques for diagnosing the diseases through the data mining of sensor data can be classified into broader categories such as data collection, preprocessing of the data by separating the noises from the signals, data transformation through ETL, and data modeling by applying association rules, knowledge discovery algorithms, classification models, clustering methods, regression models, and final summarization of the KPIs obtained through the data mining by executing the results on the dashboards with business intelligence can aid physicians to diagnose the illnesses and vital signs [18] [19].

III. Challenges for WBAN

Looking at various aspects of WBAN there are many challenges for WBAN which need to be handled separately [20]. The few challenges listing can be

A. Data Security

Data Security is one of the main challenges because if cryptography algorithm is to be applied at intra BAN level then power consumption is the main issue. The wearable sensor nodes need to have low power consumption. Also if DoS attack is to be avoided then the authentication protocol has to be very faster. Keeping this fact in mind that intra BAN node is lacking with resources like power supply and storage, data security thus becomes a challenge. Also precised encryption algorithm has to be thought for.

B. Sensor Calibration and Validation

If accurate results are to be obtained for emergency prediction or health status then the wearable sensors used should be periodically calibrated. Not only calibration but proper validation has to be applied using a good algorithm. Sensitivity and Accuracy are the two terms which play important role here. Accuracy means the closeness to the actual value or close to true positive or true negative results. While sensitivity deals with how quick the sensor takes reading. Both the terms are very important while choosing sensors at Level 1 of WBAN.

C. Energy Consumption of Various Devices

Being an embedded wearable device, energy consumption is always a challenge. Sensors along with additional electronic circuitry have to be optimized so that energy consumption has to be appropriate. Being wearable device again continuous power supply input to be given through adaptor is not a possible solution. Thus optimized circuit design using proper electronic components is a big challenge. Also power-efficient protocols are to be taken care of.

D. Compatibility of Intra BAN and Extra BAN Components

The communication technologies for intra BAN use a short-range protocol like Zigbee, Bluetooth or Wifi and while extra BAN uses long-distance protocols like internet or cellular networks. The compatibility between these intra BAN and extra BAN protocol is a bit challenging.

IV. Conclusion

Thus from the above discussion, it is to be concluded that WBAN needs to be taken care of at 3 different levels with every level having challenges differently. The intra BAN, extra BAN and the storage and analysis mechanism have to work together for success of WBAN. The main advantage of WBAN over standalone body parameter sensing is that the body parameter reading can be preserved and used for future diagnosis and prediction. Analysis of data can be done as and when required which proves to be beneficial for chronic disease patients for gaining immediate attention in case of emergency.

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