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Body Area Network and its Applications: A Survey

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Abstract

Wireless Body Area Network (WBAN) is a system which used to streamline low power gadgets and to work in or outside of human body to help assortment of therapeutic applications. WBAN contains at least one Body Sensor Units (BSU), one Body Control Unit (BCU), and long range remote gadgets. BAN also called as body sensor network (BSN) set up to make restorative and health applications more progressed. WBAN is confined not only to restorative applications but can be utilized in non-therapeutic applications, for example, sports applications and other. For medicinal applications it assumes a key part to help medicinal experts and patients for the checking of therapeutic circumstance through intelligent body sensor network (IBAN). There are numerous WBAN sensors that can measures diverse kind of physical parameters, for example, Electrocardiogram (ECG), Electromyography (EMG), body temperature and diabetes of human body. In this paper, there will be an exhaustive study on WBAN applications and the part of these applications used in real life. Through these uses of WBAN, sensors can foresee unpredictable conduct of body parameters and enable patients or sensor gadgets to ready medicinal masters before any severe condition.
Keywords: WSNs, BAN, BSN, ECG

I. INTRODUCTION

The aging of the population in many developed countries and the rising health care costs have triggered the introduction of new technological improvements to the current state of health practices. For instance, late advances in gadgets have empowered the improvement of little and canny (bio-) medicinal sensors which can be worn on or embedded in the human body. These sensors need to send their information to an outer restorative server where it can be examined and put away. Utilizing a wired association for this reason ends up being as well awkward and includes a high cost for sending and support. Be that as it may, the utilization of a remote interface empowers a less demanding application and is more cost effective [1]. The patient encounters a more prominent physical versatility and is no longer constrained to remain in the hospital. This procedure can be considered as the following stage in upgrading the individual wellbeing mind and in adapting to the expenses of the personal health care system. Where eHealth is characterized as the health care services hone upheld by electronic procedures and correspondence, the health care services is currently going above and beyond by becoming mobile. This is called as mHealth [2]. Keeping in mind the end goal is to completely use the advantages of remote advancements in telemedicine and mHealth, another sort of remote system develops: a wireless on-body area network or a Wireless Body Area Network (WBAN). This term was first instituted by Van Dam et al.,[3] and several eminent researchers have shown the interest in this[4-9].

A WBAN is a remote n/w of the wearable processing gadget. It comprises of various heterogeneous biological sensors. These sensors are set in various parts of the body and can be wearable or implanted under the patient's skin. Each of them has particular prerequisites and is utilized for various missions. These gadgets are utilized for measuring changes in a patient key signs and recognizing feelings or human statuses, for example, fear, stretch, bliss, and so on. They communicate with the BAN node, which is for the most part less vitality obliged and has all the more preparing limits. It is in charge of sending natural signs of the patient to the therapeutic specialist with a specific end goal to provide real time medical diagnostic and enable him to take the correct choices. The individual server assumes a part of the BAN organize facilitator also, can be actualized either on a devoted gadget or on a PDA[10].

Such a multi-level coordinated health monitoring system empowers an extensive variety of medicinal services applications, from health to wellness management of healthy people to preventive medicinal services, helped living, and regulated walking recovery. For instance, an advanced mobile phone application coordinated with a BAN empowers a user to closely monitor the changes in her or his crucial signs amid day by day exercises and can give input to help keep up an ideal healthy status. Additionally, the individual server application may alarm the user about lacking level of physical action or hoisted body mass list in view of the information from the WBAN, the user's personal information (height, age, gender), and suggested values for these parameters. The BAN and the individual server can be incorporated into a more extensive telemedical framework that incorporates therapeutic staff. When alluding to a WBAN where every node includes a biosensor or a medicinal gadget with detecting unit, a few specialists utilize the name as Body Area Sensor Network (BASN) or in short Body Sensor Network (BSN) rather than WBAN [11]. These systems are fundamentally the same as each other also, share similar difficulties and properties. In the tailing, we will utilize the

term WBAN which is additionally the one utilized by the IEEE [12]. In this article we display a study of the best in class in Wireless Body Area Networks. Our point is to give a better comprehension of the ebb and flow look into issues in this developing field. The rest of this paper is sorted out as takes after.

