

Recent Advancement of Wireless Body Area Network in Health applications and future challenges

¹Rekha Rani, ²Narinder singh

¹Assistant Professor, Department of Computer Science, ²Assistant Professor, Department of Computer Science

¹Guru Nanak College, Budhlada, Mansa Punjab, India, ²Guru Nanak College, Budhlada, Mansa Punjab, India

Abstract - In recent years need and interest Wireless Body Area Networks have altogether expanded. Numerous wireless techniques are very successful to understand human body and give better results but some techniques are in under observation till now. WBAN techniques selection is depend on the patient's situation and disease or various performance requirements like data rate, latency, reliability, etc. in medical observation various sensors are used with different techniques. The aim of this study is to provide detailed survey of existing wireless body area techniques. In addition to a detailed overview of existing technologies, the use of new low-power wide area network (LPWAN) technologies and future 5G, B5G, and 6G are examined, and some of these technologies suitability for WBAN applications is discussed.

I. INTRODUCTION

According to a study published by the World Health Organization (WHO), the population over the age of 60 is expected to grow to about 2.1 billion by 2050 [1]. In healthcare, many technologies are emerging to enable continuous patient monitoring and assist medical staff in making diagnoses and issuing medical orders. For convenient and uninterrupted daily activities, a network of sensors is or is attached to the patient's body to extract a series of readings related to the disease or health measure of interest and wirelessly transmit your body to that area. To that end, this article reviews the most common technologies suitable for medical WBAN applications. WBAN technology usually consists of several small sensors and a central hub. Sensor roles, data rate requirements, power consumption, and size depend on the disease or patient case being monitored. These sensors collect data and use wireless technology to transmit it to medical centers via rechargeable personal devices (PDs), which have more processing power than the sensors [2]. Continuous sensor monitoring allows medical staff to update patient status.

This fact leads to the selection of the appropriate technology for transmitting data from the patient's body to the medical staff, depending on several parameters such as reliability, power consumption, delay, weight, size and cost. This diagram shows a remote medical monitoring system using a WBAN network. In this system, multiple medical sensors are attached to the patient's body to measure multiple physiological parameters. The measured data is sent over the network to the medical team, enabling them to monitor the patient's condition. In the United States, healthcare costs are estimated to grow to \$4 trillion, he reached \$3.81 trillion in 2019. \$1 trillion in 2020. U.S. healthcare spending is projected to reach \$6.19 trillion by 2028, and prices for healthcare services are expected to grow at a compound annual rate of 2.4% from 2019 to 2028 [3].

WBAN Contribution

Although the large coverage provided by these studies on WBAN systems, some points have not been developed, like strengths and weaknesses of the technologies. Classic and future wireless (Bluetooth, WiFi, B5G, ZigBee, etc.) and IoT technology when utilized in medical applications. Additionally, to date, there have been no reviews of academic studies focusing on common diseases, nor on emotional characteristics. Variables are used in market to measure WBAN medical parameters. Then, the major contributions of this study is present the survey of the main proposed wireless technologies, towards medical applications as well as traditional wireless technologies, WBAN's outlook on 5G, 6G, and B5G also focusing on emerging uses of LoRa. In addition, we present a review of the methodology and 4044 characteristics of selected health systems related to the range of diseases studied in the literature. Technologies and sensors adapted to each of these pathologies are presented. Also present an overview of the architecture and specifics of WBAN regarding power consumption, latency, security, severity of data and noise.

WBAN Architecture

In WBAN, sensors are responsible for detecting physiological data, converting it in the digital form, and sending it to a base station. The sensed data will be sent wirelessly to a medical server where it can be stored and analyzed. WBAN may be applied on 2, 3 or 4 tiers bases depend on architecture of system and technology used. Generally it use three tiers architecture: intra WBAN, inter WBAN and beyond WBAN [4].

Intra WBAN

Intra-WBAN has two communications first among sensors and PD, and second among sensors themselves [5]. Some existing programs use a cable to connect the sensor directly to the PD, thereby avoiding the need for a wireless network in the first place. In other schemes, data can be transmitted wirelessly to a dispatcher or master node for further transmission to multi hop WBAN (PD) or directly to the single hop WBAN, where data is transmitted later. When processing to an access point (AP). Single hop WBAN: In single-hop architecture, PD receives data directly from nodes.

Inter WBAN

Inter WBAN have communication among between to multi hop WBAN and access point using wireless technology. The Inter WBAN level connects the WBAN to other Internet-accessible networks.

