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Wireless Body Area Network (WBAN) based Health Care Monitoring: A Comprehensive Review

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Abstract

The Internet of Things (IoT) based Wireless Body Area Networks (WBAN), play a very important role in the implementation of IoT devices. It is an upcoming research area in which we implement new advancement techniques, such as various algorithms. In this research, we explore how to secure IoT devices from cyber-attacks and also define how to handle the communication packets between IoT devices. Some IoT devices require more resources for communication so we define the techniques used to reduce these resources. The main purpose of this review is to provide a quick review of all techniques for novice researcher who wants to start their research in this domain. Now the universe is getting smaller due to a sharp growth in scientific and technological research. The development of communication technologies over the past few decades is remarkable. It has gotten harder for medical associates to take care of the patients by coming into the hospital and then personally checking them. The population of the world is increasing and the area is getting smaller. The development of wireless communication has provided a solution to these issues in the form of a remote health monitoring system. The WBAN in the domain of medicine provides the best way for patient monitoring inside or outside the hospital. Through WBAN, we can easily monitor the patient's state without visiting the hospital. WBAN is used in multiple areas such as energy-saving, eHealth monitoring systems to maintain the quality services of data, and many other areas. In this paper, we survey the current state of various aspects of WBAN technologies that are being used in healthcare applications, the targeted area is the eHealth monitoring system. Using multiple WBAN techniques, we aim to identify which techniques are giving better results in data transmission, storing, and maintaining patient data privacy and also identify the best performance using multiple techniques based on the two most important parameters such as 'throughput', and 'delay'. These parameters estimate the overall performance of any WBAN system. We collected data from the last 15 years' papers. The major contribution of this paper is to identify the best technique in e-healthcare among all in terms of delay and throughput used in the past recent years.

Index Terms: *Healthcare Monitoring, Sensors, Wireless Body Area Network, WBAN Application, Wireless Techniques.*

I. INTRODUCTION

In recent times, new technology has been proposed as a result of recent research efforts in the field of wireless sensor networks to improve the healthcare domain. The latest innovation is known as Wireless Body Area Networks (WBANs). The real-time monitoring of the patient's health conditions is made possible by this technology. This is a fast development technique. Today, we have many wireless devices like mobile phones such as 3G/4G, and Wi-Fi. We communicate freely with one another and share information through these wireless networks [1]. Wireless technology is used to get more focused on short-range distances. Now the technology quickly rising in terms of wireless communication in the emerging WBAN technology uses sensor and actuator nodes [2]. These WBAN sensors and actuators are placed inside or outside of the human body to measure the unusual condition of the patient [3]. The physical data is collected using sensor nodes, processes, and transmitted data through multiple media such as processors, and hardware. The actuator node receives the data from the sensor node. WBAN supports almost 256 nodes [4].

WBAN used the specified sensor to fulfill the specified requirements of the design system. This technology is used in the medical field and many others to quickly respond to the problem [5]. A WBAN is equipped with the patient to measure the patient's temperature, pulse rate Electrocardiogram (ECG), Electroencephalography (EEG), etc., [3]. If any unusual thing happens it generates a quick response and the patient is not going to the worst condition. Access online patient conditions also contains all historical information, helpful in diagnosing the accurate problem of the patient. Patient monitoring through WBAN increases significantly due to low cost with more benefits [7]. The WBAN is also used in sports to measure and monitor the performance and training of athletes. The important thing in WBAN is sending reliable data and WBAN depends upon the physical layer and Medium Access Control (MAC) layers [8].

A WBAN is an autonomous device that searches nearly a communication network to transmit data and store it in the database or sometimes it has its communication network to share data and store data [9]. This communication network or either a standard mobile phone network, a dedicated network, or using public network to share information [10]. The WBAN range of transmitted data is between 10Kbs to 10Mbs from the main or host severer [11]. MAC

protocol is used for WBAN communication. The WBAN collects different physiological data for sampling and uses that data to monitor and maintain the patient's health condition [3]. The data rate depends on the patient's physiological condition and the signal is generated; these signals may be periodic or random [12]. For example, if a patient's heart rate increases the MAC handles these variations. Node has a strong capacity they transmit the signal without any delay [13]. The WBAN application in the medical environment is monitoring the patients continuously [14], and [15].

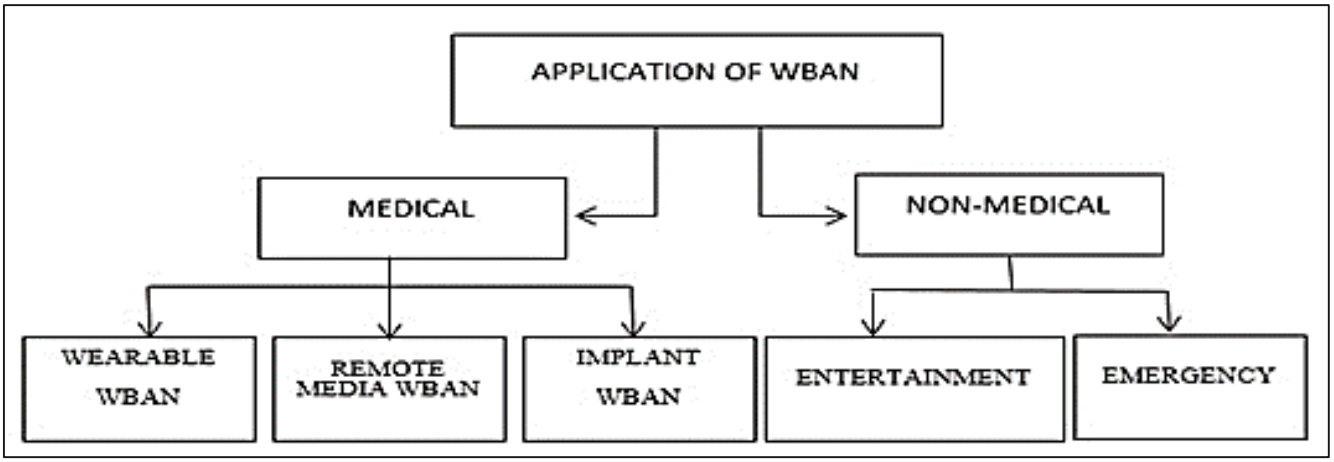

Figure I: WBAN Application

In figure I, the WBAN application in the medical field uses different node which is wearable, implant, and remote media [16]. In the implant, the WBAN node is located in the skin of the human body. Incorporate wearable node operated 400MHz used in Medical Implantable Communication Services (MICS) and wearable get physiology data and used in Instrumentation Scientific Medical (ISM) [17].