The section 2 shows the WBAN communication architecture. The challenges and issues being faced by the WBAN are discussed in the section 3. Various eminent researchers have done a lot of research work on the WBAN technology which are discussed in the section 4. In section 5 some WBAN application area are covered. Finally, section 6 refers to the conclusion separately.

II. BAN COMMUNICATION ARCHITECTURE

A basic WBAN design where the architecture is isolated into a few segments. Here we have grouped the network architecture into four areas as (Fig. 1) [13]:

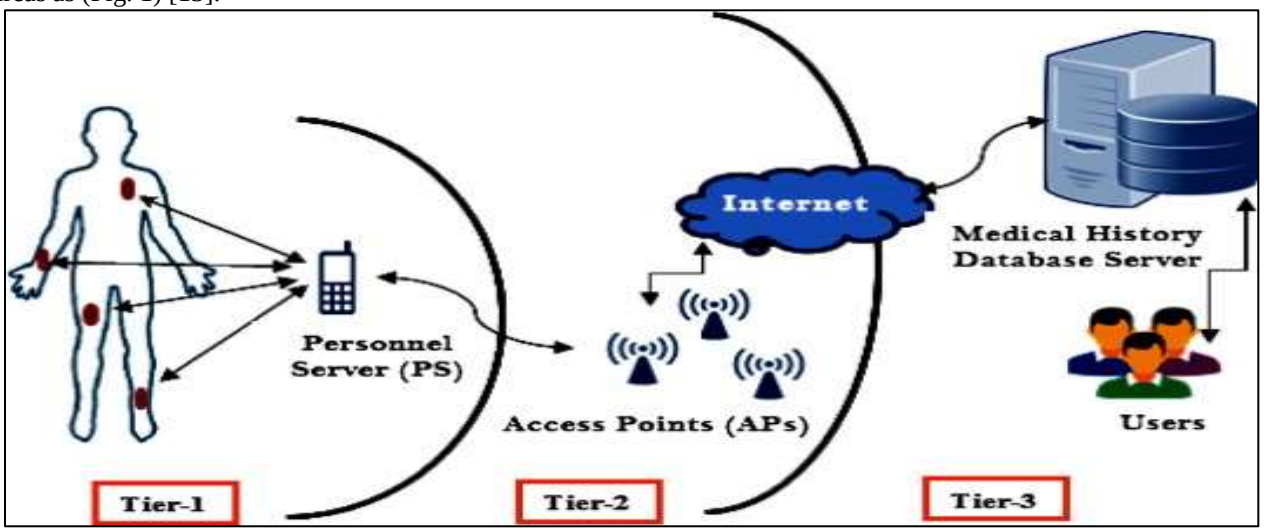

Fig. 1: WBAN Architecture [13]

The above Fig.1 represents the general architecture of a body area network (BAN) which is used to monitor the health of a user. Here we have classified the network architecture into four segments. The main area is the WBAN part which comprises of a few quantities of sensor nodes. These nodes are shoddy and low-control nodes with inertial what's more, physiological sensors, deliberately set outside or inside the human body. All the sensors can be utilized for nonstop checking of development, essential parameters like heart rate, ECG, Blood weight and so forth. These sensors get required information from human body and send it remotely to next section

The following segment is the coordinator node where the whole sensor nodes are specifically associated with a coordination node known as Central Control Unit (CCU) or Body Control Unit (BCU) or Central Node or Body Sensor Unit (BSU). Body control unit contains individual servers, these servers' gets information from sensors compute and control this information and gets the required outcomes. This section can be founded on a remote PC framework, an android cell phone or any GPS supported framework that can manipulate the received information.

The third area depends on end user's machines where end users are restorative help or doctors and their machines can be a PC or cell phones. These machines assemble required data, from the previous section, and request from end users to give reply back about patient's wellness. In the meanwhile, if there is some crisis comes about, then, machine sends caution to end user and makes it conceivable to give brisk reaction to understand with the goal that patient can get appropriate treatment.

