

Collaborating The Sensor Networks in Bio-Medical: HumanBody

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Abstract: “Body area networks” (BANs) have developed as a novel form of wireless sensor networks, owing to the swift advancements in wireless communications, biomedical sensors, and low-power circuits. The networks consist of biomedical nodes characterized by their compact size, affordability, and energy efficiency, particularly employed for the purpose of healthcare monitoring. The objective of the study is to ensure the preservation of essential parameters. This study provides a comparative examination of “body area networks” and wireless sensor networks. This study demonstrates the application of body area networks for the integration and enhancement of principles developed from wireless sensor networks. To provide a visual representation, a research investigation focusing on the issues of energy consumption and heat absorption is undertaken.

Keywords: Body Area Networks, Wireless Sensor Networks, biomedical sensors, wireless communication, and healthcare monitoring etc.

1. Introduction

“Wireless sensor networks” (WSNs) possess an inherent ability to autonomously establish and maintain structured connections among themselves. These networks are designed to periodically monitor various physical or environmental parameters, including temperature, sound, vibration, pressure, and potential hazards. Subsequently, the collected data is transmitted through the established connections to a central location or sink, where it can be analyzed, visualized, and processed. The washbasin or base station functions as an intermediary interface. By integrating inquiries and aggregating outcomes from the source, one can retrieve essential information from the association. A sensor network that is widely distributed is most likely to possess a substantial quantity of sensor nodes. The nodes inside the sensor network possess the capability to engage in communication with one other.

Furthermore, an alternative method involves the utilization of radio waves. The sensor location that has been removed is equipped with the capability

to detect and measure force. The individual nodes of a wireless sensor network (WSN) typically possess limited resources, including a restricted data collection capacity and a limited communication bandwidth. The sensor networks face the risk of autonomously determining an appropriate configuration for their connectivity after their deployment. On certain occasions, I am required to engage with them through a kind of communication known as multi-skip correspondence. At present, the sensors have been successfully deployed and are actively gathering data through requests transmitted to a designated "control site" for the purpose of executing expedited navigational adjustments or conducting perception-based assessments. The sensor systems have the capability to operate in either a continuous or event-triggered mode. Both Global Positioning System (GPS) and local engineering evaluations can be utilized to gain an understanding of the geographical region and organize collected data. Actuators possess the capability to be incorporated into sensor devices that are situated in locations that are challenging

to access, thereby enabling them to execute certain actions upon the fulfilment of predetermined circumstances. These entities are commonly known as “Wireless Sensor and Actuator Networks” (WSANs).

The elderly demographic is experiencing a notable increase in size and a progressive development in age. The continuous increase in life expectancy can be attributed to the ongoing developments in the field of healthcare. Chronic diseases afflict a global population of 850 million individuals with some spending up to 85% of their income on treatment. They invest a large portion of their savings in health-care plans. Individual monitoring is necessary because it is always better to prevent a disease than to treat it, as a required activity on a regular basis. The emergence of “wireless sensor networks” (WSNs) has led to the development of novel applications, which in turn need the establishment of unconventional ideal models to achieve certain objectives. In order to meet the demand for low device complexity and low energy consumption, it is necessary to establish an appropriate balance between communication and signal/information processing capabilities, such as achieving long association lifetimes. This has resulted in a significant undertaking in the realm of resealing during the past decade, with a multitude of ideas emerging in this domain. Presently, a significant proportion of research in “Wireless Sensor Networks” (WSN) has been dedicated to the development of energy-efficient and computationally efficient algorithms and protocols. However, the scope of application for these advancements has been predominantly restricted to the domain of data gathering and decision-making inside networked systems. This proposal suggests the implementation of a Cable Mode Transition (CMT) evaluation, wherein a limited number of dynamic sensors are chosen to uphold K-thought regarding a particular scene, like how the K-accessibility of the association is preserved. The assignment of lethargic times to interface sensors is conducted in a manner that does not

compromise the alliance's idea and receptiveness requirements, which are submitted to rigorous examination. The establishment of a precise timeline holds significant importance inside a

deferral network. The network topology that has been developed seeks to mitigate the delays associated with data gathering in sensor networks that are challenging to access, hence prolonging the operational duration of the alliance. The utilization of hand-off concentrations was deemed by specialists to decrease the numerical demands of the alliance. In order to determine the optimal sink position, calculations based on Particle Swarm Optimization (PSO) were employed. Energy-efficient communication has also been able to propose a quantitative solution for determining the optimal sink position to prolong the lifespan of the connection. Historically, assessments of sensor networks that are not easily reachable have primarily concentrated on sensor position centers that are uniform in nature. Currently, researchers are directing their focus towards heterogeneous sensor networks, characterized by varying levels of energy consumption.

