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A Survey on Wireless Sensor Networks in Human Healthcare Monitoring System

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Abstract: **Wireless Sensor Network (WSN) is widely used in medical applications to monitor the human physiological activities periodically like blood pressure, glucose level, heart rate, sugar etc., Basically, sensors are of two types such as Wearable and Implanted. Wearable devices are used on the body surface of a human or just at close proximity of the user for action. The implantable medical devices are those that are inserted inside human body to measure the needs. There is no need for a doctor to check the patient's activities periodically and it reduces the overhead in exiting technologies which are created for smart work. Wireless Sensor technology can be designed with hundreds or thousands of sensing nodes. These sensing nodes are used to capture or sensing the data and then the data can be passed to several nodes to acquire the patient physiological details and other needful information's. Such sensitive are maintained by using some security and privacy methods. This paper reviews the various types of wireless technologies used for medical applications such as WLAN, WPAN, WIMAX and WBAN and states their frequency, range standard etc., These wireless technologies are compared based on the factors such as energy consumption, security, routing protocols in order to increase the efficiency and effectiveness of the monitoring system.**

Keywords: Healthcare, Wireless Sensor, Routing Protocols, Security and Energy consumption.

I. INTRODUCTION

Different wireless technologies are used in medical applications such as WBAN, WPAN, WWSN etc., and Wireless Body Area Network (WBAN) is a widely using technology used in medical applications with continuously operating sensors, which measures the patient physiological signals such as mobility, blood pressure, heart rate and glucose levels, etc., Two categories of wireless sensor networks namely wearable and implanted are present in the field. The survey is presented with Wearable Wireless Sensor Networks (WWSN). The performance analysis of the wireless sensors networks how will they perform in healthcare or hospital environment in a secured manner such as packet segmentation, packet loss, access delay etc., Implement a Wireless Personal Area Network (WPAN) to monitor the patients periodical activities such as EEG, ECG, GSR etc., and communicate with personal server integrates information from different sensors are taken for research.

There are many other applications too e.g. body position measurement and location of the person, overall monitoring of sick patients in hospitals and at homes. Body-area networks can collect information about an individual person's health, fitness, and energy expenditure. Cross-layer is becoming an important studying area for wireless communications. In addition, the traditional layered approach presents three main problems

- Traditional layered approach cannot share different information among different layers, which leads to each layer not having complete information.
- The traditional layered approach cannot guarantee the optimization of the entire network.
- The traditional layered approach does not have the ability to adapt to the environmental change.

Because of the interference between the different users, access conflicts, fading, and the change of environment in the wireless sensor networks, traditional layered approach for wired networks is not applicable to wireless networks. The base stations are one or more components of the WSN with much more computational, energy and communication resources. They act as a gateway between sensor nodes and the end user as they typically forward data from the WSN on to a server.

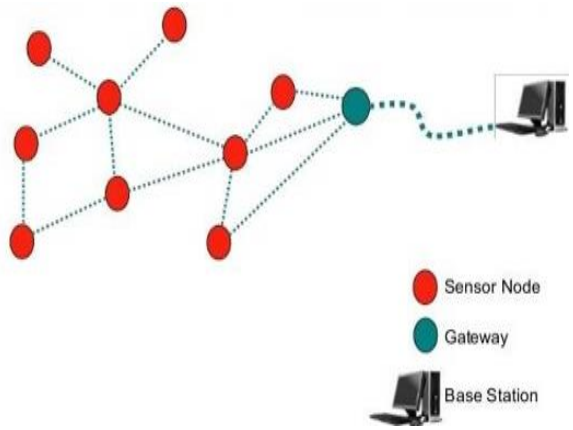

Fig. 1. Architecture of Wireless Sensor Networks

Above figure represents the basic architecture of Wireless Sensor Networks by means of working mode. To address the fast growing sensor technology in this area, a new field known as Wireless Body Area Networks (WBAN) has emerged. Applications of wireless sensor networks mainly focused on the monitoring of health status of patients have been in demand and various projects are in the development and implementation stages. Sensor technologies in healthcare application scenario are shown in Figure 2.

