WEARABLE AND IMPLANTABLE WIRELESS SENSOR NETWORKS FOR BIOMEDICAL APPLICATIONS: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Offering applications across a variety of areas, encompassing business, transportation, commerce, surveillance systems, healthcare, providing management of struggling people, disaster prevention, and many other, low - power wireless technologies have the ability to fundamentally alter how people live every day. Sensor network-based wireless usage throughout care and biomedical technologies have been receiving a growing amount of attention, but the accompanying privacy and security concerns continue to be open areas of discussion. There is reason to be optimistic about the potential application of this technology to our expanding senior citizen population as well as our healthcare systems, which are becoming more congested and demanding of patients' attention. However, in order for these systems to become a pervasive form of technology, healthcare providers and regulatory bodies will need to determine an adequate level of security and privacy. The primary purpose of this study is to gain an understanding of the application of wireless sensor networks that can be worn or implanted in the body for use in biomedical applications. Systematic literature review was the approach that was taken for this research. A huge increase in chronic diseases will need to be managed in the future healthcare system, which will have limited resources due in part to the ageing of the population. In this study, it was discovered that human behaviour monitoring, carried out by way of physiological measurement, is capable of being accomplished in an effective manner through the utilisation of wireless sensor technology. The provision of medical treatment will move out of hospitals and into communities, with individuals taking on a greater share of responsibility for their own health as a result of the proliferation of wireless technology.

Keywords: *wireless sensor networks; body area networks; wearable sensors; implantable sensors; healthcare applications; biosensors.*
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INTRODUCTION

Wireless networks (WSNs), which are increasingly being used in medical contexts, are quickly evolving these advances into health monitoring (BSNs). The biomaterials may measure things include eeg activity, pulse rate, cardiac output, and other medical conditions, apart from vital signs and electromyograms. Accelerometers, for instance, can be utilised to detect the rate of a person's heartbeat, as well as movement and even muscular activity. As a result of the rise in popularity of portable electronic gadgets like cellular phones and MP3 players, more and more people are making it a habit to carry one or more of these devices on their person at all times (Yadav et al., 2022). In 2001, Zimmerman conducted research into the operation of several electrical devices near or on the patient's psyche. Herzog utilised it as a route now for discussion and referring it as a fiber optic system (PAN) transmissions that took place inside the body. Later on, around the year 2001, To refer to software and connections that employ comfortable to wear (on/around) and implanted technologies, the word "portable ieee 802.11" (PAN) was changed to "wearable sensors" (BAN). As a result, BSN, or biological internet, is a sensory - motor that detects health features. (Koydemir& Ozcan, 2018). A wearable sensors networking, or WBAN for short, is a special purpose wireless device that consists of a number of networking and connected networks to enable direct tracking in a range of different scenarios, according (Lamonaca, Carn, and Scuro, 2021).