2. Related Work

Currently, scholars are directing their attention towards heterogeneous sensor networks, characterized by varying energy consumption patterns. Emerging association structures involving diverse devices, alongside a novel trend in this domain, are effectively eliminating existing obstacles and broadening the scope of potential applications for “Wireless Sensor Networks” (WSNs), which are undergoing quick advancements. ‘Wireless Sensor Networks,’ commonly referred to as WSNs, have garnered significant attention in recent times. The exploration of “Wireless Sensor Networks” (WSNs) can be treated as a relatively young area of study. Here is a summary of a challenging issue pertaining to the structure. Daily, a notable number of novel applications and potential commercial prospects arise. The market for WSN is projected to experience significant growth, with an estimated increase from \$0.45 billion in 2012 to \$2 billion by the year 2022. Figure 1 illustrates the upward trend in income within the WSN market for the period from 2010 to 2014. A “Wireless Sensor Network” (WSN) is a system comprised of small devices referred to as sensor nodes, which are dispersed in a spatial manner and work together to collect and aggregate data from the

observed area using wireless connections. The data obtained from different focal points is transmitted to a central repository, where it is either utilized within the local system or integrated with external networks, such as the internet. WSN advancement offers numerous advantages compared to traditional structure-based association solutions. These advantages include reduced prices, more adaptability, improved endurance, enhanced precision, greater flexibility, and simplified affiliation. Consequently, WSN progression has found widespread use in various domains. With the continuous advancement of technology and the increasing sophistication, affordability, and unobtrusiveness of sensors, a vast number of remote sensors are being used across many applications.

New possibilities in medical devices have emerged as a result of increased investigation into wireless sensor networks (WSN). The WSN is regarded as one of the most important technological breakthroughs of this century, and its significance is recognized. This knowledge is beneficial to health, psychology, fire prevention, security, and even the military. The advantage is that you will be able to keep track of everything. Traditionally, healthcare monitoring has been done on a check-in basis, with patients kept informed about their symptoms; a physician examines the patient, makes a diagnosis, and then, if possible, monitors the patient's progress during treatment. Wireless network infrastructures are used to monitor health in most cases. On the other hand, the coverage of these network infrastructures is limited. Biomedical sensors, like electrocardiograms, are now exclusively used in health monitoring applications. To put it another way, they have not yet been incorporated into communication networks. Given the increasing quantity of essential physiological indicators that necessitate simultaneous monitoring, it is imperative for many biomedical sensors to collaborate in order to gather concurrent readings. Moreover, the transmission of collected data from a sensor device to external parties is often imperative. Consequently, the establishment of a network including interconnected biological sensors has paramount importance. The factor would exert a substantial influence on the quality

of life experienced by patients, as well as the rates of success observed in their treatment outcomes. Furthermore, this technology exhibits potential for diverse future applications, encompassing the diabetes, monitoring of cardiovascular disease, and asthma, as well as facilitating case consultation through health-care systems and telemedicine among other possibilities.

"Body Area Networks" (BANs) have derived as a recent outcome of this technological advancement. These Wireless Sensor Networks (WSNs) represent a novel generation of technology specifically developed to monitor individuals' health status. A Body Area Network (BAN) comprises a collection of interconnected nodes, each equipped with wireless communication capabilities, biological sensors, and motion detectors. The nodes are responsible for gathering crucial physiological data, which is subsequently transferred wirelessly to a central unit for data processing. The nature of BAN nodes confers several advantages, including as mobility, ubiquitous connectivity, and integration [1]. Certain nodes have the capability to incorporate actuators, such as pacemakers or devices designed for the storage and administration of medications.

This article examines several issues associated with "Body Area Networks" (BANs). This study demonstrates the incorporation of concepts from the Wireless Sensor Network (WSN) literature into the BAN framework, resulting in notable enhancements. In this study, we examine the interconnectedness of energy use and heat absorption, focusing on their respective difficulties.