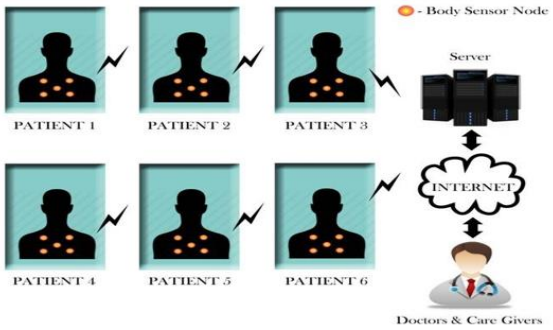

Fig. 2. Wireless Technology in Healthcare Monitoring System.

In wireless body area network is used to capture the patient's sensitive data so need to secure them in a proper way from unauthorized access. This paper concerns of major social implications like privacy and security. It mainly focuses on the causes and effects of these two issues. Basically, Wireless Sensor Network (WSN) is a wireless network consisting of spatially distributed autonomous devices that use sensors to monitor physical or environmental conditions. These autonomous devices, or nodes, combine with routers and a gateway to create a typical WSN system. Sensor networks are the key to gathering the information needed by smart environments, whether in buildings, utilities, industrial, home, shipboard, transportation systems automation, or elsewhere. Recent terrorist and guerrilla warfare countermeasures require distributed networks of sensors that can be deployed and have self-organizing capabilities. In such applications, running wires or cabling is usually impractical. A sensor network is required that is fast and easy to install and maintain. The smart gateway is designed to enable WSN and public communication networks to access each other with seamless internetworking.

II. RELATED WORK

One of the challenging processes in wireless sensor network is to distribute the data to several nodes. From this sensing the data, allocation of task, scheduling the task are the important consideration in wireless sensor networks. Operating systems and middleware architectures for WSNs implement a several services for distribution of data. Using Wireless Sensor Networks (WSNs) in health care system has yielded a tremendous effort in recent years. However, in most of these researches, tasks like sensor data processing, health state decisions making and emergency messages sending are completed by a remote server. Transmitting and handing with a large scale of data from body sensors consume a lot of communication resource, bring a burden to the remote server and delay the decision time and notification time.

Sunil et al presented the system Architecture for smart Healthcare using Wireless Sensor Network (WSN) with GSM Module and Microcontroller. They represent monitoring system to monitor the physiological parameters such as Blood Pressure (BP), ECG, Body Temperature and Respiration etc. The coordinator node has attached on body of patients for collecting the signal from wireless sensors. The wireless sensors send this signal to base station or control room of physician. This wireless sensors form wireless body sensor network (WBSN). Node of each WSN composed of health care sensors and RF transeceiver which send data to back end sever. Sensors can choose in the range of WSNs, while RF transeceiver is implemented as a coordinator which manages WSN other than forwards data. The sensing data of each patient are stored in back-end server with each having its own ID. The data analysis, database inquiry, data manning and the system management are processed on the web page of server. The system can detect abnormal condition of patients and send the SMS or e-mail to the physician. It is advantageous to patient and associate relative of patient and others who may use the continuous remote health monitoring.

By using wireless sensor network their system improves the quality of medical healthcare system. By using Wireless sensor networks it make patients life more comfortable and provide viable solutions. The security is very important in monitoring of healthcare which may provide by wireless sensor network. So it is an emerging research topic and it is worth studying. They provide a clearly comprehensive study of security research in healthcare application using WSNs and also present the design, deployment, and evaluation of a wireless pulse oximetry monitoring system in a hospital unit. . The study presented in their paper involves real patients monitored in a clinical setting. The patients were monitored in situ to realistically assess the feasibility of WSN technology for patient monitoring. Our research is kind of network architecture named Health monitoring network which integrates WSNs into internet. Each WSN is organized as a mobile ad-hoc network with one allocated mesh router connecting with internet. The health care data collected by sensor node are all transmitted to mesh router, then forwarded to back-end web server through internet. The whole network administration including working mode setting for sensor node, sensing data managing and analyzing are processed on back-end server. A test bed is constructed to test the performance of Health Care Monitoring Net, where sensor node measures blood pressure, ECG, heart rate, temperature. Deepak et al developed a portable real-time wireless health monitoring system which is used for remote monitoring of patients heart rate and oxygen saturation in blood. The system was designed and implemented using ZigBee wireless technologies. All pulse oximetry data are transferred within a group of wireless personal area network (WPAN) to database computer server. The sensor modules were designed for low power operation with a program that can adjust power management depending on scenarios of power source and current power operation. Their sensor was designed for reducing the cost, size and comfortable in daily life usage. From their experimental results, the system can successfully install for testing in patient's home for health care monitoring and the wireless sensor network can operate on an area of 10-15 square meters.