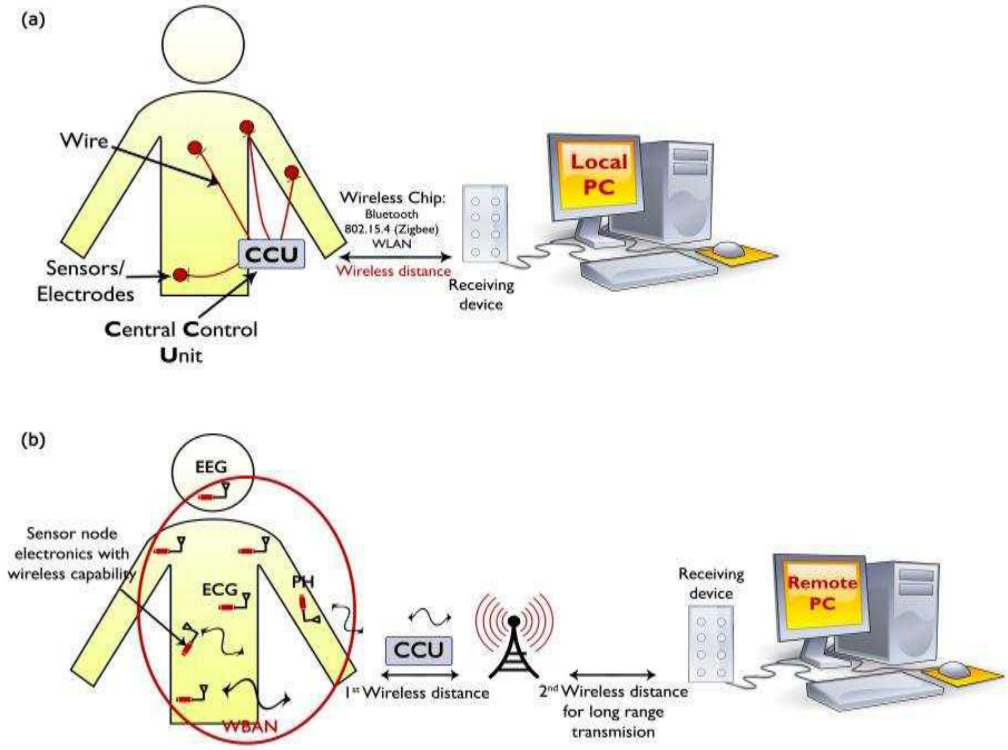

Figure 1: A typical WSN system for detecting and transmitting signals from a human Body (Chandrasekaran, Hemalatha, &Thamizhvani, 2020)

WBANs are used in hospitals to monitor a large number of patients in real time. To implement a complete WSN in hospital, constant supervision of several sufferers' biomedical signals is required. WBANs provide sensory information in a discrete and effective way, including body/intra-body temp, heart rate, and artery blood pressure. Observing people's life is a new embedded vision network application. Wireless sensors are carefully positioned on or within a patient's body to construct WBANs. Real-time cardiological recording using WBANs makes it possible to continuously track the progression of illnesses or degenerative diseases. A revolutionary deployment of cellular wsns for it on circuits is now possible because to recent advancements in ieee 802.11 (Chandrasekaran, Hemalatha, &Thamizhvani, 2020). The primary objective of this research is to carry out an in-depth literature review on the topic of the application of wireless sensor networks that can be worn on the body or implanted within the body for the purpose of usage in biomedical applications.

METHODOLOGY

Systematic Literature review is used in this research. This systematic literature review identifies and maps essential concepts and theories for autonomous wireless microsensors in biomedical applications. To establish the search scope, purpose, organisation, perspective, audience, and coverage, a taxonomy was developed and executed. As the goal of this SLR is to understand the theoretical underpinning and practical application of autonomous wireless micro sensors for biomedical, the search included various types of research literature. The goal was to combine and synthesise research literature to build autonomous wireless micro sensors. Both conceptual and methodological issues shaped the findings. The evaluation tried to be objective, giving no particular viewpoint more weight than others. All organisations directly or indirectly involved in biomedical applications were in attendance. An initial study of the available articles revealed a large quantity of research in this area; therefore, only a representative sample of the studies chosen using the selection criteria was covered.

RESULTS AND DSCUSSIONS

The provision of interfaces for the disabled, Examples of the therapeutic uses of internet of things include patients health surveillance, diagnostic tools, medication delivery in hospital, telemedicine of human clinical information, and following and monitoring clinicians and/or patient inside one school. Other applications include the monitoring of drug administration in hospitals (Li et al., 2018). The potential of WSN for healthcare monitoring will be investigated in some detail in this study (Jha et al., 2018), although the primary emphasis of this paper will be placed on implanted and wearable body area networks.

HUMANITARIAN PHYSIOLOGICAL DATA TELEMONITORING: Because once necessary, lab tests may use the bodily data collected by wireless sensor network since it may be stored for a long period of time. Secondly, the gadgets can track and identify the lifestyle of elderly people thanks to their ability to be placed. For instance, the Sherbrooke Department of Pharmacy, France, developed a "health smart home" in order to investigate the practicability of such systems (Han et al., 2019).