In remote media, which monitor patients from remote areas. The non-medical WBAN applications are entertainment, emergency, sports, and military. Entertainment accommodates games and social network applications. The devices that are used such as MP3, microphone, and virtual reality also included. Emergency WBAN is implemented for the emergency purposes such as fires. The human body sensor transmits data to the host person to avoid more damage [18].

Figure II describes the architecture of WBAN. The general architecture of WBAN consists of different levels first is; (a) Intra BAN communication, (b) Inter BAN communication, and (c) Beyond BAN communication. The Intra BAN communication depends on the personal and sensor nodes of the wireless body. Personal devices get data from sensors such as ECG, Pulse Sensor, EEG, and Temperature, and transmit to the access point.

In Inter BAN communication the personal node communicates with the main node. The access point gets data from the personal device of a patient and others also get data from other WBANs.

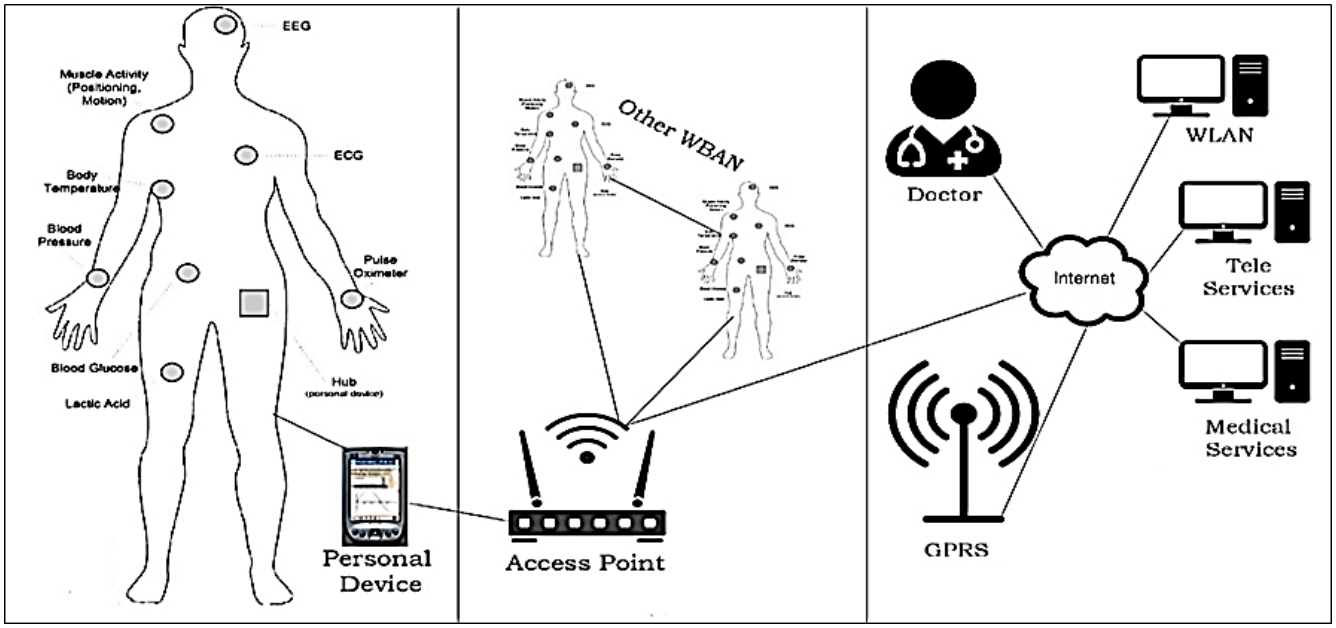

Figure II: WBAN Architecture

The Beyond BAN communication is between the personal device to the internet. The sensor transmits the information through the personal device and then the access point transmits data to the server [19].

There is a different framework that is proposed, consisting of sensors, a Remote Base Station (RBS), a PC, a Client, a Server, and a Data Access Router, and also Some hospital communities use cloud servers to store the data of the patient. There are two modes of the proposed framework, indoor and outdoor patient mode. The hospital provides the services of monitoring patients through the cloud. This technique helps to monitor remote areas of patients in an emergency using wireless biosensors. Their sensor nodes are placed in the patient body. These nodes generate the signal and send it to the hospital server through the cloud when any abnormal activity happens in the human body. The quick and efficient data transmission uses different protocols such as DTN, MAC, AODVR, DSDV, and DSR and also uses a priority algorithm. This algorithm is very helpful in transferring emergency data to the destination at a time.

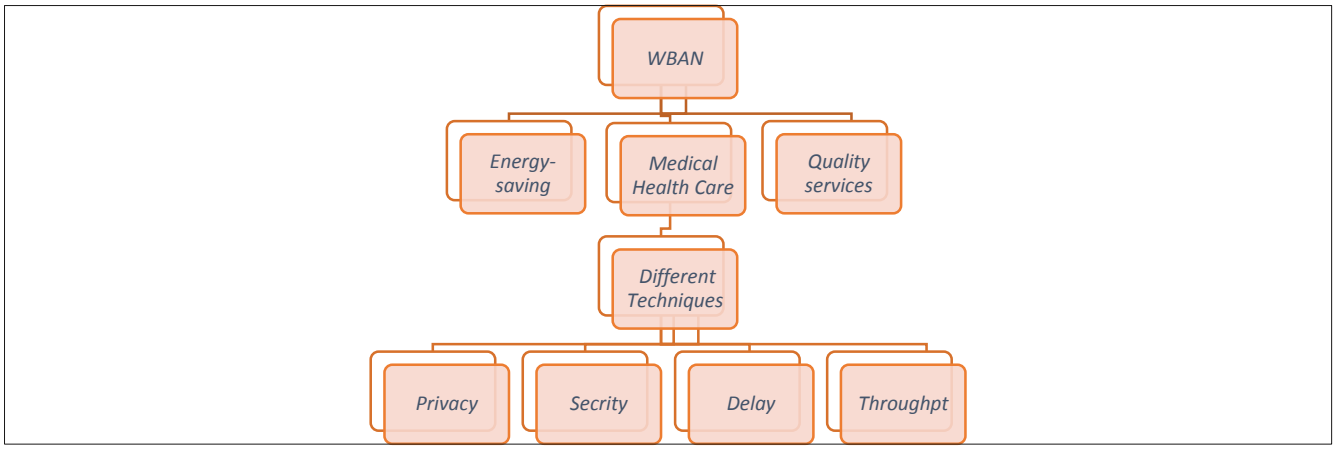

Figure III: Methodology

Figure III defines the methodology of this paper, WBAN is used in different areas we discussed the medical health care monitoring system using different techniques. In this field, the security and privacy of patient data is our priority so in this review we extract the best techniques from existing research to maintain the issues of security and privacy and also define the best way to transmit data quickly in an emergency in terms of delay and throughput. We reviewed all recent year papers related to medical security and privacy using different techniques such as cloud, biosensors, telemedicine, cognitive approach, and some other routing protocols.