The last segment will be a control center which comprises of end node devices, for example, cell phone for message, PC for checking and email and server for putting away the data in the database. This can be seen from Fig. 2. as shown below:

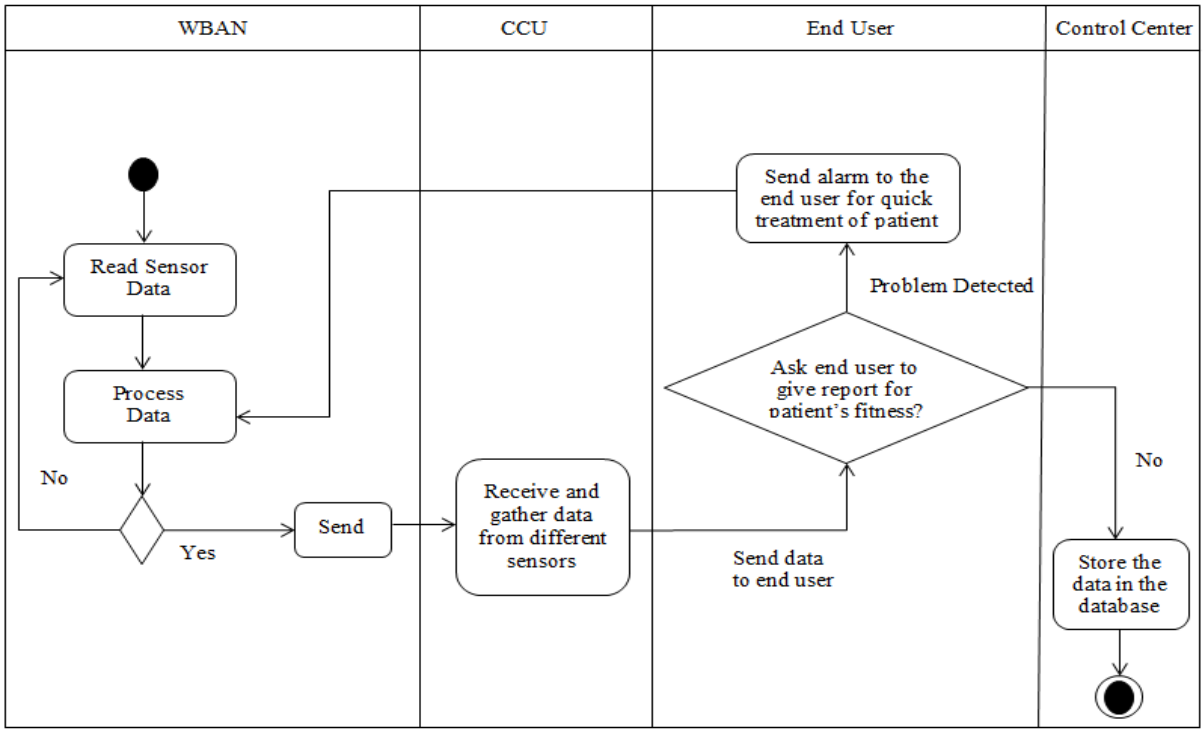

Fig. 2: Activity diagram of WBAN Architecture

The phases of communication in WBAN are divided into three phases: -

A. Inter-WBAN Communication

Tier 1 portrays the organize collaboration of nodes and their separate transmission ranges (~ 2 meters) in and around the human body. This means that communication between the nodes of the same body. Here, all of the information from all nodes of body will be sent to coordinator node.

B. Intra-WBAN Communication

The coordinator node or personal server node sends data to one or more Access Points (AP) which associates the WBAN with different network systems like cellular network or the Internet. The personal server node act as a gateway [14]. This communication is further divided into two parts: -

1) Infrastructure based

Here, arrangement of network is dynamic in restricted space like hospital as well as it provides security control and centralized management services. AP can go about as database servers identified with its applications. This is shown in Fig. 3[15].

