Journal of Applied Medical Sciences, vol. 3, no. 3, 2014, 5-18
ISSN: 2241-2328 (print version), 2241-2336 (online)
Scienpress Ltd, 2014

Wireless Sensor Networks with its Effective Impact in the Health Care Application

Ibrahiem M. M. El Emary[1] and Amal H. Al-Gamdi[2]

Abstract

Wireless sensor network (WSN) technologies is considered as one of the main research areas in computer science. These WSNs comprise tiny wireless computers that sense, process, and communicate environmental stimuli, including temperature, light, and vibration. WSNs have been under rapid development and has become essential in various domains like industrial operations (factory, production, supply chains) and health care (home monitoring, biomedical, food safety), So, the main objective of this paper is to provide a quick overview of current developments and future trends of research on WSN for continuous monitoring of patients as a major application of WSN in the field of healthcare systems. Finally, this paper assure that the application of the Wireless Sensor Networks in healthcare systems is mainly divided into three categories: monitoring of patients in clinical settings, home and elderly care center monitoring for chronic and elderly patients, and collection of long-term databases of clinical data. In these three categories, the sensors allow vast amounts of data to be collected and mined for next-generation clinical trials. Data will be collected and reported automatically, reducing the cost and inconvenience of regular visits to the physician. Therefore, many more study participants may be enrolled, benefiting biological, pharmaceutical, and medical-applications research.

Keywords: WSN, WSMN, Smart, ECG, LAN, WMN, MEMS, Ad Hoc and Multihop.

1 Introduction

Wireless Sensor Network (WSN) is basically a collection of large number of self powered small sensing nodes that gather information from the field where they are deployed and communicate that information in a wireless fashion and finally handing over their processed data to a base station. These WSN are used as a result of its numerous

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[1] Inf. Science Dept., KAU, Jeddah, SA.
[2] E-Health Dept., Public Health Admin., Ministry Of Health, SA.

Article Info: *Received :* June 19, 2014. *Revised :* July 8, 2014.

advantages like low cost, wide coverage of the experimental area, real time data access and self-configuration. Thus because of these different reasons their use is increasing in the field of health also. Physically, (WSN) is considered as a network with no wired infrastructure; where it consists of hundreds to thousands of autonomous sensors. The sensors are wide spread in the space with a wireless communication established between them. These sensors are made to work cooperatively to detect and analyze the physical conditions, such as, temperature, vibration, pressure at different locations. This development was originally made use of in the field of military. Wireless Sensor Network gradually extended its applications in the field of health care applications, home automation, traffic control etc. Every sensor in the network consists of a wireless ad hoc network and also supports a multi-hop algorithm.

Sensor nodes in the network can be considered to be micro computers which consists of the basic components and their interfacing. Sensor nodes consists of a processing unit with a very less computational power and memory. They also consist of sensors and a communication device. A battery is a source of power supply to the node . The sensors in Wireless Sensor Networks vary from each other in their computational ability, communication resources, and storage capacity. Sensor nodes and the end user are connected to each other by means of gateways. Various sensor nodes of the Wireless Sensor Network communicate with each other through a communication channel which has no wired infrastructure. There is a huge development of Wireless Sensor Networks (WSNs) in the recent days [1].

A lot of research work has been going on in the recent times on the wireless sensors and health department. Basically, a WSN health care system consists of three main parts: body and home environment sensor network, access devices like gateway and public communication networks and care takers like remote central server, doctors, nurses and the relatives. The gateway is used to bridge the gap between the WSN and the public communication networks. That is they are used to work as the impedance matching devices, protocol translators and rate convertors between them. In the health care system, the sensors are attached to the body of the patient under observation. All the data collected from his/her body is wirelessly transferred to the head node and from there it is sent to the central processor for further processing [2].

Owing to the rapid development of new medicines and medical technologies, the aged population have been resulted in a speed-up increase. Thus, more rehabilitation centers are created for the requirements of homecare as well as more medical personnel is needed to offer medical treatments and to prevent accidents for aged patients. To provide a more humane environment for these aged patients' physical and physiological heath care, monitoring and recording of their physiological status is very important [3]. It occupies a large portion of center's human resources to regularly observe and record the physiological status of patients. It still cannot guarantee to obtain the necessary patients' status information on time and to prevent accidents from happening even if we have sufficient professional nursing staff who works very carefully. In order to reduce the nursing staff loading and prevent sudden situations that cause accidents, a physiological signal acquiring and monitoring system for the staff to collect the physiological status information of patients to the nursing center with physiological sensors module is essential.