The major contributions of this research paper are as follows:

- An overview of WBAN systems in health care monitoring in term of parameters such as throughput and delay were thoroughly reviewed.
- Describe the architecture and different techniques used in Wireless Body Area Networks.
- Discussed how these techniques help to reduce the existing problems.
- Define different proposed frameworks that are used in the existing research.
- Directions for future research to bridge the gaps in knowledge.

In Section II we explore the WBAN techniques. Section III presents various techniques used in WBAN. Section IV discusses the comprehensive analysis of WAN techniques. Section V concludes the paper and discusses future trends.

II. STATE-OF-THE-ART TECHNIQUES

There are multiple state-of-the-art techniques that are used in WBAN for communication between patients and doctors and for storing this information [20].

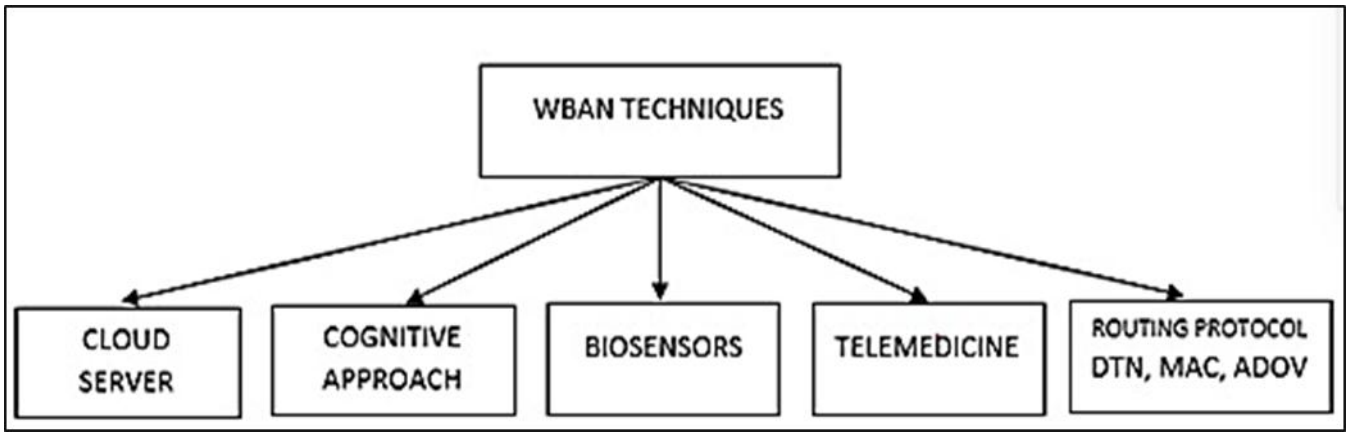

Figure IV: Wireless Body Area Network Techniques

Figure IV, defines WBAN techniques, the Conative approach, Clouds servers, Delay Tolerance Network (DTN), Media Access Control (MAC) protocol, Telemedicine, Ad Hoc distance routing protocol or Ad Hoc On-Demand Distance Vector (AODV), and Biosensors are used in the medical health monitoring system.

These all techniques help store and transmit patient data. We used multiple techniques, the cognitive approach is used in differential environmental change. These changes occur during the transmission of data, but this approach handles these problems [21]. The cloud approach is used to store data in a clouded server. In medical care, there are large amounts of data so it is difficult to manage large amounts of data in the local center, we store data in the cloud and can easily assess it through an internet server. We use different protocols such as AODV, MAC, and DTN to maintain the information. Some medical organizations use biosensors to get information from users and store it in the cloud to monitor the user's condition in the medical field [22].

In the existing work, the researcher used different techniques for monitoring and controlling the patient condition and storing patient data but we combine all these techniques and define the best techniques to monitor remote area patients and securely transmit data to the hospital.

III. TECHNIQUES USED IN WBAN

A. Cloud Server

A cloud server is a central server over a network. The cloud servers are used in WBAN for communication and storing information. Cloud servers allow their resources to a remote user through the network. The cloud servers also provide the same application as provided in the traditional servers located in some local data centers. The difference between cloud and traditional servers is that the traditional server contains the physical location to hold data but in the cloud, there is a virtual location that contains data. Through the cloud server, the user accesses data from any remote area. The user accesses data from any physical location through an internet connection. In health care when the hospital server requests are allowed to access, then the cloud server allows the user servers to get data from the cloud [23].

a) Security and Privacy in E-Healthcare Monitoring with WBAN:

F A Khan et. al stated that communication security is important because it shares information automatically. The proposed system presents the cloud-based mobile healthcare framework using a WBAN. The proposed system is divided into two parts First, it tries to secure inner sensor communication by key generation, and then secondly, the record of a patient is securely stored in the cloud server of the hospital. The proposed method gets better as compared to other methods because of multiple key generations in an inefficient manner [24].

In figure V, the proposed framework sensors are placed outside or inside of a patient body, for reading data using the Remote Base Station (RBS) of the client, and through the cloud server of the hospital.