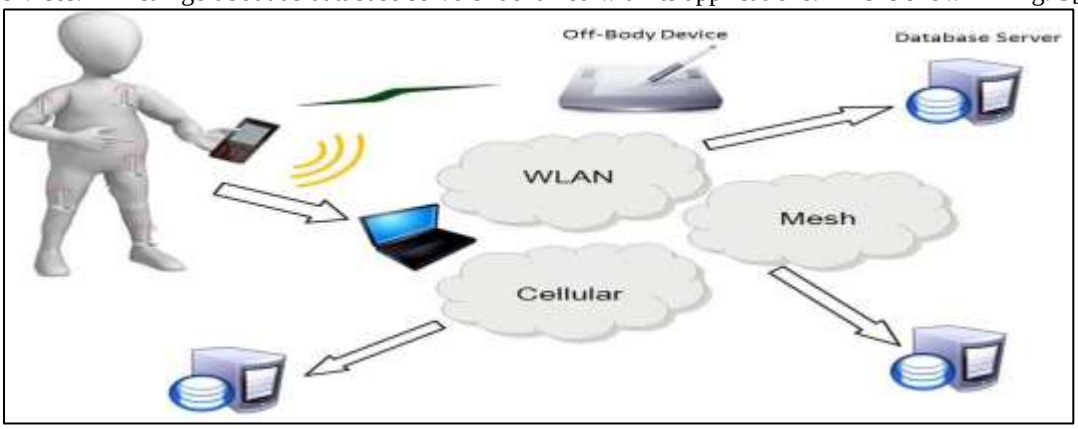

Fig. 3: Inter-WBAN based Communication: Infrastructure mode [15]

2) Ad-hoc based

In this architecture, different APs transmit data inside therapeutic focuses as appeared in Fig. 4. The APs in this design frame a mesh construction that empowers adaptable and quick arrangement, considering the system to effortlessly extend, give bigger radio

scope due to multi-bounce spread and bolster quiet versatility. The scope of this setup is substantially bigger looked at to the infrastructure based architecture, and encourages the development around bigger ranges. In fact, this interconnection develops the scope range of WBANs from 2 meters to 100 meters, which is reasonable for both short and long term setups. This is shown in Fig. 4 [16].

Fig. 4: Inter-WBAN based Communication: Ad-hoc mode [16]

3) Beyond-WBAN communication

In this level, a gateway is given in type of some personal device assistance (PDA) which makes a correspondence way between tier 2 and tier 3. The outline of this level is application particular. For case, through web we are associated with the medical servers (MS) of some particular clinic where all our observed is getting put away consistently. On the off chance that a few parameters get approaches towards the basic circumstances then the framework will generate an alert signal and send it to the PDA in type of some emergency SMS or direct to the coordinator node over patient's body.

III. CHALLENGES AND ISSUES

In the present life, where the innovations in systems and remote sensors have been developing quickly, there are a few challenges that are experienced by these new innovations also, can be overcome by making these innovations more progressed and solid. There are some imperative difficulties also, issues [17] which are for the most part confronted by WBAN applications. The most imperative and huge challenge of WBAN framework is Data security [18] of remote gadgets. The same number of specialized gadgets send information through same kind of encryption for all information, and on the off chance that anybody could be capable to get encryption key once than that individual may get all the unscrambled information and if the information is secure and ought not be shared by others than it might continue in a undesirable way. Also, in some cases there might be a man who can check and change information of patient and afterward sends the off-base data to end client, so the information going between gadgets ought to be exceptionally secure [19]. This test ought to be maintained a strategic distance from while making military application utilizing WBAN. Alternate difficulties that ought to be maintained a strategic distance from are, at first the sensor gadgets ought to be low power expending and are not expected to get charged after brief time. The other concern ought to be that the sensor gadgets ought to be of little size as though the quiet put any sensor gadget onto their body it ought to not be awkward and ought not to influence their schedule exercises.

IV. RESEARCH WORKS

WBAN system are currently exceptionally prominent idea among numerous scientists and a considerable measure of work is proposing utilizing this way to deal with screen health condition, most work is done to screen heart state of heart patients, however, it is a wide field so it is not constrained to simply screen heart, from different work beneath are some investigates that have been studied in our examination.

A. BSNs: A method to screen Heart Rate

The proposed technique in this paper [20] is likewise going to screen the heart rate ailments through BAN phrasing. To characterize the patients' day by day movement and give the setting data, this approach utilizes accelerometer information from the Body Sensor Networks (BSNs), likewise a sensor gadget set inside the human body. It is used to screen the heart rate and body exercises of a human body.

If anything goes wrong by heart, then a flag will be recognized by sensor gadget and it will pass a crisis flag to the appended remote gadget, kept by doctor, that recognize the crisis level and after that doctor will send suitable message or alert an alarm

signal through a computer system and patient gets notification related to their health. As typical BAN system of medicinal services additionally employs on three tier architecture, in which first tier is low power remote gadget connected to the patient's body which is utilized to screen changes in patient's heart's condition with the help of sensor and microcontroller. The second tier is close to personal server which is based on PDA, this system contains each patients support data and at whatever point if there is some sure change occurs in patient's health, it gathers the information from WBAN by utilizing GPRS. If critical issues occur, then, it alerts the relevant doctor to monitor and check the patient's health condition. The third tier is the remote gadget utilized by doctors to watch the patient's condition by utilizing got information and at that point send message to patient that which drug needs to take.

