Mobile Wireless Sensor Networks: Healthcare in Hospitals

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Abstract— Wireless Sensor Networks (WSN) have attracted much attention in recent years. The applications of Wireless Sensor Network are immense. Wireless Sensor networks have been used for various applications like environment monitoring, health monitoring and etc. Applications of Wireless sensor network in healthcare leads to an area called Body Area Network (BAN) or Body sensor Networks. In recent years we have witnessed that the wireless body area network technology is increasing pressure on quality of healthcare because of increasing population of aging people and health consciousness people. As a result Wireless body area networks are an emerging technology for providing this kind of health facility to the required people. In this paper we present an overview of wireless body area networks and we also present novel ideas to improve healthcare systems in India with the help of telecommunication and information technology.

Keywords- Wireless sensor networks; body area networks; mobility; e-healthcare;

I. INTRODUCTION

The population of elderly people and those suffering from diseases is increasing in the developed countries. It is one of the major challenges of the world [1]. Hence the necessity for providing the quality health care to rapidly growing elderly population is an important issue. So by providing continuous health monitoring, we will detect the early emergency conditions and diseases of the patients and also provide a wide range of health services to people with various types of problems and physical disabilities [2]. The quality of healthcare for patients to be improved by using electronic health technologies and the applications of e-Health technologies helps doctors and physicians to pursue early detection of abnormal status of patient’s health [3].

The wireless sensor network (WSN) is an emerging technology in terms of health care services for early detection of emergency conditions by monitoring the health parameters. WSN consists of small portable devices equipped with a variety of sensors (such as body temperature, pulse-rate, Blood pressure and so. on), which are low cost and low power that integrate limited computation, sensing and radio communication capabilities and used to capture the real time health parameters from large number of patients and transmit captured data (health parameters) to handheld devices (like PDA’s and Cell phones) that are carried by physicians or health care providers.

Figure1. Wireless Body Area Network

The potential benefits by deployment of Wireless sensor networks in healthcare applications are easy access of updated patient data at any time and from anywhere, immediate response to emergency situations, provision of high quality healthcare with low cost and provision of an individual health monitoring system. These features in WSN’s are opened up new opportunities in healthcare related systems. These opens up an area called Body Area Networks. As shown in the Figure1 the Body area networks are type of wireless sensor networks that are composed by several small sensors aimed to be deployed on patient’s body or in the patient’s body which are capable of collecting the data (health parameters such as body temperature, blood pressure, pulse rate, ECG and so. on) and transmit wirelessly to a system to check the status of patients health condition or to healthcare takers who is taking care.
The following paper is organized as follows. In section two we discuss about overview and innovations and latest trends in the wireless body area network. The third section discusses about various possible paradigms Body area networks. The fourth and fifth sections explain about various possible solutions for providing better rural healthcare facilities.

II. WIRELESS BODY AREA NETWORKS

A. Overview

Wireless body area network is a system which can continuously monitor the health conditions of patients to prevent and early risk detection by sharing the information with care takers and physicians. Based on the operating environments this can be classified into two types one is called wearable body area network which is operated on the surface of body and another is implantable body area network which is operated inside the human body. The IEEE 802.15 Task Group 6 (BAN) is developing a communication standard optimized for low power devices and which are placed on, in or around the human body to serve a variety of applications like healthcare and personal entertainment [4]. Wherever Times is specified, Times Roman or Times New Roman may be used. If neither is available on your word processor, please use the font closest in appearance to Times. Avoid using bit-mapped fonts if possible. True-Type 1 or Open Type fonts are preferred. Please embed symbol fonts, as well, for math, etc.

B. Innovations and Latest trends

The latest advancement in medical technologies, there are mainly three terms being used in the medical industry. The three terms are “Telehealth”, “Telecare”, and “Telemedicine”. Most of the people think the above three terms are interchangeable, when in fact they are not.

- Telehealth [5] is the broad term used to refer to providing health care services, health care education and health information services at a distance. Telehealth allows things like remote doctor-patient consultation, remote monitoring of vital parameters and health education services. This technology helps medical practitioners to evaluate and diagnose patients remotely, prescribe treatment, e-prescription and monitor fluctuations in the patient’s condition at distance.