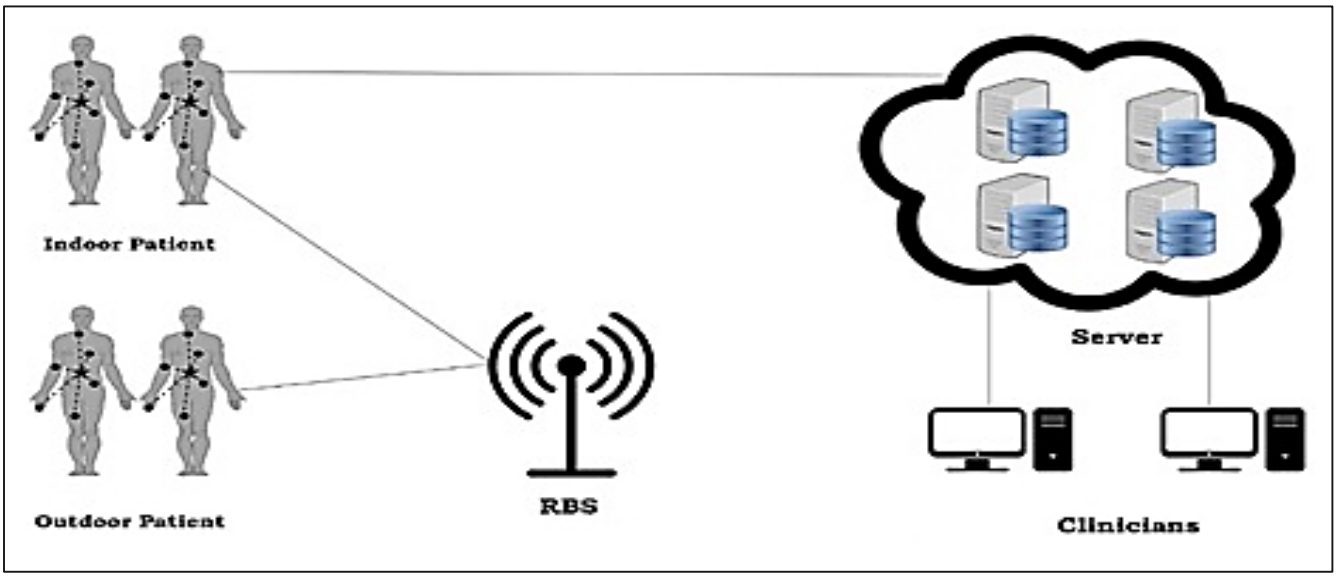

Figure V: Healthcare Monitoring Network

In the proposed framework two modes are used to monitor the patient, first, inside the hospital, and second, outside of the hospital. In inside-hospital mode, the hospital provides a connection between the patient and server through the local servers of the hospital cloud, and for the patient outside hospital mode, the connection between the patient and hospital through the cloud with a 'remote base station'. In the inside mode of the hospital, the patients are kept under observation in the hospital. The sensors attached to the bodies are capable of measuring human behavior through the sensor of the Personal Server (PS). Each patient has a PS that is responsible to catch data from the node and transfer data to the main hospital server. In the hospital, each department has its server, and then the department server is connected to the main server.

If the patient is not in range of the hospital server then use a remote base station to transfer data. The remote base station transfers data to the server of the hospital. When the data reached the data was stored in the database of the hospital cloud. The proposed method used a multi-

biometric scheme to increase the 'key length' and generate multiple keys randomly to secure the patient data. The proposed method provides a cloud-based security framework for mobile healthcare.

b) WBAN Security: Study and Implementation of a Biological Key-Based Framework:

Karmakar, Koushik, et. al, in their proposed system the implementation framework is a biological key, which proposes Advanced Encryption Standard (AES) for security [25]. The AES technique gets a key to confirm the patient data, if correct then the user is authentic. The proposed network method is based on a cloud-based environment. This method analyzed the end-to-end delay in communication by applying different keys for getting the information of the different patients. The key from the patient is by nature unique. An ECG key gets from the patient and ECG varies from human to human so the key generated from the patient is unique. Multiple human biological features are used for multiple processes like thumb images. An image was read by the sensor and generated a key. A key provides help in identifying the patient. Sometimes use different authentication methods. The implementation was performed on cloud base environment because the cloud base server locates remotely and we can easily asses through the cloud server.

c) A Remote Patient Monitoring based on WBAN Implementation with the Internet of Things and Cloud Server:

Majeed et. al, in the medical science field, the WBAN gets more importance. Its implementation for patient monitoring from remote areas and this method reduced the cost [26]. The patient carried the sensor on the body to transmit the signal using a cloud environment. The proposed method used Wearable Vital Signals (WVSBAN). It required additional devices with a cloud server that used multiple sensors to transmit the data to a cloud server using the HTTP protocol with Wi-Fi. The cloud server analyzes, store, and display data. Throughout this methodology, the cloud server sends altered messages to the doctor, and ambulance by SMS. The website displays the information that is obtained from the sensor. Through this website, the patient can access the data at any time anywhere. The data of the patient is updated every 30 seconds. The proposed framework track patient by using a global cloud server, monitoring and uploading the data on the website.

d) Privacy Preserved Medical Service Provider Selection in Cloud-based WBAN:

Pattanayak et. al propose that the emerging field in healthcare is WBAN [27]. The proposed framework used Medical Service Providers(MSP) and WBAN connected with the cloud server and updated the data using a smartphone and smartwatch. For emergencies, purposes used MSP and data transmitted to the hospital as soon as possible. In the proposed framework which designed three algorithms. These algorithms are used for the initial parameter with generating the key, the second algorithm is used for detecting the emergency, and the last algorithm is used for selecting the MSP that cannot compromise the user privacy and transmit data quickly. The proposed method maintains the privacy and security problems of patient data.

B. Cognitive Approach

The cognitive approach is used when environmental change is occurring during the transmission of data. In the cognitive approach, handle the noise and physical features. In the cognitive approach using cognitive network (CN). The cognitive network deals with the network problem such as complexity medium, an end-to-end connection, etc. if any problem in the wireless network occurs that can't be solved by using some local network protocol approaches. The cognitive approach is an advanced technique to deal with network problems [21].

a) Recent trends in Wireless Body Area Network (WBAN) research and cognition-based adaptive WBAN architecture for healthcare:

Rathee, Dheeraj et. al explain that WBAN is based on Radiofrequency (RF) [22]. Through RF multiple nodes are interconnected with sensor and actuator nodes. These nodes are placed inside or sometimes outside (surrounding area) of a human body.

WBAN technology is extremely used in the medical and non-medical fields, and also highly contributes to the biomedical field and scientific area.