An Intelligent Agent (IA) Wireless Sensor Network (WSN) refers to a network composed of small wireless nodes with limited resources, which autonomously organize themselves and collaborate to accomplish a designated objective [1]. Wireless Sensor Networks (WSNs) exhibit several distinctions when compared to conventional wireless networks. Wireless Sensor Network (WSN) nodes possess constrained processing capabilities and memory resources, necessitating their dependence on either battery power or energy scavenging in various applications [2]. Furthermore, it should be noted that the

Bioengineering Sensor Network (BWSN) is a compact wireless sensor network (WSN) specifically developed for implementation in medical or healthcare contexts [3]. Examples of applications in the field of Body-Worn Sensor Networks (BWSN) include emergency response, patient monitoring, disaster, and ambient supported living for disabled, elderly individuals or old age [4]. The “Body-Worn Sensor Networks” (BWSNs) can be seen as a specific category within the broader domain of Wireless Sensor Networks (WSNs), as they possess similar attributes and features. Depending on their intended purpose and specific use, these technologies may introduce supplementary difficulties. The potential enhancement of healthcare quality can be attributed to the development of novel applications and services inside “Body-Worn Sensor Networks” (BWSNs). In the present

setting, due to the inherent characteristics of the data transmitted through “Body-Worn Sensor Networks” (BWSNs), it is imperative to provide a superior standard of service quality (QoS). Nevertheless, it is imperative that the QoS policy does not exclusively focus on conventional QoS communication measures such as jitter, delay, processing power, and queue length rate. The subsequent parts define the Quality of Service (QoS) prerequisites for “Body-Worn Sensor Networks” (BWSNs) in section II. They deliberate on the necessity of efficiency and equilibrium in BWSNs, and propose a formation approach grounded on Relay Nodes and Energy-Aware routing to prolong the system's lifespan. The proposed technique is critically evaluated and obtained data are analyzed, leading to the formulation of certain conclusions.

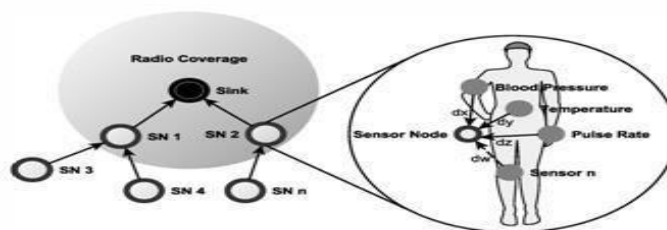


Fig 2.1. Each sensor node in a BWSN can generate distinct data flows.

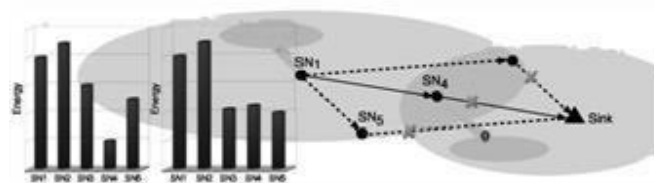


Fig 2.2. Distribution of residual energy in imbalanced and balanced networks.

From WSN to BAN

Wireless Sensor Networks are a novel class of tiny powerful computers enabled by recent advances in miniaturization and wireless communication (WSNs). WSNs are huge, large scalable, and personality systems that were designed primarily for assessment and control. These systems consist of a multitude of compact and cost-effective nodes that possess the ability to do computer science

tasks, sensing operations, and communication functions. To the best of our knowledge, the concept of intelligent particles has not yet been realized. On the contrary, the concerns and challenges faced by Wireless Sensor Networks (WSNs) present a multitude of novel opportunities. Wireless Sensor Networks (WSNs) are expected to have significant applications in several fields, such as animal migration tracking, environmental monitoring,

industrial control, security surveillance, and personal use. Healthcare monitoring has emerged as a prominent topic of focus in recent years, alongside several other sectors.