Aleksandar et al demonstrates the use of WWBANs as a key infrastructure enabling unobtrusive, continual, ambulatory health monitoring. This new technology has potential to offer a wide range of benefits to patients, medical personnel, and society through continuous monitoring in the ambulatory setting, early detection of abnormal conditions, supervised rehabilitation, and potential knowledge discovery through data mining of all gathered information. We have described a general WWBAN architecture, important implementation issues, and our prototype WWBAN based on off-the-shelf

wireless sensor platforms and custom-designed ECG and motion sensors. We have addressed several key technical issues such as sensor node hardware architecture, software architecture, network time synchronization, and energy conservation. Further efforts are necessary to improve QoS of wireless communication, reliability of sensor nodes, security, and standardization of interfaces and interoperability. In addition, further studies of different medical conditions in clinical and ambulatory settings are necessary to determine specific limitations and possible new applications of this technology.

D Mahesh Kumar present a prototype of a smart gateway which is an interconnection and services management platform especially for WSN health care systems at home environment. By building a bridge between a WS and public communication networks, and being compatible with an onboard data decision system and a lightweight database, their smart gateway system is enabled to make patients' health state decisions in low-power and low-cost embedded system and get faster response time o the emergencies. We have also designed the communication protocols between WSN, gateway and remote servers. Additionally Ethernet, Wi-Fi and GSM/GPRS communication module are integrated into the smart gateway in order to report and notify information to care-givers.

This new technology has potential to offer a wide range of benefits to patients, medical personnel, and society through continuous monitoring in the ambulatory setting, early detection of abnormal conditions, supervised rehabilitation, and potential knowledge discovery through data mining of all gathered information. This system can be placed in a hospital or a patient's house, through this wireless sensor network the sensor nodes collect Some physiological indexes of the patients or monitor the running state of the medical devices and transmit the data to the sink node or the local computer. The wireless sensor network can connect to the remote central server by several means. This remote health care system has good scalability and high flexibility and may have a widely application in the community medical service system, care unit and so on. An even bigger, more widely used remote medical service system can be built by connecting the wireless sensor networks to the Internet. This thinks it is very important to serve the patients better. Certainly, some kind of special wireless sensor networks can be developed for special medical use to perfect the remote care system based on wireless sensor networks. The presented gateway-central health care system is a prototype.

Tasks like sensor data database, DDS and real-time report are conducted in a low power embedded system. Hardware and software design of the gateway are presented and transmit protocols are designed for this gateway- central system. A series of experiment results show this prototype system is feasible and reliable. Optimizing the interconnection by employing GPRS communication between gateway and remote server to extend the available coverage of the health care system and upgrade the DDS. Then, it may consider for integrating internet-base webpage and voice call function in the gateway.

III. CHALLENGES IN PROPOSED SYSTEM

WSN is an emerging area in all fields and it offers wide variety of applications and these applications can be implement in real world. To implement them more efficient protocols and algorithms are needed. Design a new protocol or algorithm addresses challenges of this field. To design a better protocol or algorithm, it is necessary to first clearly understood challenges. These challenges are summarized below.

A. Security

In sensor networks, security is another important and challenging parameter. An effective and efficient compromise should be achieved, between security demands for secure communication and low bandwidth required for communication in sensor network. Whereas in traditional networks, the focus is on maximizing channel throughput with secure transmission.

B. Fault-Tolerance

Sensor nodes are prone to failure because of unattended environment. A sensor node may fail due to hardware or software problem or energy exhaustion. If few of sensor nodes fail, working protocol should handle all type of failures to maintain connectivity and prolong lifetime of network. For example, routing or aggregation protocol, must find suitable paths or aggregation point in case of these kinds of failures.