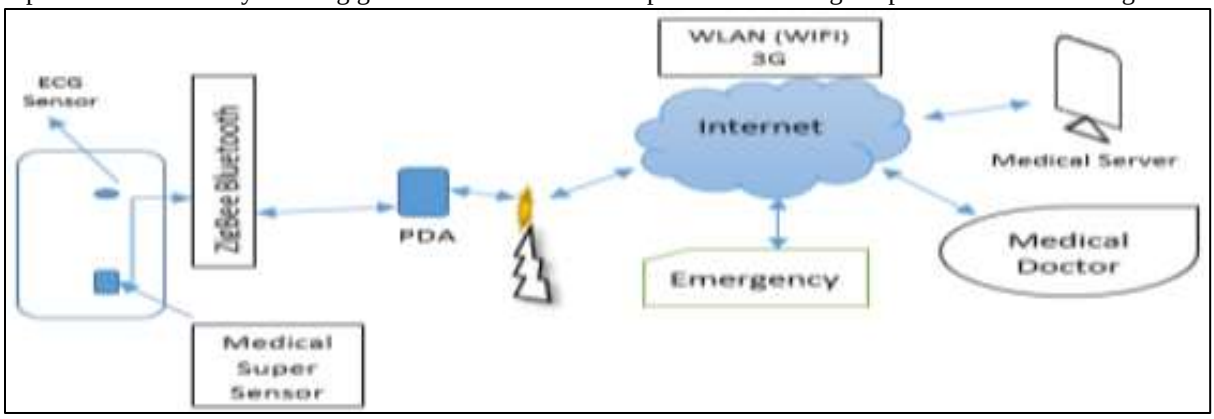

Fig. 5: BSNs: A method to screen Heart Rate [21]

B. Detection of Heart Attack using BAN

The BAN system proposed in this paper [22] utilizes an antenna, a Bluetooth gadget and an android based versatile gadget for correspondence. The antenna depends on low creation procedure, a Bluetooth gadget is utilized to send and get signs and information correspondence is done by utilizing an android gadget. This framework enables the user to detect ST rise through their GPS empowered advanced mobile phones. At the time of crisis; patients are traced easily with the help of GPS empowered brilliant gadgets. The microcontroller set at the sensor would have the capacity to screen the blood thickness in the body and on the off chance that it found any coagulation in the blood, then, at that point the framework instantly can caution the patient and around then the specialist right away approaches on android system of patient to take any headache medicine to anticipate additionally blood thickening.

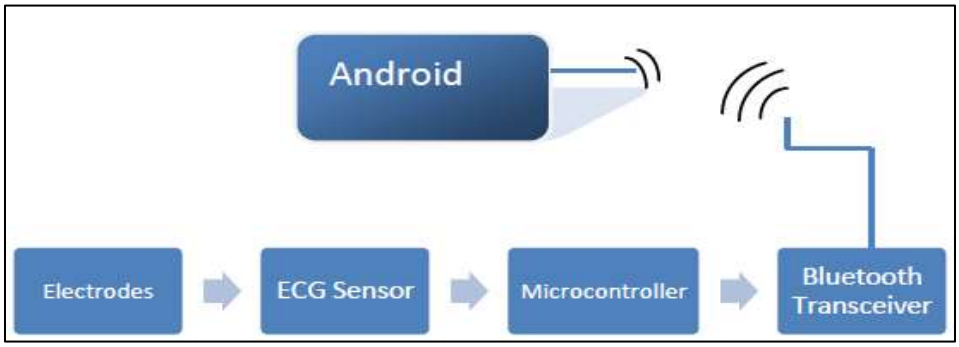

Fig.6. WBAN for heart attack detection [21]

The Fig.6. demonstrates the design of this framework, where the general framework depends on four things. The first is ECG sensor that is utilized to screen and figure electrode signals of a human body. At that point the figured esteemed signals are sent to microcontroller that helps these signs to move into Bluetooth transceiver. This Bluetooth transceiver is joined with analysts possess composed reception apparatus called PIFA that helps flags and computed information to be gotten on patient's android gadgets. The signs that are sent and got are checking ECG through a sensor set on patient's trunk. That ECG sensor associated with anodes through a wire and furthermore joined to the handset.

