A Survey Paper on Wireless Body Area Network in Healthcare System

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Abstract— The increasing use of wireless networks and the constant miniaturization of electrical devices has empowered the development of Wireless Body Area Networks (WBANs). In these networks various sensors are attached on clothing or on the body or even implanted under the skin. The wireless nature of the network and the wide variety of sensors offer numerous new, practical and innovative applications to improve health care and the Quality of Life. The sensors of a WBAN measure for example the heartbeat, the body temperature or record a prolonged electrocardiogram. Using a WBAN, the patient experiences a greater physical mobility and is no longer compelled to stay in the hospital. This paper offers a survey of the concept of Wireless Body Area Networks.

Keywords— wireless sensor network, wireless body area network, health care, electrocardiogram

I. INTRODUCTION

Wireless Sensor Networks (WSNs) are used to monitor certain parameters in many applications like environment monitoring, inhabitant monitoring, battle field, agriculture field monitoring and smart homes. These wireless sensors are dispersed in sensing area to monitor field. WBAN is new emerging sub-field of WSN. A key application of WBAN is health monitoring. Wireless sensors are placed on the human body or implanted in the body to monitor vital signs like blood pressure, body temperature, heart rate, glucose level etc. Use of WBAN technology to monitor health parameters significantly reduces the expenditures of patient in hospital. With the help of WBAN technology, patients are monitored at home for longer period. Sensors continuously sense data and forward to medical server. BAN is also called as BSN. BSN is becoming very important aspect in the human’s life. As the technologies based on BSN are increasing day by day. These technologies are used in mainly healthcare system. In medical healthcare system it is used as patient monitoring system. For medical monitoring system it requires some kind of hardware resources, sensors etc. also the network will be formed of sensors and hardware for solving the problems in healthcare system. BAN is built from sensor, battery and processor. Various IEEE standards are available for BAN. IEEE 802.15.6 standard is for BAN. Various advantages are taken for other wireless communication standards from IEEE 802.16 Group 6. IEEE 802.15 standard for short range, low complexity, low cost and also very low power consumption. Three aspects are presented by IEEE 802.15.6 standard which are physical layer(PHY), medium access layer(MAC), and security aspects. BAN is used for sensing the values from the body of patient. Those can be ECG sensor, motion sensor, heart rate sensor, pressure sensor, positioning sensor etc. To make the connection between the sensors and hardware device the wireless sensors are used. The wireless technologies are the next step for improving the mobile health applications.

Fig. 1 Example of patient monitoring in Wireless Body Area
Mobile health is also referred as mHealth and electronics health is referred as eHealth. A Wireless Body Area Network contains small and intelligent systems or devices attached to the body of the patient which is to be continuously monitored by the mobile health application over a wireless communication device which can be Zigbee or Bluetooth. WBAN gives the continuous data and monitoring and real-time graphs and feedback to the user, patient or to the doctor allocated for that patient. Next the values taken are used for analyzing purpose. The analyzed values are used to check that any kind of disease will occur. The data is recorded for the long period of time.

II. WIRELESS BODY AREA NETWORK

Wireless body area network is also part of BAN or Wireless Body Sensor Network (WBSN). It is composed of one or more Body Sensor Units (BSU), one Body Central Unit (BCU) and work with long range network such as ZigBee or Bluetooth etc. By using new technologies in electronics the small sized and intelligent sensors are used in the biomedical system to improve the performance of the health care system. The sensors are connected to the small sized hardware and the data from the sensors is used to transfer. Also the data is sent to the medical server and it is analyzed over there and stored. Wired connection used for this purpose is time consuming and even much complex. Also it includes more deployment cost and maintenance cost.

Wireless connection used in the WBAN applications is easier and cost efficient. The patient can move anywhere and there is no need to be present in hospital or no need to stay under observation. By using such systems can improve the medical health care and minimizes the cost.

In general, the devices used are of two types such as actuators and sensors. Sensors are used to measure the parameters of the patient’s body such as body temperature, heart rate etc. To make the connection between the sensors and hardware device the wireless devices are used.