- Telecare [6] refers to technology that helps the patients at home to stay safe and healthy with the help of telecommunication technology. Telecare involves continuous remote monitoring of patients for real time alerts and emergencies and to track the change over a time period. In this way, telecare helps manage a wide range of risks associated with a patient’s independent living.

- Telemedicine [7] refers specifically to the provision of health care services and education over a distance with the help of electronic communication and information technologies. Telemedicine allows functions like video consultation with specialists, remote medical evaluations and diagnoses and the digital transmission of medical imaging.

The latest trends in the area of telemedicine and body area networks are

1) On-body implants
2) In-body implants
3) Health carts

On-body implants are the sensors that are placed on the body or that are sewed into the fabric (wearable sensors) that can be worn. These on-body and wearable sensors are capable of monitoring the vital parameters like body temperature, blood pressure, and ECG etc [8] [12]. The smart jacket by Sibrecht Bouwstra and Dr. Wei Chen from et al from TU/e University Netherlands is one of such prototype for wearable sensor networks. The smart jacket shown in Figure2 is used for continuous monitoring for neonates. Neonates are a special group of patients that consist of premature infants who may suffer from diseases that are mainly caused by immaturity of their organs, and full term infants, who become severely ill during or immediately after birth [13].

Figure2: Smart jacket (Courtesy http://www.intechopen.com/books/intelligent-and-biosensors/intelligent-design-for-neonatal-monitoring-with-wearable-sensors)
The Figure 3 and Figure 4 show the flexible wireless sensor to measure ECG and wearable units from IMEC Netherlands. (Courtesy IMEC, Netherlands) and smartex Italy (Courtesy smartex, Italy).

The in-body sensors are the sensors that are implanted in the body to measure vital parameters from the transplanted organs or activity of the affected organs in order to monitor and provide the better services in advance. The Rogers research group, Illinois University is developing the in-body sensors and implants for cardio and neural activities and artificial eyes. The Figure 5 shows the work from the Rogers research group [9].

The traditional method of providing healthcare is to consult doctor. With the help of recent advancements in medical technologies the vice versa of the traditional methods are enabled. The new healthcare model encourages the use of remote clinic care, consultants and home healthcare to assist in remote patient assessments. Systems like Distance Doc by “Mediphan” and Transportable Exam Station by “GlobalMed” are some of examples for latest trends in telemedicine [10][11].

III. MOBILE WIRELESS SENSOR NETWORK PARADIGMS IN HEALTHCARE

Recently, there has been increasing interest in the society and healthcare providers for body sensor networks (BSNs) or body area networks (BANs). The advances on lightweight, intelligent wearable sensors make BANs really suitable for continuous monitoring of humans physiological activities, health status and so on. Based on the network architecture of sensor networks BANs can be classified mainly into three categories. The BAN based health care systems can be classified as the following paradigms

1) Mobile doctor terminal, Static patients with BAN.
2) Mobile patient’s terminals, static doctor terminal.
3) Mobile doctor as well as patient’s terminals.

The first paradigm deals with case where all the patient terminals are static and the doctor terminal is mobile. In this paradigm the doctor comes to the patients ward to check the patient condition. As soon as doctor comes to patients ward the doctor terminal collects the data from the patients BAN and updates the doctor terminal with the updated collection of data. Similarly the second paradigm deals with case where mobile patient’s terminals and static doctor terminal is very helpful for out-patients who come regularly to hospitals for their check up. As soon as patient comes to the hospital the installed BAN in or on the patient body exchange data on to the hospital’s network.
The third paradigm deals with the case where both doctor and patient terminal’s are mobile. This can be very effectively used in the situations where doctors visit the rural areas for the health camps. Patients dump the data on the nodes installed at the camp site and when doctor comes for the next visit the doctor terminal collects the data from the node installed at the camp site. Thus we can monitor and detect the illness of the patients easily with the help of the BAN.