WSN technology is still in its early stages of development. However, the challenges associated with human body monitoring are not addressed in WSN research. A novel cohort of Wireless Sensor Networks (WSNs) has arisen in the form of

Body Area Networks (BANs). BANs offer a novel paradigm in various domains of WSNs technology, including the Application layer, the routing strategic thinking, the network layer, and other relevant areas within the biological biosensor context. Despite the shared hurdles in battery technology, Wireless Sensor Networks (WSNs) and Body Area Networks (BANs) encounter distinct obstacles, as seen.

Table 1. The distinctions between WSNs and BANs

	“Wireless Sensor Networks”	“Body Area Networks”
Capacity	The capability to cover broad areas, spanning multiple km.	The human body imposes limitations in terms of measurement, specifically in centimeters.
Node number	There exists a significant quantity of nodes required to achieve comprehensive coverage.	There exists a restricted quantity of ubiquitous nodes.
Accuracy	The redundancy is compensated for.	The disposability of failure nodes is a common occurrence. The task at hand poses a considerable level of complexity.
Failure	Nodes are disposable. Frequently considered to be	The challenging task of replacing implanted nodes. The concept being discussed pertains to either motion or the generation of heat by a living organism.
Energy	The topic of discussion pertains to the comparison between solar power and wind power.	The concept being discussed pertains to either motion or the generation of heat by a living organism.

A body area network (BAN) is a collection of wearable on-body computing devices. It can also include biosensor devices that are implanted in the body. According to IEEE A BAN is defined as “low power devices operating on, in, or around the human body (but not limited to humans) to serve a variety of applications including medical, consumer electronic personal entertainment, and other,”. The BANs have a wi-fi network. However, the healthcare monitoring applications and biomedical continue to pose the greatest research and engineering challenges. Indeed, the evolution of BANs should keep pace with the rapid advancements in the medical field, with Accuracy measurements are required by each node. The primary goal of ensuring the implementation of continuous and comprehensive surveillance of individuals in their residential or occupational settings.

Requirements in body area networks

BANs can be considered as a type of Wireless

Sensor Networks (WSNs), although they exert significant pressure on WSNs by employing various strategies to maximize their capabilities. Indeed, body area networks (BANs) are constrained to the confines of the human body, with a limited number of nodes being deployed. The potential for substantial data loss in Body Area Networks (BANs) arises from the inherent constraint of having a limited number of sensing devices. This stands in contrast to Wireless Sensor Networks (WSNs), where nodes provide redundant information, thereby mitigating the risk of data loss. Consequently, it is imperative for every node, especially nodes to furnish accurate measurements. In order to assure the provision of real-time data delivery and quality-of-service that may be necessary to conduct supplementary measurements. This is particularly crucial within the medical domain, as the reliability of these measurements holds utmost importance. Furthermore, BANs are frequently made up of networks of devices that perform different tasks. ECG, blood pressure, pulse oximetry, temperature,

respiratory, and other devices are examples of these devices. Such a wide range of characteristics necessitates a variety of approaches.

Some BAN devices, However, it is necessary for the implant to be inserted in vivo, directly into the human body. The replacement of implanted biosensors requires the consideration of biocompatibility and robustness. Moreover, considering the limited availability of electricity, the system operates with minimal energy demands. Furthermore, in

the context of Body Area Networks (BANs), nodes are strategically placed near or within the anatomical structure of the human body. This phenomenon has the potential to cause significant absorption of magnetic radio-frequency radiation, resulting in an increase in body temperature. Based on the established safety thresholds for radio-frequency energy exposure, it is recommended that the distribution of communications be equitably allocated among a collective of individuals.

3. Energy scavenging

Because Implanted biosensors provide challenges in terms of accessibility and replacement due to their inherent nature the energy consumption of BANs is critical. A pacemaker battery, for example, typically lasts 5- 10 years. Because the pacemaker's battery is sealed inside, replacing it necessitates the replacement of the entire system. An extra amount of e has been added to extend the life of battery-powered devices. BANs introduced a new type of energy scavenging, in contrast to WSNs, which place a strong emphasis on solar energy. By harnessing the thermal energy and mechanical vibrations generated by the human body, gadgets have the capability to extract power. The graphic below illustrates that while the motion and heat of the human body offer novel opportunities, they also give rise to additional obstacles.