Beyond-WBAN

Beyond WBAN refers to the communication between the AP and the remote medical center. A gateway is used as a bridge to perform the communication via Internet or cellular networks. After receiving the data, medical specialists are allowed to analyze it to provide necessary health advice. This tier allows also restoring patient medical information which can be necessary to plan for treatment.

WBAN characteristics

- Therefore, the goal in WBAN is to obtain an efficient power system while using miniaturized batteries.
- The first point to consider to obtain an efficient power system is choosing a power efficient wireless technology for WBAN, which is discussed in the next section.
- The low latency of data transmission ensures the successful transmission of real-time data to the medical center.
- Privacy and security of the patient's medical data are two indispensable requirements for WBANs.
- Many cryptography techniques and algorithms are proposed in several works in the literature to achieve secure WBAN systems.

Real time WBAN applications

Data that is vital and cannot tolerate a long response time is used in several medical WBAN applications. Real-time WBAN systems should have sensors that can sense and transmit information to the medical team immediately. To assign each sensor a distinct priority level, it is crucial to distinguish the criticality of the sensor. The interference is getting worse as there are more and more WBANs, which is a major problem. Network performance and sensor power consumption may both be impacted by interference.

We describe methods for reducing interference in WBAN systems. When the time frame is divided into time slots that are less than the number of nodes, the fundamental issue with TDMA is the potential delay in the delivery of crucial data. Wireless technologies are used for exchanging data sensed by sensors, remove the cable requirements among sensor nodes and AP. The selection of suitable wireless technology is an essential part of WBAN technologies where an inappropriate technique can waste of energy and time. There are some main technologies of WBAN.

Bluetooth

It is a protocol for data sending and receiving using a 2.4GHz wireless connectivity. Bluetooth is a protected and perfect wireless protocol for low-cost, short distance, low-power transmissions among electronic devices. F or WBAN systems, Bluetooth will be usually used for the communication between the sensors and therefore

the PD within the first tier, it's free and supported by most devices. It will be used for sensors of relatively high rate requirement, but it's not a perfect choice in terms of power consumption.

Bluetooth low energy

BLE is designed for significantly lower power consumption. This allows apps to communicate with BLE devices that have stricter power requirements, such as proximity sensors, heart rate monitors, and fitness devices.

BLE has a range of 10 m, which make it difficult to be used in other than the first tier in WBAN. Synchronization can be done in a few milliseconds compared to Bluetooth seconds which is very valuable for latency-critical devices used in WBAN health-monitoring applications. It uses 2.4 GHz frequency and the time needed for connection setup and data transfer is less than 3ms [6,7].

ZigBee-IEEE 802.15.4

ZigBee- IEEE 802.15.4 is wireless methods give a long battery life, a short data rate and a safe networking [8]. ZigBee is network that is easily installed and configured, it supports different network topology and huge nodes. ZigBee is a safe networking wherever it offers three tiers of safety mode to save the data from hackers [64]. With 100m range, it operates at 2.4 GHz, 868 MHz, and 915 MHz frequency bands by a data rate of 250 Kbps, 20 Kbps and 40 Kbps for every operating frequency correspondingly. In WBAN it may be used for monitoring pulse and temperature, etc. [9]. It takes low data rate, so it cannot be used with all WBAN medical applications because it needs high data rate that's why it is not easy to use in big hospitals for number of patients [10].

WiFi-IEEE 802.11

Today WiFi is most popular wireless communication which provides fast, secure and reliable communication. It is embedded in mobile laptops, phones, tabs, etc. Wifi is enabling to deliver up to 600 Mbps data rates. Generally WiFi have four standards, it can operate in 2.4 and 5 GHz bands [11]. This technique is suitable for huge amount of data communication with high speed wireless connection that permits voice and calls streaming. In wireless body area networks, the use of WiFi is not preferred for first tier due to its high energy utilization, in few WBAN medical applications, it utilized for communication in second tier among AP and PD.

Light-Fidelity (Li-Fi) is a highly efficient, high-speed, secure, eco-friendly, non-hazardous mobile wireless technology, that uses high speed PCM modulation of light source to transmits and receive data. Li-Fi gives high private and secure connection, high bandwidths and low interference [12]. Li-Fi helps to save privacy of patient as ensuring a reliable communication. Light source requirement is the main limitation of Li-Fi. This limitation prevents cross walls communications and imposed communication to in short range.

Low Power Wide Area Networks (LPWAN)

LPWAN methods are popular in research and industrial communities thanks to their energy efficient communication and long range. It is an efficient adopted protocols, so the lifetime of end nodes of LPWAN based technique is of order of years [13]. The main popular LPWAN technologies are WiFi HaLow, SigFox, LoRa, NB-IoT, and INGENU RPMA.