IV. MOBILE BAN: RURAL HEALTHCARE BASED HOSPITAL

The Mobile BAN health care system is the Medical Expert System which consists of several features like sensors, video camera, medicine dispenser and assistant is helping the patients who are coming to Medical Expert System for checking their health condition. Based on the condition of the patient he may give the necessary medicines or provide the communication between patient and doctor through telecommunication network. The existing healthcare system in which the symptom is detected by patient first and then he visit a hospital where a physician/medical practitioner takes vital parameters and used then to diagnose the patient condition and then prescribe the necessary treatment. This system is good organized in urban/developed areas but where as in rural villages this facilities are very less and that are also limited to some places. In such cases the patients has to go nearby hospitals if exist otherwise they have to travel to other stations, in such scenarios the treatment will be delayed and the chances are high where patient condition will become more critical. To solve the above problems we suggesting the Medical Expert System which is Mobile BAN rural healthcare based hospital is equipped with various sensors to measure vital parameters like body temperature, heartbeat, blood pressure, Respiratory rate, etc. In some emergency cases there may be implants installed on the patient’s body or inside the patient’s body for measuring parameters like electrocardiogram (ECG) and Electromyography (EMG). The rural healthcare center is installed with appropriate software and hardware to display these sensed phenomena. The system can be operated in various ways,

- Fully automatic.
- Semi automatic.
- Mobile hospital.

The BAN installed on or in the patient’s body will be collecting the vital parameters of the patient in a periodic manner. When the patient goes to the mobile health care system the data collected by the sensors on or in the body exchange the data. If the patient doesn’t have BAN installed on or in the body the assistant will attach the wearable sensors and collect the data. If the patient is suffering with normal or regular common diseases like cold, fever etc the medicine dispenser near the machine will dispense the appropriate medicine. If abnormal behavior is observed the machine will suggest the patient to meet the doctor on his next visit.

The semi automatic and mobile hospital is operated with the help of a novice person from the village. He will assist the people who come to the health center for check-up. The machine is equipped with all the sensors needed for measuring the vital parameters. The assistant collects the parameters from the patients who come to the healthcare center and give the medication as applicable. If he finds some abnormalities in the measure phenomenon he will connect the machine to the PSTN network to call the expert and ask for advice and convey the same to the person. Thus after serving in one village the machine is moved to next village and does the same in every village and periodically visits the villages on regular interval basis. Thus with the help of Mobile BAN we can provide better health care for rural people who suffer with lack of proper health care facilities as well as proper infrastructure.

V. E-VAIDYAM: WEB BASED EXPERT MEDICAL ADVICE SYSTEM

Now a days with the increase of the working husband and wife culture and also gated community culture there is a need for web based home health care systems. By using medical advice system old people who stay at home are provided better health care. As shown in the Figure 7 each person has BAN implant on his body and all the BAN’s are connected to central control station at secretary offices of the gated communities. With the help of installed medical software the system detects the abnormal situations and the central system is capable of sending messages and e-mails to the relatives and also can communicate to the doctors present in the vicinity of the gated community. The person at the office will be regularly monitoring the vital parameters
measured. If any abnormality is observed in any of the old people’s data the person will immediately inform the doctor present in the community and also at the same time he can also send the information to their relatives via mobile or internet (mail). If the local community doctor is not available he can contact the doctors present in the vicinity.

Figure 7: Web based healthcare system

In the hospitals where there is need for continuous monitoring, checking and repeated measuring the vital parameters, in such cases with the help of WBAN installed on patients these tasks can be accomplished. The WBAN on patients will continuously monitor the parameters and send the sensed phenomenon on to the hospital server. If the doctor needs to check any patient information then by using patient id he can get the information from the server to his PDA/handheld devices.

CONCLUSION

In this research paper, various ideas related to utilization of wireless sensor networks are suggested. The Body Area Networks effectively enable monitoring patient health and communicate with the doctor. Various paradigms of Mobile WSN’s for healthcare are documented. Web-based medical advices system, called e-vaidyam is proposed for effective and affordable healthcare.

REFERENCES