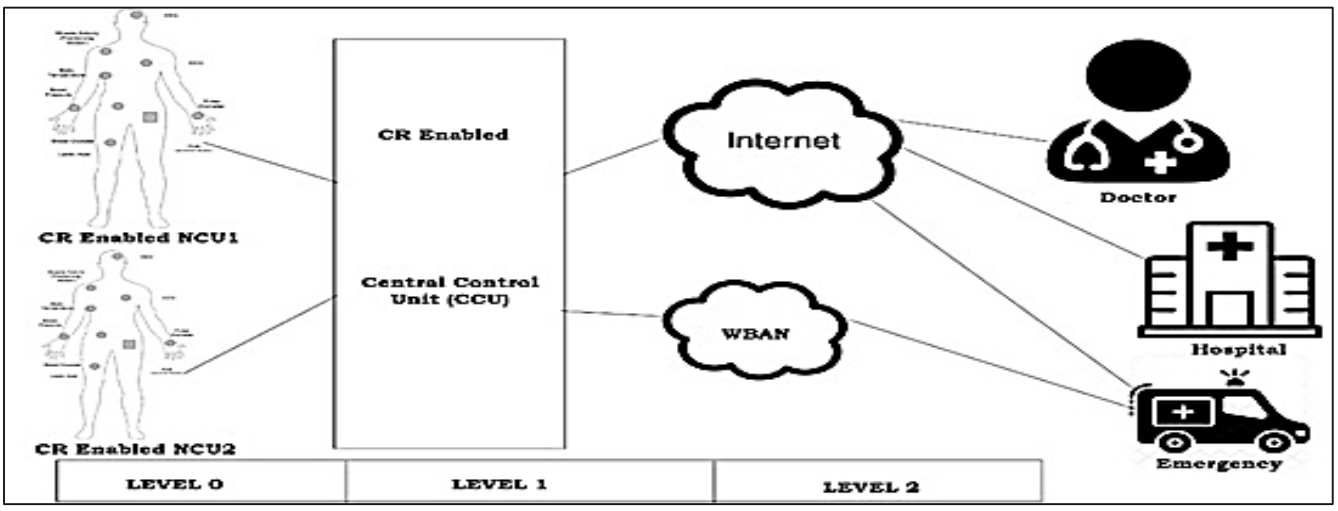

Figure VI: The Architecture of CR-Enabled WBAN

In medicine, the WBAN provides better methods for patient monitoring at the hospital and home. WBAN provides some best technologies for healthcare. WBAN communicates multiple sensors with repeatedly changing environments, and these environmental changes cause a lot of problems. The main problems are reliability, QoS, management, and usability. The proposed WBAN research provide some solution to the major problems using the cognitive approach.

The proposed method consists of two technologies, the first is conventional WBAN and the second is Cognitive Radio Technology (CRT). The cognitive approach leads to a huge improvement in resources. The CR-enabled architecture has three levels of communication. Level 0, level 1, and level 2 as shown in figure VI.

In this figure, there are three levels in the proposed framework. In Level 0, we have a core, sensor nodes, and CRT-based Network Coordinate Unit (NCU). Collect the information through the sensors and transfer it to the centralized body controller. The core can be designed with a cognitive approach. NCU device is located on the human body. The NCU's purpose is core communication through the access nodes. Process and data transmitted to Level 1 using a Central Controlling Unit (CCN). In Level 1 we communicate with multiple patients using WBAN. The NCU connected wirelessly, and CRT was enabled with CCU. The main function is communicating with NCU using the CRT approach. In Level 2 the communication level will be using a network such as a cloud server, etc. The communication is connected wirelessly to the doctor, emergency services, and hospital. The proposed architecture provides the new media access control and physical layers for WBAN and also proposes the CRT for efficient results.

C. Delay Tolerant Network (DTN)

A DTN is a network used for very large-distance communication, such as space communication. In some environments, the internet does not work and delays data transmission. DTN overcomes the environmental challenges of the transmission of data. DTN is most useful in deep-space communication. The existing network is unable to handle such issues. DTN protocols operate with IP protocol or independently. IP network store and transmit operation. DTN nodes to store bundle for an extended period, each data bundle received and forwarded data immediately. DTN network used an automatic store and forward mechanism. DTN accommodates different wireless technologies, such as radiofrequency, ultra-wideband, and free space technologies. These networks overcome the problem associated with connection and high rate error using stored and forward message switching [28].

a) Modeling on Body Delay Tolerant Network Sink Locality of Wireless Body Area Networks for Different Body Postures:

In this paper, as proposed by Mile et. al, the WBAN has a long delay between sensor nodes so that's why we make a sink node to reduce the delay [29]. The proposed method simulates a network that acts as a sink node. All nodes send data packets to the sink node and the sink node transfer packet to other nodes within a specific time. In WBAN loss of the connection between nodes is due to postural mobility. The disconnection between nodes affects the efficiency of the whole network. A WBAN creates a model to deal with disconnection. We proposed the 'Omnet++ tool' to be used to localize the sink node in the human body. Determining the best sink node locality increases the performance of WBAN. The proposed method, DTN selected for communication with a WBAN have a strategy to determine the sink node in human. The Delay Tolerance Network (DTN) reduces the long delay if a delay occurs. DTN is applied in WSNs network connections due to environmental behavior. Using the omnet++ tool to determine the localities of the skin node during the running and sitting state. The delay has been reduced due to the sink locality.

In this research, the researcher deployed multiple nodes on a human body and used MAC protocols. A WBAN mobility of postural can be defined as multiple body postures. Date communication happens among the node and sink node. The information gets from all nodes and transmits that information to the sink node and through the skin node data is transmitted to the server. We have two possibilities; posture mobile and statics. In each posture, we have a different value of delay, which is recorded. In both types of posture, first, the selector finds the posture type and then according to that type chooses the sink node for data transmission. In the case of mobile posture, the target location is specified by the data moving between nodes until the destination is reached. In static posture, the simulation time of data is already defined, and the data transfer after the completed time is fixed for transmission. A WBAN posture approach was applied and selected the WBAN best sink node locality. The proposed framework enhanced the performance of WBAN. The evaluation of selecting the best sink node locality is reducing the delay in transmission.

b) Secure Medical Data Transmission for DT-WBAN in the Military Environment:

Saravanakumar et. al, in their research paper, the WBAN consists of multiple sensors such as ECG, EEG, and, blood pressure [30]. All the above sensors are used to track human behavior and notify the emergency when something wrong happens. The main problem is data transmission in the WBAN so the researchers proposed the DTN framework. Implementation of the DTN to transfer data securely. Traditional frameworks failed due to the abnormal environment so DTN applies to handle these types of environments. The result of using DTN has reduced the security threads and increased protection. In the military DTNs are used as body sensor networks to track the position. The position is relative or absolute. The parameter gets data and forwards it to the Local Process Unit (LPU) which may be a smartphone, smartwatch, etc. The LPU acts as a wireless network in the middle of the base station and server. If anomalies are sensed by LPU then immediately generate the warning message. The proposed framework is used to avoid the data-packed drop during the transmission. The transmission of data within DT-WAB was successful.