V. APPLICATIONS

There are extensive variety of utilizations for this WBAN technology which incorporates Medical applications, stimulation, fitness, sports and military. The expansion in quick figuring gadgets, sensors and scaling down of these gadgets has prompted this extensive variety of uses of day by day schedule.

A. Medical Applications

The Population is expanding step by step and it is normal by 2030 that there will be more than 750 million old people around the globe. So the more seasoned individuals are there will be more prominent requirement for various approaches to screen their therapeutic status and remain at home checking their health condition without remaining at healing center. A portion of the physiological sensors utilized as a part of WBAN is ECG (Electrocardiogram) sensor which screens the heart rate or the hearts action persistently, EMG (Electromyography) sensor which screens the electrical signs created by the muscles ceaselessly, EEG (Electroencephalography) sensor which screens the electrical movement of the cerebrum which is reason for cerebrum PC communication [23]. Different sensors incorporate for measuring circulatory strain and breathing sensors.

1) Electrocardiogram (ECG)

Heart is a supplement rich organ that pumps blood all through the body. Every heart beat is empowered by the electrical flag that go through heart muscle or myocardium .keeping in mind the end goal to check the capacity of heart a specialist may play out the ECG. It is strategy for watching the electrical action of the heart for quite a while by setting terminals on a patient's body. These anodes distinguish the modest electrical changes on the skin that emerge from the heart muscle depolarizing amid every pulse.

For the most part the Electrocardiogram created which in the event that it is strange prompting destructive infections like Heart assault. With the assistance of these sensors, set, the variation from the norm in electrical action is shown at the before arrange which can prompt avoidance of heart assault by receiving certain measures [24]. With the assistance of this sensor, one can distinguish heart assault preceding the assault.

B. Sports Applications

Among numerous utilizations of BAN in different fields we too have a few applications in sports field .The significant utilize is to recognize whether a stance of body may prompt any sprain or bring on any cracks. The sensors situated at different joints in the body dependably check whether position is proper or not. If not then the individual is instantly informed to change his/her stance. Along these lines sportsmen utilize this while playing critical matches to maintain a strategic distance from sprain and issues.

VI. CONCLUSIONS

In this overview, a review of the on-going research in WBANs regarding system architecture, some research work and a few difficulties that are worried in these applications are also have been discussed. From study, we have discovered that these applications are working viably in their own particular behavior yet at the same time some more research is expected to make these applications efficiently and as indicated by the vat development of numerous new and propelled maladies. There are still a few issues and ailments that ought to be screen through these gadgets; so there is a need to make more WBAN gadgets and make a human life more secure and diminished. Furthermore, a rundown of existing and relevant sensors, open issues, and future work in WBANs is additionally introduced. WBANs will consider constant checking of patients in restorative applications, able to do early recognition of unusual conditions bringing about major enhancements in the personal satisfaction. Significantly, even essential indispensable signs checking (e.g. heart rate) can empower patients to participate in ordinary exercises instead of being home bound or close-by particular medicinal administrations. In rundown, the procedural research on this profitable innovation has huge significance in better use of accessible assets that will no question genuinely influence our future prosperity. We really accept this exploration to be a wellspring of motivation towards future advancements in WBANs.