Body motion

Inertial-power scavenging enables the generation of electrical power through the utilization of motion and vibration. The conversion of electrical power from natural human body motion can be

achieved with relative ease. Electronic self-winding timepieces that rely on mechanical movement, such as the Seiko Automatic Generating System and the ETA Auto quartz serve as notable illustrations of this phenomenon. The utilization of piezoelectric or capacitive methodologies exhibits greater potential. The augmentation of power in BANs is accompanied by the emergence of novel difficulties. Indeed, because to the inherent flexibility of the human body, the gadgets possess the capability to exhibit movement, albeit in relation to each other. When designing the network architecture, it is important to consider the potential for frequent changes in the network topology. BANs must to possess the capability to effectively respond to these alterations, such as modifying the routing scheme and granting nodes the ability to autonomously organize themselves.

Body heat

The Peltier-Seebeck effect explains how temperature differences can be converted directly into electrical power. The Carnot's theorem, like any other heat engine, thermoelectric energy efficiency is limited. To achieve satisfactory levels of power and voltage large thermal gradients are required in practice. This restricts the use of thermoelectric energy in BANs, which is generated by the body's own heat. Although it is not possible to control the temperature of the environment, the average human body temperature remains relatively constant at approximately 37 degrees Celsius (98.6 degrees Fahrenheit). It is probable that the temperature in BANs will vary from this prevailing value. The transmission of radio-frequency signals from wireless nodes that are either located on the body or implanted within it has been found to contribute to the absorption of radiation, hence potentially causing thermal consequences. In order to ensure safety, it is imperative to minimize the absorption of radiation.

WSN to BAN routing information

This section focuses on addressing the routing problem in Body Area Networks (BANs) by employing approaches derived from the "Wireless Sensor Network" (WSN) research. The objective of

our study is to illustrate the way "Body Area Networks" (BANs) adopt and enhance concepts derived from "Wireless Sensor Networks" (WSNs). This paper outlines three distinct approaches, each aimed at achieving a common objective: the mitigation of energy absorption by the human body and subsequent dissipation as thermal energy. This challenge is addressed through the utilization of a cluster-based routing system and a 'temperature-aware routing system'.

In "wireless sensor networks" (WSNs), there is a desire for routing algorithms that include many qualities. These properties include the maximization of system lifetime by ensuring uniform battery usage among nodes, as well as the ability to be applied to large-scale networks. Conventional network protocols, such as direct transmission, multi-hop, and clustering, fail to fulfil these specified criteria. The LEACH (Low Energy Adaptive Clustering Hierarchy) technique, as described in reference [9], effectively achieves the necessary characteristics through the integration of a hierarchical protocol with cluster head nodes for data aggregation and compression, as well as the implementation of a randomized rotation mechanism for the cluster head nodes. Indeed, in the case of most nodes, specifically the non-cluster head nodes, the utilization of a cluster-based hierarchy facilitates the achievement of shorter communication distances. The allocation of energy requirements is evenly balanced among all sensors by the rotation of cluster head nodes and the adaptation of corresponding clusters. Furthermore, data is compressed at each cluster head node, resulting in a further reduction in energy consumption.

Several BAN algorithms have been created based on the LEACH protocol and a node clustering structure. The authors in reference [11] priorities node self-organization over LEACH's random election process, as the latter may lead to the formation of isolated nodes. In their study, the researchers in [12] employ clustering techniques to effectively decrease the quantity of lengthy direct communications, while simultaneously implementing parallel methods 'Temperature-aware routing'. The "Specific Absorption Rate" (SAR) is a quantitative measure utilized to assess the magnitude of power dissipation resulting from

thermal effects. The term "specific absorption rate" refers to the measure of power absorbed per unit mass of tissue. The specific absorption rate (SAR) ought to be considered inside the body area network (BAN), whether at a local or global scale, by calculating its average value across the entirety of tissue mass situated between the transmitting and receiving entities. The thermal impacts of body area networks (BANs) are mitigated as a result of specific absorption rate (SAR) considerations. The study conducted by [14] investigated the concept of temperature-aware routing through the implementation of a strategy involving the rotation of cluster head nodes. This rotation was determined based on the nodes' leadership history and their respective locations within the network. In this study, the authors suggest an adaptive least-temperature routing algorithm that effectively directs data away from regions and locations with elevated temperatures. In order to accomplish this objective, the implementation of multi-hop routing is employed, wherein each node selects the subsequent node with the minimum temperature as its next hop. In order to mitigate this drawback, one potential approach is to employ the shortest path routing algorithm that minimizes the cumulative temperature. In their study, the authors [16] employ Dijkstra's algorithm to assign graph weights based on node temperature values, so enabling the identification of the shortest temperature path.