D. Medium Access Control (MAC) Protocol

MAC protocol is used in WBAN. MAC deals with channel assessments. An attack on this layer may cause risk. Used multiple schemes in MAC to prevent unfair attacks. MAC is an important layer used for communicating with different nodes and accessing data. The MAC layer uses Time Division Multiple Access (TDMA) and Carrier Sense Multiple Access (CSMA) mechanisms for data transmission. MAC layer is helpful in the frailer case of data transmission. MAC used the BNS framework. The BAN uses an infrastructure of classes and layouts. This infrastructure consists of new modules, sub-modules, and functionalities that can be implemented and added to the existing framework. The MAC the BAN frameworks add some features such as storing data and also storing the information of the neighboring node [31].

a) A Hybrid and Secure Priority-Guaranteed MAC Protocol for Wireless Body Area Network:

Ullah, Sana et. al, presented their research findings in a research paper. The researcher proposes a secure Medium Access Control Protocol (PMAC) for wireless body area networks [32]. The MAC supports two Contention Access Periods (CAPs) the first CAP is used for the normal and critical conditions in traffic of data transmission and the second is used to handle a huge amount of data packet transfer. This framework used a set of keys to identify whether the user is legal or illegal. Analyze the delay, throughput, probability of data packets losing, and power consumption.

It prioritizes the nodes by using a CSMA procedure in the CAPs. The protocol supports two CAPs and one Contention Free Period (CFP). The imported things are modified according to the Contention Window (CW). The validation of analysis is performed using computer simulations. The analysis of PMAC is performed by using both methods first is analytical and the second is simulation. The WBAN performance increases in terms of latency, energy consumption, and throughput using the MAC protocol.

E. Telemedicine Based

Telemedicine is a developed platform in the field of healthcare. Telemedicine is the real-time delivery of medical services and is helpful from a distance. Telemedicine is used to deploy a modern communication network to provide a platform that monitors patients remotely. Telemedicine is used for healthcare delivery and has also become very important in healthcare. Telemedicine provides more convenience to the patient due to this the patient is satisfied and increases specialized access in remote areas. Telemedicine is an effective way to provide help in an emergency, and also help patients remotely. Telemedicine has a positive impact on the treatment of patients [33].

a) Telemedicine-Based WBAN Framework for Patient Monitoring:

Chakraborty et. al proposed the WBAN Framework which is used for visual off telemedicine-based wireless body area networks [34]. A proposed framework is based on a telemedicine system. There are three phases. The first phase is how to collect and process information about the patient. The second is how to transmit patient data securely. And the last is how to analyze the information of the patient in an accurate manner.

In figure VII, the framework is to access patient data through the Internet. After the collection of patient data, the data is sent to the hospital server, and then the data is transferred to the monitoring center to diagnose the patient's problem.

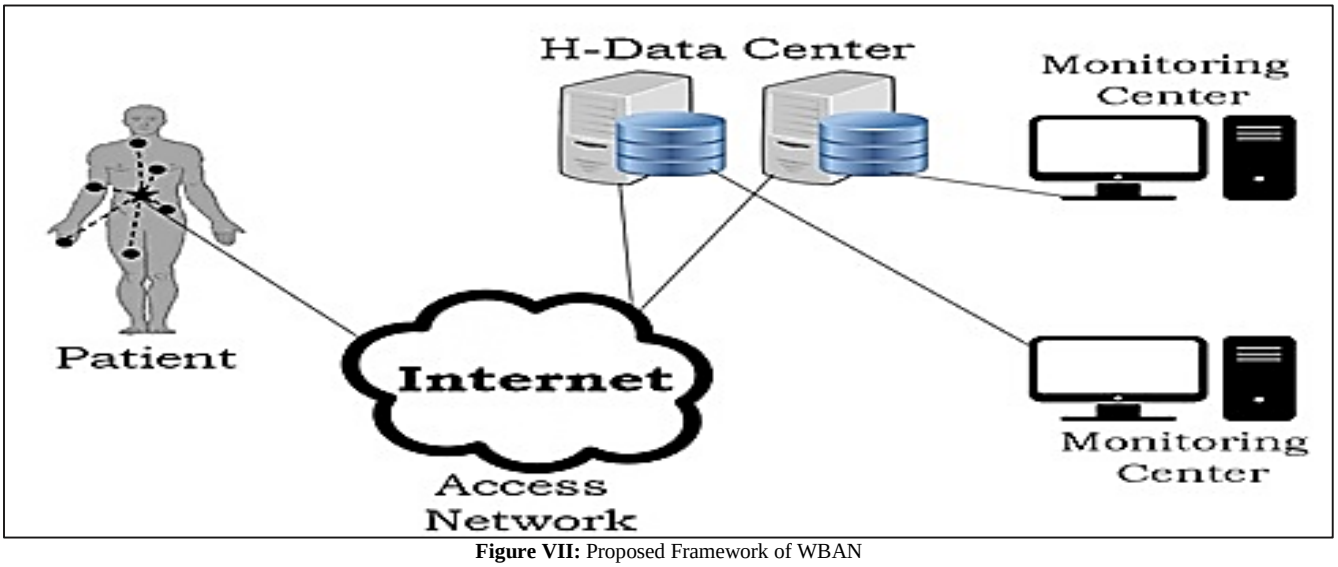

Figure VII: Proposed Framework of WBAN

The framework is distributed into multiple phrases. In the first phase, a WBAN contains multiple nodes for getting the data from the patient's body and transmitting that information to the main node called the master node. It uses star topology when the BANC is located in the center and all sensors are linked with the main node. In the proposed system, the major aspect of the WBAN is getting accurate data, storing the information, and most importantly monitoring the patients. The architecture defines the QoS requirements for sensors. The proposed system is used to

decrease the health problem for patients both inside and outside using WBAN. The WBAN model increases performance to detect patient health conditions and generate good communication between doctor and patient.