REFERENCES

[1] D. Cypher, N. Chevrollier, N. Montavont, & N. Golmie,"Prevailing over wires in healthcare environments: Benefits and challenges," IEEE Communications Magazine,44(4), 56–63, 2006.
[2] R. S. H. Istepanian, E. Jovanov, & Y. T. Zhang, "Guest editorial introduction to the special section on m-health: Beyond seamless mobility and global wireless health-care connectivity," IEEE Transactions on Information Technology in Biomedicine, 8(4), 405–414, 2004.
[3] K. Van Dam, S. Pitchers, & M. Barnard, "Body area networks: Towards a wearable future," In Proceedings of WWRF kick off meeting, Munich, Germany, March 6–7, 2001.
[4] R. Schmidt, T. Norgall, J. Morsdorf, J. Bernhard, & T. Vonder Gun, "Body area network ban—A key infrastructure element for patient-centered medical applications," Biomedizinische Technik, Biomedical engineering, 47(1), 365–368, 2002.
[5] Benoit Latre, Bart Braem, Ingrid Moerman, Chris Blondia, Piet Demeester, "A survey on wireless body area networks," Wireless Networks, 17.1, 2011, 1-18.
[6] C. Otto, A. Milenkovic, C. Sanders, & E. Jovanov, "System architecture of aC. wireless body area sensor networkfor ubiquitous health monitoring. Journal of Mobile Multimedia,1(4), 307–326.
[7] B. Gyselinckx, C. Van Hoof, J. Ryckaert, R. F. Yazicioglu, P. Fiorini, & V. Leonov, "Human: Autonomous wireless sensors for body area networks," In: Proceedings of the IEEE custom integrated circuits conference, pp. 13–19, 2005.
[8] A. D. Jurik, & A. C. Weaver, "Remote medical monitoring," 2008, Computer, 41(4), 96–99.
[9] B. Lo, & G. Z. Yang, "Body Sensor Networks: Infrastructure for life science sensing research," In Life science systems and applications workshop, 2006, IEEE/NLM, Bethesda, MD, pp. 1–2.
[10] Emil Jovanov & Aleksandar Milenkovic, "Body Area Networks for Ubiquitous Healthcare Applications: Opportunities and Challenges," Journal of medical systems, 35.5, 2011, 1245-1254.
[11] E. Jovanov, A. Milenkovic, C. Otto, P. De Groen, B. Johnson, S. Warren, G. Taibi, "A WBAN System for Ambulatory Monitoring of Physical Activity and Health Status: Applications and Challenges," 2005, IEEE Engineering in Medicine and Biology 27th Annual Conference, Shanghai, pp. 3810-3813.
[12] Avneet Kaur, Jasdeep Malhotra, "A Survey Paper on Wireless Body Area Network in Healthcare System," International Journal of Advanced Research in Computer Science and Software Engineering, Volume 7, Issue 5, May 2017, ISSN: 2277 128X.

[13] Min Chen, Sergio Gonzalez, Athanasios Vasilakos, Huasong Cao, Victor C. M. Leung, "Body Area Networks: A Survey," Mobile Netw Appl, 2011, 16:171–193.
[14] M. Al Ameen, J. Liu, K. Kwak "Security and privacy issues in wireless sensor networks for healthcare applications," J Med System, 36 (1), 2012, pp. 93-101.
[15] Samaneh Movassaghi, Mehran Abolhasan, Justin Lipman, David Smith, Abbas Jamalipour, "Wireless Body Area Networks: A Survey," IEEE Communication Surveys & Tutorials, 2013.
[16] Al-Janabi, Samaher, et al., "Survey of main challenges (security and privacy) in wireless body area networks for healthcare applications," Egyptian Informatics Journal (2016).
[17] A. N . K. S. K. Moshaddique Al Ameen, "QoS Issues with Focus on Wireless Body Area Networks," 2008.
[18] M. L . A. W. LOU, "Data security and privacy in wireless body area networks," 2010.
[19] J. L . K. Moshaddique Al Ameen, "Security and Privacy Issues in Wireless Sensor Networks for Healthcare Applications," vol. 36, No. 1, 2012.
[20] P. D . Sneha S Joseph, "BSNs: A Special Approach to monitor Heart Rate," vol. III, no. X, 2014.
[21] Amna Asif, Irshad Ahmed Sumra, "Applications of Wireless Body Area Network (WBAN): A Survey," ESTIRJ, Vol. 1, NO.1, April, 2017, pp. 64-71.
[22] Georg Wolgast, Casimir Ehrenborg, Alexander Israelsson, Jakob Helander, Edvard Johansson, and Hampus Manefjord, "Wireless Body Area Network for Heart Attack Detection," IEEE Antennas & Propagation Magazine, 2016.
[23] Rashmi, Vidya Kumari, "A Study on Wireless Body Area Network of Intelligent Motion Sensors for Computer Assisted Physical Rehabilitation," IJARCCE, Vol. 6, Issue 1, January 2017.
[24] Stefina Macwan, Nikhil Gondaliya, Nirav Raja, "Survey on Wireless Body Area Network," IJARCCE, Vol. 5, Issue 2, February 2016.