Implanted sensor networks in vivo provide additional constraints, including limitations arising from the absorption of communication power in the tissue, known as specific absorption rate (SAR), which is dissipated as thermal energy. Consequently, conventional propagation models that consider losses caused by free-space wave propagation and multiple-path fading are rendered invalid. The presence of saline water in the human body characterizes the composition of the hu. The transmission of information Considerable progress has been made in the domain of quantifying and computing Specific Absorption Rate (SAR) within human tissues, alongside establishing thresholds for safe absorption levels. The disparity between in-body propagation losses and on-body propagation

losses is widely recognized. Consequently, the efficacy of data routing between implanted nodes for long-range communications may be compromised. The authors of reference [18] propose the utilization of an on-body coordinator as a novel network design for implanted networks. The coordinator functions as a central hub, facilitating the transmission of data between interconnected implanted nodes.

Most healthcare professionals' decisions nowadays are based on data obtained from electronic or/and computer systems. This type of information about a person's health must be of medical quality. [5] defines medical quality as "the extent to which health-care systems, services, and supplies for individuals and populations increase the likelihood of positive outcomes. The term Quality of Service (QoS) is used in a variety of ways in the industrial and scientific communities. The International Telecommunications Union defines Quality of Service (QoS) as the "totality of characteristics of a telecommunication service that can be measured" in its E.800 recommendation. Its ability to meet the expressed and implied needs of the service's user ", Communication networks (including BWSNs) used to transport medical data are a keystone in ensuring high standards of quality in healthcare professionals' services, according to this definition. According to RFC2386, Quality of Service (QoS) is defined as follows: "The network must meet a set of service requirements. Battery-powered wireless sensor networks (BWSNs) consist of multiple sensor nodes that rely on battery power. These nodes are required to operate for extended periods, with the specific duration depending on the intended application. It is essential for BWSNs to have a lifespan ranging from 24 hours to several days, as dictated by the specific requirements of the application. Consequently, the optimization of energy efficiency emerges as a crucial necessity for Body-Worn Sensor Networks (BWSNs) with the aim of prolonging the network's operational lifespan. Radio-frequency transmission is commonly linked with some of the most energy-intensive operations in Body-Worn Sensor Networks (BWSNs). In recent years, there have been numerous proposals for building routing protocols that prioritizes energy efficiency. The primary

objective of these approaches is to identify paths that are energy-efficient in order to prolong the overall lifespan of the network

[10] [11]. However, it is important to note that energy efficiency alone may not be sufficient to ensure an extended network lifespan. It is critical to consider the Remaining Energy (RE) on each sensor n . When the SN1 node sends messages to the sink, it may choose to route them via SN4, which serves as its ideal parent node and provides the most energy-efficient path to the sink. However, this routing decision has the potential to render SN4 inactive as a result of energy depletion, as indicated by reference [13]. The factor can significantly influence the network's capacity to fulfil the Quality of Service (QoS) criteria. However, it is desirable to have an energy-balanced network that incorporates alternate pathways. The concept of network lifespan, as explored in the referenced literature [21], can be delineated by multiple definitions. In this investigation, the system

lifetime was determined as the point at which the First Dead Node (FDN) emerged. This criterion was chosen due to the limited number of nodes and low redundancy levels often found in Body-Worn Sensor Networks (BWSNs). Multiple simulations were conducted to assess the network longevity, and the findings indicated a noteworthy enhancement of 45 percent. The area designated for dining purposes.

Conclusion

The objective of this study was to illustrate the interconnectedness between Body Area Networks (BAN) and Wireless Sensor Networks (WSN), whereby both domains mutually exchange and improve upon each other's concepts. The routing problem was utilized as a means of demonstration, wherein BAN incorporates supplementary restrictions including SAR, temperature and energy usage. All these restrictions are interconnected. The lack of adherence to the BAN survey framework is apparent in this paper. The investigation of physiological biosensors and the MAC layer, as well as the examination of security concerns, were not undertaken. We direct interested readers to more comprehensive research articles.

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