![Fig. 2 Architecture of wireless body sensor network](image)

III. ROUTING ISSUES AND CHALLENGES IN WBAN'S

Design and development of efficient routing protocols for WBSNs is a challenging job due to their unique requirements and specific characteristics. In the following sections, we discuss the routing issues and challenges of WBSNs.

A. Network Topology

Network topology describes the logical way in which the different communicating devices communicate with each other. Efficient routing protocol development requires a proper network topology as it affects the overall performance of the communication system. Proper network topology is very important for WBSNs because of the energy constraint, body postural movements, heterogeneous nature of the sensors and short transmission range.

B. Topological Partitioning

The network topology of WBSNs often faces the problem of disconnection or partitioning because of body postural movements and short range transmissions. Different researchers have tried to solve the problem of disconnection and partitioning in different ways. For example, the authors of use Line-of-Sight (LoS) and None-Line-of-Sight (NLoS) communication, while the authors of use store-and-forward routing to solve this problem. Therefore, the proposed routing protocols should take care of the different topological changes.

C. Energy Efficiency

Energy efficiency covers both the local energy consumption of nodes and the overall network lifetime. For implanted bio-medical sensors, it is not possible to replace the power source, while for wearable bio-medical sensors replacing the batteries might lead to discomfort of patients. Therefore, both energy consumption and network lifetime are major challenges in wireless body sensor networks. Communication among the sensor nodes consumes more energy as compared to sensing and processing. Any proposed algorithm should be able to use different paths and/or nodes to send
the data instead of depending on a single path and/or node preventing the consumption of total energy of that specific node(s).

D. Limited Resources

Along with limited energy source, WBSNs also have short Radio Frequency (RF) transmission range, poor computation capabilities, limited storage capacity, as well as low bandwidth—which may keep on changing due to noise and other interferences. Researchers must be aware of the limited resources when designing routing protocols for WBSNs.

E. Quality of Service (QoS)

In WBSNs different types of data require different quality of services as it deals with vital signs of the human body. The authors in have classified the patient data into critical data (like EEG, ECG etc.), delay sensitive data (for example video streaming), reliability-sensitive data (like vital signals monitoring respiration monitor, and PH monitor) and ordinary data (for example temperature, heartbeat, etc.). The other data-centric applications of WSNs also cannot tolerate latency and/or any loss of packets. The proposed protocols need to be aware of the different types of quality of service required for different types of patients’ vital sign- related data.

F. Radiation Absorption and Overheating

The two sources of temperature rise of a node are antenna radiation absorption and power consumption of node circuitry, which will affect the heat sensitive organs of the human body and may damage some tissues. Researchers should carefully develop the routing protocols for WBSNs to keep human tissues safe from any overheating caused by radiation absorption and operation of the implanted bio-medical sensor nodes.

G. Heterogeneous Environment

Different types of sensor nodes are required to sense and monitor the different health parameters of human beings, which may also differ in computation, storage capabilities and energy consumption. Thus the heterogeneous nature of WBSNs also imposes some more challenges.

H. Path Loss

Path loss or path attenuation is a measure of the decline in power density of an electromagnetic wave as it propagates through the wireless medium. It is the ratio of the power of transmitted to received signals. The wireless communication between the implanted sensor nodes is through the human body where the path loss exponent varies from four to seven, which is very high as compared to the free space, where it is two. The researcher must consider the path loss while designing routing protocols for wireless body sensor networks.

I. Security and Privacy

Like other applications of WSNs, security and privacy are among the basic requirements of WBSNs. It is impossible to apply the conventional techniques of security and privacy because of the low energy availability, limited resources and other constraints. Researchers should take care of the privacy and security of the patient’s data while designing routing protocols for WBSNs.