Cellular technologies

With the ever growing of the wireless communication-based applications, new cellular technologies have been proposed in order to tackle the challenges of the high data rate, the massive number of connected devices, the low latency and others. In this section, we focus on the cellular future technologies and their impacts and challenges related to the WBAN applications.

Fifth-generation (5G) and B5G

In wireless body area network, 5G could produce major improvements for medical applications, particularly for critical and urgent applications require a real time communication of data as well as high data rate. 5G can get a very high

development for telesurgery using automatic platforms with haptic, video and audio feedback [14]. B5G mobile transmission, it should attain a system of capacity more than 100 times compare to 5G networks, high data rate in range of TBs/second, high reliability, low latency, that can be very capable for healthcare applications in wireless body area network [15].

5G and B5G gives 2D transmission, where as 6G will move to 3D services with holographic transmission that will transform the intelligent healthcare systems especially for tele surgery which needs a very high information rate. Other applications like remote patient medical treatment and diagnostic supervising will be feasible, where doctors can make a diagnosis distantly using holographic communication that can relieve physical burden and economical for patients [16].

II. CONCLUSION AND FUTURE SCOPE

The development of Wireless Body Area Network (WBAN) has grown with the introduction of 5G technology. This paper attempts to highlight recent developments in WBAN as well as upcoming difficulties. Also discussed are the roles that 5G, B5G, and 6G will play as well as their effects on healthcare delivery systems. The Covid-19 epidemic can serve as an inspiration for WBANs. This epidemic demonstrates how effective WBANs are at lowering medical costs and facilitating patient-physician interaction. One of the primary criteria for the future WBAN systems may be a high speed data rate. So, well organized security schemes may be developed to secure medical data because of its criticality and sensitivity. Moreover, ethical laws should be developed and considered to maintain safe patient data.

REFERENCES

1. World Health Organization (WHO). Geneva.
2. Wang, J., et al. "A multitiers service architecture based diabetes monitoring for elderly care in hospital", *International Journal of Multimedia and Ubiquitous Engineering*, 8(3), 387–398, 2013.
3. Keehan, S. P., et al., "National health expenditure projections", 2019–28: Expected rebound in prices drives rising spending growth: National health expenditure projections for the period 2019–2028. *Health Affairs*, 39(4), 704–714 2020.
4. Chen, M., et al., "Body area networks: A survey. *Mobile networks and applications*", 16(2), 171–193, 2011.
5. Antonescu, B., et al., "Wireless body area networks: challenges, trends and emerging technologies", In *Proceedings of the 8th international conference on body area networks* (pp. 1–7) 2013.
6. Ghamari, M., et al., "A survey on wireless body area networks for ehealthcare systems in residential environments", *Sensors*, 16(6), 831, 2016.
7. Negra, R., et al., "Wireless body area networks: Applications and technologies", *Procedia Computer Science*, 83, 1274–1281, 2016.
8. Chung, Y.-F., et al., "Design of a wireless sensor network platform for tele-homecare. *Sensors*", 13(12), 17156–17175, 2013.
9. Cecilia, H., et al. "Wireless medical sensor networks: Design requirements and enabling technologies. *Telemedicine and e-Health*, 18(5), 394–399, 2012.
10. Arefin, M. T., et al. "Wireless body area network: An overview and various applications. *Journal of Computer and Communications*, 5(7), 53–64, 2017.
11. Arunapriya, K., et al. "Lifi for medical care using visible light communication", *International Journal of Applied Engineering Research* ISSN, 13(11), 0973–4562, 2018.
12. Smilty Chacko, Deepu Job, "Security mechanisms and Vulnerabilities in LPWAN", *IOP Conference Series Materials Science and Engineering* 396(1), 012027, 2018.
13. Lee, H.-C.; Ke, K.-H. Monitoring of Large-Area IoT Sensors Using a LoRa Wireless Mesh Network System: Design and Evaluation. *IEEE Trans. Instrum. Meas.* 2018, 67, 2177–2187.
14. Miran Taha, Jesús Tomás, Jaime Lloret, Lorena Parra, "An Architecture and Protocol for Smart Continuous eHealth Monitoring using 5G " *Computer Networks*, 2017.
15. K. David and H. Berndt, "6G vision and requirements: Is there any need for beyond 5G?" *IEEE Veh. Technol. Mag.*, vol. 13, no. 3, pp. 72–80, Sep. 2018.
16. Jovanov, E., et al., "Stress monitoring using a distributed wireless intelligent sensor system", *IEEE Engineering in Medicine and Biology Magazine*, 22(3), 49–55, 2003.