C. Power-Consumption

A wireless sensor node can be a popular solution when it is difficult or impossible to perform a mains supply towards sensor node. However, because the wireless sensor node is normally positioned in a hard to reach location, changing the battery regularly will not be free and inconvenient. An essential take into account the introduction of a wireless sensor node is making sure that there's always adequate energy accessible to power the system. The facility consumption rate for sensors in the wireless sensor network varies greatly good protocols the sensors use for communications. The Gossip-Based Sleep Protocol (GSP) implements routing and many MAC functions in a energy conserving manner. The effectiveness of GSP has already been demonstrated via simulation. However, no prototype system has become previously developed. GSP was implemented for the Mica2 platform and measurements were conducted to discover the improvement in network lifetime. Results for energy consumption, transmitted and received power, minimum voltage supply necessary for operation, effect of transmission power on energy consumption, and different methods for measuring time of a sensor node are presented. The behaviour of sensor nodes when they're all around their end of lifetime is described and analysed.

D. Ad-hoc Deployment

Sensor nodes are randomly deployed in required monitoring field without any infrastructure. For an example, for fire detection in a forest the nodes are typically dropped in to the forest from a plane. Sensor nodes itself create connections with other nodes and form an infrastructure. Hence new protocol or algorithm should be able to handle this ad-hoc deployment.

E. Reliable communication

Reliable communication in WWBANs is of utmost importance for medical applications that rely on WWBANs. The communication requirements of different medical sensors vary with required sampling rates, from less than 1 to 1000 Hz. One approach to improve reliability is to move beyond telemetry by performing on-sensor signal processing.

F. Physical Resource Constraints

The most important constraint in sensor network is the limited battery power of sensor nodes. Sensor nodes are left in unattended environment where recharge and replacement of battery is not possible. Sensor node's lifetime dependents on battery power. Thus effective lifetime of sensor network is directly dependent on battery. Hence the energy consumption is main design issue of a protocol. Limited computational power and memory size is another constraint due to that individual sensor node can store and process less amount of data. So the protocol should be simple and light-weighted. Limited bandwidth is also a constraint due to this communication delay can be high.

G. Quality of Service

Some applications like multi-media or time critical needs QoS. Multi-media application requires enough good quality of contents (video, audio and image). In time critical application, the data should be delivered within a certain period of time from the moment it is sensed; otherwise the data will be useless. New protocols which are designed for such applications should handle QoS.

H. Scalability

In monitoring field, number of sensor nodes deployed could be in order of hundreds, thousands or even more. It depends upon the application. It may possible that initially deployed sensor nodes are not enough to monitor the environment.

I. Interoperability

Wireless medical sensors should allow users to easily assemble a robust WWBAN depending on the user's state of health. Standards that specify interoperability of wireless medical sensors will promote vendor competition and eventually result in more affordable systems.

TABLE I. WIRELESS TECHNOLOGIES AND THEIR FEATURES

Sl. No	Name	Standard	Frequency	Area covered
1	WIFI	802.11a	-	<100m
2	GSM	-	Depends on network provider	850-1900MHz
3	GPRS	-	Depends on network provider	850-1900MHz
4	Bluetooth	802.15.1	2.4Ghz	15-100m
5	Wimax	802.16	2-11Ghz	<10Km
6	Zigbee	802.15.4	2.4Ghz	<75m

Above table shows the list of wireless technologies and also point out their key features such as standards, frequencies that are holding and finally the range covered. Every technology had their own advantages and disadvantages based on their features.

IV. CONCLUSION AND FUTURE WORK

This paper surveyed the existing WSN technology that can be used in health care monitoring. The current state of the art technologies were analysed based upon how well they can meet the information requirements laid by the dictatorial authorities. In existing, researchers raised the major social implications like security problem, privacy issues, energy consumption of sensor nodes and then analysed about the causes and effects of these major issues. This is not a complete list of challenges, but these do constitute some of the major challenges as wireless sensor networks become widespread and move into many other application domains such as agriculture, energy, and transportation. Our survey is about the increase of energy consumption and security among wireless sensor networks and it as a major consideration to implementing the wireless technology in medical field. Based on the disadvantages of existing system this paper planned to overcome those disadvantages especially energy consumption and privacy issues to fulfil the needs of the growing field. Security issues will also be considered in the future work.

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