IV. RELATED WORK


We provide an in-depth study of applying wireless sensor networks to real-world habitat monitoring. A set of system design requirements are developed that cover the hardware design of the nodes, the design of the sensor network, and the capabilities for remote data access and management. A system architecture is proposed to address these requirements for habitat monitoring in general, and an instance of the architecture for monitoring seabird nesting environment and behavior is presented. The currently deployed network consists of 32 nodes on a small island off the coast of Maine streaming useful live data onto the web. The application-driven design exercise serves to identify important areas of further work in data sampling, communications, network retasking, and health monitoring.


Wireless Sensor Networks (WSNs) with their dynamic applications gained a tremendous attention of researchers. Constant monitoring of critical situations attracted researchers to utilize WSNs at vast platforms. The main focus in WSNs is to enhance network life-time as much as one could, for efficient and optimal utilization of resources. Different approaches based upon clustering are proposed for optimum functionality. Network life-time is always related with energy of sensor nodes deployed at remote areas for constant and fault tolerant monitoring. In this work, we propose Quadrature-LEACH (Q-LEACH) for homogenous networks which enhances stability period, network life-time and throughput quiet significantly.

Wireless Body Area Networks (WBANs) form a new and interesting area in the world of remote health monitoring. An important concern in such networks is the communication between the sensors. This communication needs to be energy efficient and highly reliable while keeping delays low. Mobility also has to be supported as the nodes are positioned on different parts of the body that move with regard to each other. In this paper, we present a new cross-layer communication protocol for WBANs: CICADA or Cascading Information retrieval by Controlling Access with Distributed slot Assignment. The protocol sets up a network tree in a distributed manner. This tree structure is subsequently used to guarantee collision free access to the medium and to route data towards the sink.


This paper presents a location based store-and-forward packet routing algorithm for wireless body area networks (WBAN) with frequent postural partitioning. A prototype WBAN has been constructed for experimentally characterizing on-body topology disconnections in the presence of ultra short range radio links, unpredictable RF attenuation, and human postural mobility. A location based packet routing protocol is then developed. The performance of the proposed protocol is evaluated experimentally, and is compared with a generic probabilistic routing protocol and a specialized on-body packet flooding mechanism that provides the routing delay lower-bounds. It is shown that via successfully leveraging the node location information, the proposed algorithm can provide better routing delay performance compared to existing probabilistic routing protocols in the literature.


Wireless body area sensor networks will revolutionize health care services by remote, continuous and non-invasive monitoring. Body area sensor networks (BASN) should monitor various physiological parameters of a person for a long period of time. Thus, efficient energy usage in sensor nodes is essential in order to provide a long life time for the network. This paper investigates the effect of adding a relay network to the network of body sensors to reduce energy consumption of sensor nodes when transmitting data to the sink.

V. PROPOSED WORK

Wireless Body Area Sensors are used to monitor human health with limited energy resources. Different energy efficient routing schemes are used to forward data from body sensors to medical server. It is important that sensed data of patient reliably received to medical specialist for further analysis. Proposed scheme facilitate mobility at cost of low throughput and additional hardware cost of relay node. They deploy sink at wrist. Whenever sink node goes away from transmission range of nodes, it uses a relay node which collect data from sensor nodes. In opportunistic protocol, whenever patient moves his hands, the wireless link of sink with sensor nodes disconnects. Link failure consumes more power of sensor nodes and relay node also more packets will drop, which causes important and critical data to loss.

To minimize energy consumption and to increase the throughput, we propose a new scheme. Our contribution includes:

- Our proposed scheme achieves a longer stability period. Nodes stay alive for longer period and consume minimum energy.
- Large stability period and minimum energy consumption of nodes, contribute to high throughput.

VI. CONCLUSION

WBNSN is a technology that can provide a paradigm shift towards proactive management by focusing on prevention and early detection of different diseases. It can revolutionize the next generation healthcare issues and reduce healthcare costs. Designing routing protocols for WBSNs is a challenging task due to unique in-body and on-body constraints. In this paper, first we discussed the architecture of Wireless Body Sensor Networks (WBSNs) and then the routing issues and challenges of WBSNs.

REFERENCES