A HOSPITAL'S MAKING CONTINUOUS OF DOCTORS AND CLIENTS: A modest sensor node is fastened to each patient while they undergo treatment. The roles that sensors serve can cause them to vary, and each individual sensor node will have its own unique job to carry out. For instance, one sensor node could be responsible for determining the heart rate, while another sensor node could be responsible for determining the blood pressure. In addition, medical professionals have the ability to carry a sensor node with them at all times, which enables other medical professionals in the facility to locate them.

DRUG ADMINISTRATION IN HOSPITALS: If sensor nodes can be attached to medication, there will be less of a risk that patients will be given the incorrect drug or that doctors will prescribe the wrong medication to them. Patients will therefore have sensor nodes that identify their allergies and determine the medication that is necessary for them. It has been demonstrated that the use of computerised systems, such as those described in (Han et al. 2019), can assist reduce the adverse effects of medications.

Based on the specific functionalities being employed, data capture through such sensing in body area wireless networks may be the latter copy the original or point-to-point. Figure 1 illustrates how watching one's pulse rate requires entire stomachs and/or implants monitors to feed data stateful firewall to a sink node, that may then immediately the information to something like an out-of-body server. (Abdalkafor&Aliesawi, 2022) Players' postures might be distributed detected (Han et al., 2019), but this would involve point-to-point data exchange amongst a variety of being on equipment. Communication transmissions may occur immediately or during a subsequent date. While tracking vital signs on a person necessitates real-time load levelling, tracking vital signs on an athletes may be done offsite for pre-processing and statistical purposes. In contrast, patient monitoring applications are not like this. Standard wireless body-to-body internet protocols involve administration circuitry, wireless transceivers, and a number of small sensing devices that are lightweight, low-power, and lightweight. Because it is an essential part of the system, the power supply for these components needs to be as compact as possible, as light as possible, as kind to the environment as possible, and as long-lasting as possible.

In contrast to traditional WSNs, wireless body area networks (WBANs) are more compact, have fewer nodes, cover less area, and offer less chances for redundancy, as seen in Figure 2. When working with the two to ten nodes that are typical of a WBAN, scalability might contribute to inefficiencies in the workflow. If a BASN wants to limit the amount of space it takes up and the amount of resources it uses, adding redundant sensors and paths to the network cannot be a feasible solution to the problems of node failure and network congestion. WBANs are also characterised by their inherent hierarchical structure. They acquire a significant quantity of data in a continuous and lifelike manner, which should be processed by microprocessors in order to derive the required information. The processing of data must be done in a hierarchical fashion in order to take advantage of the imbalance of resources, to keep the efficiency of the system up, and to guarantee the availability of data in case it is required.