F. Ad-hoc On-Demand Distance Vector Routing Protocol

The Ad-hoc On-Demand Distance Vector (AODV) routing protocol is a destination-based protocol. It is used to create the routes between the nodes and holds the IP address of the destination node. In HODV the network is quiet until the connection is established. AODV does not create extra traffic between links and maintains the router as long as required. The ad-hoc network used a free loop routing protocol. This is designed for wireless and mobile node environments. AODV contains a table for maintaining the routing value. In the table, we contain the destination file's address and sequence to maintain the record of all packages that are transferred from sources to destination. The ad-hoc routing protocol is designed to support both unicast and multicast routing networks. The ad-hoc routing protocol builds routing between the sources and destination node if required [35].

a) Priority-Based AODV Routing Protocol/or Critical Data in Wireless Body Area Network:

M Ambigavathi et. al, explained that in AODV a node gets the message to connect and hold, then checks that a router is valid for the destination in the table [36]. If the hub demands to be utilized the course contains minimal failures so the section is not utilized. This section is used again after some time. In the entire process if the mistake happens then retransmit the hub and the whole process perform again. To develop AODV, improve the security of the network, and evaluate the performance of delivery. The purpose of the proposed framework is to provide an alternative easy way to change the AODV routing link but due to do this increases the delay during routing and also increases the bandwidth size of the network. A multiple-access router is used to access the data from the server. The Ad-hOC Network is shown in figure VIII.

In figure VIII, the Ad-hoc network used multiple routers to access the data from multiple servers. Some routers are used as access routers and also assign one core router to the network and the core router is connected to the internet. AODV is dynamic so for coordination no need for a base station. In this framework, if the user holds the data they use a table to hold the data. To hold data, make a system between a user and a server table that holds all the records of multiple users. This is executed by utilizing an Ethernet hybrid link. Traditional AODV protocol used the queues approach. All nodes hold the data to the sensor and transfer it to the destination. In the network, there are multiple nodes. If an emergency is detected at any node using a sensor the data transfer waits in the queue for a long time which may cause a problem. In this paper, the researcher proposed the AODV using the priority algorithm which is very helpful in transferring the emergency data to the detection at a time.

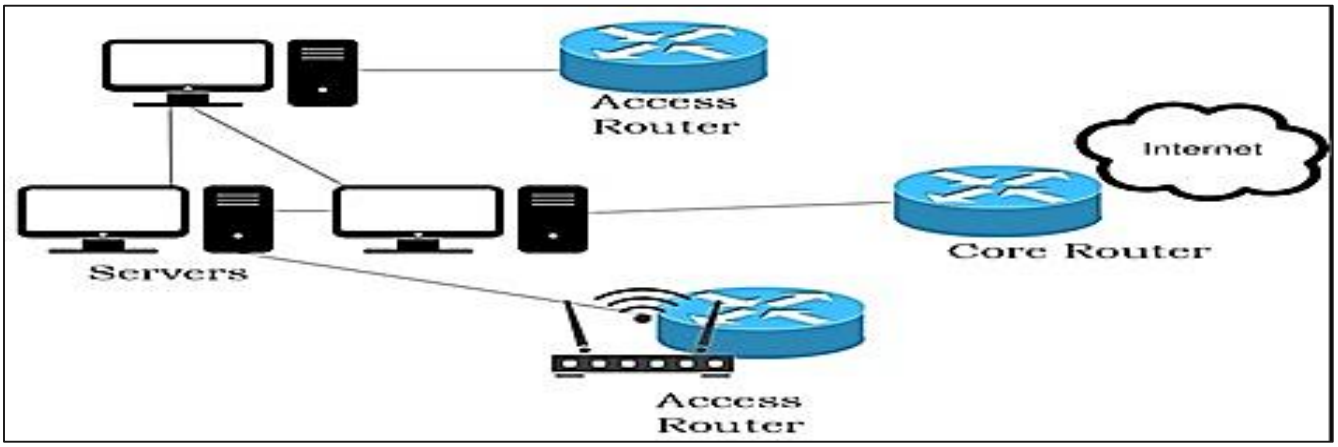

Figure VIII: The Ad-hoc Network (AODV)

b) Performance Analysis of Static Wireless Body Area Network for Different Routing Protocols:

Shinde et. al, proposed in their research paper and performed three different routing protocols for WBAN [37]. These protocols are Ad-hoc On-Demand Distance Vector routing, Destination Sequenced Distance Vector Routing, and Dynamic Source Routing. In the proposed framework, the first step is the architecture of WBAN design and the next step is to design all the above routing protocols and after that perform the analysis of all these protocols which produced a better result for data transmission from node to the healthcare server and also compare in term of throughput and delay of the network. The different sensors are attached to the human body to monitor different behaviors; all these nodes are connected to a central hub. There is a three-node place in the human body and to create four nodes the researcher gives a 50-second simulation time after that analysis of the results. In the proposed framework change the sensor rate from 250 to 2000Kbps check for all three protocols and get the result in terms of delay, and throughput.

G. Biosensors

The Biosensor performance plays an important role in WBAN. The biosensor is a collection of multiple sensors that collect information from multiple biological sensors. The information collected from the sensor is used in decision-making. The biosensor is used to monitor the patients and these sensors are placed inside or around the

patient's body. It reduced the huge healthcare infrastructure and used a sensor that transmits information. Now the biosensor is in demand because of its low power consumption and in WBAN used for communication and exchange the user information. In the medical field the biosensor is mostly used for patient monitoring through biosensors we get quick information in an emergency [38].

a) A Biometric-based Security for Data Authentication in Wireless Body Area Networks (WBAN):

Author S. N. Ramli et. al, faced in WBAN some issues with security, data loss, and asses control [39]. If we implement a high-security system, then the result is an inconsistency increase so we implemented security of WBAN in low complexity and computing and increase efficiency. The proposed method used biometrics in the security of WBAN and reduced complexity. This method used a hybrid authentication model. In proposed model required unique features of the human body using hardware and software. In addition, the biometric approach is used to identify the key elements of the human body to secure the cipher key used in WBAN communications. Because the data is very sensitive and is sensed, collected, and transferred in WBAN, the biometric should present 100% consistency.
In this method, a security framework is used to secure data within WBAN. If the ECG feature data is sent as a biometric key for checking the validity of data within WBAN. Due to the unique biometric key, the data sand and received corrected the data cannot mix with other patients. This approach addressed the challenges by using biometric information other than the cryptographic key distribution method.

b) Secure and Energy-Efficient Framework using the Internet of Medical Things for e-Healthcare:

The researcher Saba, Tanzila, et. al, proposed a design for a healthcare monitoring system that reduced the energy consumption between the biosensor node and also patient in an emergency using these wireless biosensors [40]. This increases the privacy of patient information from the sink node using the Wireless Body Area Network (WBAN). This framework technique helps monitor remote areas of the sensor nodes placed in the patient's body connected with the adjacent node. The sink node gets data from all nodes and transmits it to the main server. The sink node contains more resources. The framework is designed by two algorithms first is the interconnection of all biosensors nodes in the form of a graph with different parameters assigning the cost to each edge calculating the minimum cost and making another graph with minimum cost. The second algorithm is Kruskal's. this algorithm already contains the list of neighbor nodes that transmit data to the sink node and from the sink node to sever. In this paper, the internet of healthcare monitoring is secure and has less delay in a packet transfer.
All existing review papers only targeted a signal area using some specific technique. In this paper, we review all recent papers related to health care. We define different techniques used in medical care to reduce the problem of security and privacy of data.

IV. COMPREHENSIVE ANALYSIS & DISCUSSION

In this survey, we discuss the wireless body area in healthcare using different approaches. The research improves the privacy and security of patient data using a cloud server approach and also provides a cloud-based security framework for mobile healthcare. A global cloud server is used to monitor and upload the data on the website. Through the cognitive approach, we achieved efficient results in an emergency. The different protocol is used to avoid the data-packed drop during the transmission such as DTN, MAC, and AODV. Using these protocols, the WBAN performance increases in terms of latency, energy consumption, and throughput. The healthcare monitoring system is secure and has less delay in packet transfer when we use biosensors. In this paper, we also compare different WBAN e-health care techniques to evaluate in terms of delay and throughput because if we do not access patient data timely it could be a life threat for the patient. In table I and table II we present the comparative analysis of existing research for best, average, and worst cases and also compare our survey with the existing survey in table III. In the existing survey, the researcher used specific techniques for specific target applications but in our review, we discuss different techniques used in medical applications.

Table I: Case Table

S. No.	Cases	Abbreviation
1.	Best Case	B
2.	Average Case	A
3.	Worst Case	W

Table II: Comparative Analysis of WBAN-based E-Health Care Techniques

S. No.	AUTHOR	DELAY			THROUGH PUT			SUMMARY
		B	A	W	B	A	W	
1.	Rathee, Dheeraj et al [22]		✓		✓			• Used CRT and MAC Layer for efficient results. • The main function of communication with the network control unit using the CRT approach.
2.	Khan, Farrukh Aslam et al [24]		✓		✓			• The cloud server is used for storing a record of the patient. • To store recode inefficient manner used multiple key generation method.
3.	Karmakar, Koushik et al [25]	✓				✓		• Cloud servers and AES are used to maintain the security of patient data. • The unique key-generated method is used for authentication.
4.	Majeed et al [26]		✓			✓		• Used Wearable Vital Signal method and multiple sensors for transmission of data. Used cloud servers with Wi-Fi. • The website displays information that information updated every 30 seconds.

5.	Pattanayak et al [27]		✓			✓		• Medical Service Providers and cloud sever used. • Update data in the cloud using a smartphone and smartwatch.
6.	Mile et al [29]	✓			✓			• The Omner++ tool is used to reduce the delay during transmission. • Determine the skin node locality in multiple posture mobility that reduced the delay.
7.	Saravanakumar et al [30]		✓		✓			• DTN framework used for secure data transfer. • Used Local Process Unit for data passing.
8.	Ullah Sana et al [32]		✓		✓			• Secure prioritizes MAC protocol using priority guaranteed procedure. • packets delivery for a large amount of data used the MAC
9.	Chakraborty et al [34]		✓		✓			• Monitoring both indoor and outdoor patients. • Used star topology and got all node's data from transfer to the master node.
10.	M Ambigavathi et al [36]	✓			✓			• AODV uses the Priority algorithm which is very helpful in transferring emergency data to the destination at a time.
11.	Shinde et al [37]			✓	✓			• Used three protocols AODVR, DSDV, and DSR. • Change the sensor rate from 250 to 2000Kbps and check for all three protocols to calculate the delay and throughput.
12.	S. N. Ramli et al [39]		✓			✓		• Used a hybrid authentication model method. • A biometric key is used for checking the validity of data
13.	Saba Tanzila et al [40]		✓		✓			• Increases the privacy of patient information. • Used two algorithms first the interconnection of all biosensors nodes and the second algorithm is Kruskal's.

Table III: Comparison with the existing survey of WBAN healthcare

S. No.	Ref #	Year	Summary
1.	Y Qu et al [41]	2019	This paper only focuses on routing protocol and analysis of which protocol is best for targeted application.
2.	Damilola et al [42]	2019	In this paper, the researcher used LPWAN to improve the data transmission rate and latency in the WBAN remote healthcare system.
3.	Houssein Taleb et al [43]	2021	In this paper, the researcher focuses on adaptive sensors and wireless technology used in medical applications.
	Proposed	2022	In our paper, we describe multiple WBAN techniques in the e-health monitoring system.

V. CONCLUSION

Wireless Body Area Network (WBAN) is used in the field of medical and non-medical. In medicine, used for patient monitoring inside or outside of the hospital. WBAN is used in different areas such as energy-saving, health monitoring systems, maintaining the quality services of data, and many other areas. In this paper, the targeted area is health monitoring. Using different wireless body area network techniques, we identified which techniques are giving better results in data transmission and storing and also maintaining patient data privacy in terms of delay and throughput. Using DTN and ADOV protocols we get better results as compared to other protocols. In DTN we used omnet++ to reduce the delay during transmission and in ADOV used the Priority algorithm which is very helpful in transferring the emergency data to the destination at a time. Using the cloud approach, we improve the privacy and security of patients and access emergency data on time. Through WBAN's different techniques, we easily monitor the patient's state and provide help in an emergency. Moreover, a comparison of different techniques has been analyzed in terms of delay and throughput so we select the appropriate techniques according to the targeted application. This survey will benefit novice researchers to study the WBAN techniques in the healthcare field.

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Authors Contributions

The author Qaisar Ayyub took all the responsibility of conducting this research study.

Conflict of Interest

The authors declare no conflict of interest and confirm that this work is original and not plagiarized from any other source, i.e., electronic or print media. The information obtained from all of the sources is properly recognized and cited below.

Data Availability Statement

The testing data is available in this paper.

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