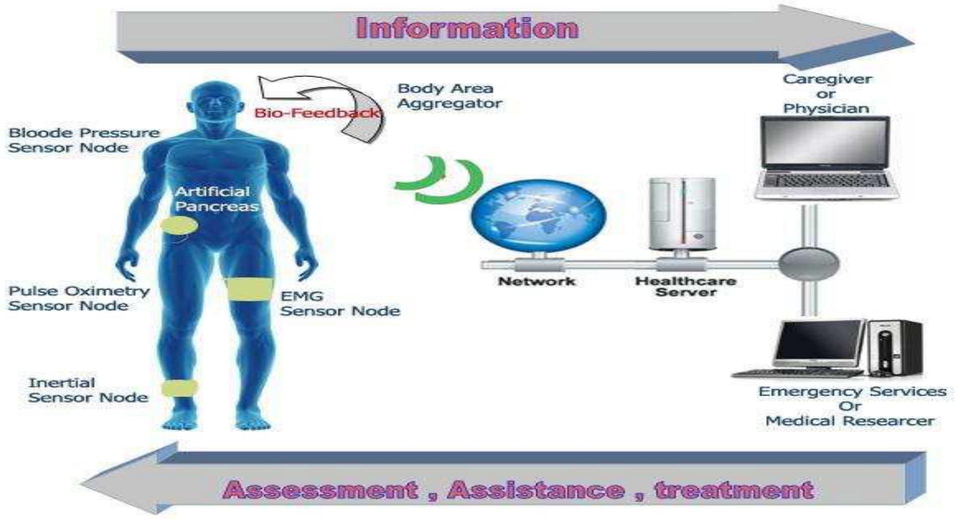

Figure 2: WBAN and its environment (Sowmya, Rout, and Patjoshi, 2021)

The use of WBANs in the medical setting involves Implantable wireless sensor networks that may instantaneously transmit genetic material across a percentage point to an inlet that must either be maintained on the brain or is situated in a conveniently accessible location position. A range of medical signals, including as electrocardiography (ecg, photoplethysmograms, electroencephalograms, pulse rate, humidity, and humidity, must be able to be detected by the sensor's circuit boards. The sensor's electrical components must also be simplified and have minimal power requirements. In a wireless personal connection, the information gathered from the controllers is then sent to distant locations for diagnosis and treatment usage. By integrating additional cellular connections with transmission line capabilities, this is made possible.

The measurements used in health doctors are currently not entirely wearable. This is because of their bulky electrical wiring and the need for wiring to connect to a number of different sensors. The current application of a sensor network that is utilised in a number of cutting-edge medical facilities is depicted in Figure 1(a). A wireless control unit is utilised to collect data from sensors that are connected via wires, and then the data is transmitted to a remote station in order to be monitored. It is not advised that patients use wires since the control unit is awkward to use, and this is done to ensure the patients' comfort. Figure 1(b) demonstrates that the future medical sensor network will require tiny and wearable sensor nodes that are able to wirelessly connect with the receiving device.

According to (Yadav et al., 2022; Ghosh et al., 2021), The structure and functions of something like the WBAN in query must contain the following noteworthy upgrades in order to properly use its advantages and characteristics for the medicinal environment going forward: Sensor node electronic design that is both inexpensive and compact, and it features wireless connectivity. Sensor nodes will have the ability to send data across a distance of a few metres or more. Miniaturizing sensor nodes allows for easier wearability and implantation, which is why this process is necessary. The combination of the functionality of the link layer and the physical layer should be utilised in the development of energy optimization methods for wireless devices. This will result in the provision of a longer battery lifetime, which in turn will increase the lifetime of the sensor nodes. It is recommended to make use of the mechanism known as "sleep mode" that for the bulk of something like the duration the mobile nodes are in low-electricity usage mode, which occurs when there is no need for data transmission. For each patient, it is necessary to determine which physiological data are crucial and which are not crucial. As an illustration, the importance placed on vital signals such as electrocardiograms may vary from patient to patient, but for certain individuals, it may be more than the importance placed on their temperature. As a result, the system used by WBANs needs to give priority to the vital data (Ghosh et al. 2021).

CONCLUSION

This study demonstrates that WBANs have significant potential for use in a variety of medical settings. It examines a variety of healthcare systems and applications, focusing mostly on implanted and wearable sensor systems, and the characterization of most significant difficulties and unsolved research questions with WBANs. It is possible that In a short time, expanding usage of these new small body networks will become as natural as the act of putting on fabric as nanotechnology continues to develop sensor nodes that are both smaller and capable of performing numerous functions. The usage of WBANs is anticipated to grow during the forecast period becuase smart venues will be equipped with wireless networked sensors that can assess weather parameters and conduct preventive measures determines the presence of people in such areas. This is because wireless networked sensors will be incorporated into smart environments. In order to reduce health issues, the strategy has the capability to become ubiquitous, where each individual would receive a computing module that can integrate with the cloud technology system organically.

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