2 Wireless Sensor Networks Against Traditional Technology

The significant advances in hardware manufacturing technology and the advent of the Micro-Electro-Mechanical-Switches (MEMS) paved the way for building smart sensor nodes that are capable of performing three important functions: sensing, processing, and wireless communication. These wireless sensor nodes are characterized by being intelligent, small-sized, low in cost, battery-driven, and easy to install and repair. These characteristics opened wide doors for a broad range of applications attained by deploying wireless sensor nodes in a dense, distributed manner to form specialized Wireless Sensor Networks (WSNs). The main objective of WSNs is to monitor physical or environmental phenomena like temperature, sound, vibration, relative humidity, pollutants, etc. They also collect data to be reported to a central processing unit that analyses the gathered data and take certain measures accordingly. Starting with critical military applications like battlefield surveillance, WSNs eventually entered enormous number of civil applications such as motion tracking, traffic monitoring, fire detection, seismic sensing, home automation, to mention only few.

An interesting field where the use of WSNs proves effectiveness is the field of Intelligent Transportation Systems. An Intelligent Transportation System uses technological advances in computers and information technology to improve the efficiency of both new and existing transportation systems. By providing surveillance and tracking services, traffic conditions, in both urban and rural areas, can be monitored continuously. A direct consequence of that is resolving the congestion problem by properly directing the traffic away from the highly crowded and congested roads. Moreover, ITSs can be used to manage parking lots, report emergency situations, navigate destinations, and propagate traffic conditions on highways, provide traveler information, avoid vehicle collisions, and enhance driver’s safety. ITSs depended on traditional monitoring sensors including inductive loops, video cameras, ultrasonic sensors, radar [4]. However, these sensors suffered from major drawbacks that affected the sole purpose behind incorporating astuteness in transportation systems. In particular, these sensors are bulky, power-hungry, expensive to connect, maintain and overhaul, and connected through wires to central data processing locations. These characteristics subvert the scalability of ITSs and affect their major objectives, like traffic nursing or collision evasion. Integrating WSNs into ITSs can be enticing due to their special topographies that overcome the problems associated with traditional wired sensors.

Wireless sensor networks have many advantages over traditional sensing technology, due to their embedded construction and distributed nature. The first, and for many the most notable, feature is their cost. Using low-power and relatively inexpensive microcontrollers and transceivers, the sensor nodes used in wireless sensor networks are often less than one hundred dollars in cost. This opens the doors for many commercial or military applications, as the relatively diminutive cost of nodes allows for not only large numbers of sensors to be deployed, but also for large numbers of sensors to be lost. For example, sensor nodes can be dropped from a plane, allowing widespread coverage of an area with minimal effort involved in positioning the individual nodes. The relatively low cost of the sensors allows for some nodes to be damaged or lost without compromising the system, unlike larger, more centralized sensors [5]. Another advantage wireless sensor networks hold over traditional wireless sensing technology lies in the mesh networking scheme they employ. Due to the nature of RF communication, transmitting data from one point to another using a mesh network takes less energy than transmitting directly between the two points. While embedded systems must respect their power envelope, the overall energy spent in RF communication is lower in a mesh networking scenario than using traditional pointto-point communication [5]. Sensor networks can also offer better coverage than more centralized sensing technology. Utilizing node cost advantage and mesh networking, organizations can deploy more sensors using a wireless sensor network than they could using more traditional technology. This decreases the overall signal-to-noise ratio of the system, increasing the amount of usable data. For all these reasons and more, wireless sensor networks offer many possibilities previously unavailable with traditional sensor technology [5].

3 WSN Architecture and Monitoring Process

Wireless Sensor Network (WSN) is a network of large numbers – up to thousands – of tiny spatially distributed radio-equipped sensors. Each node in a sensor network is composed of a radio-transducer, a small microcontroller and a long lasting battery for energy source [6] . These sensor networks are used for gathering information needed by smart environments and are particularly useful in unattended situations where terrain, climate and other environmental constraints may hinder in the deployment of wired/conventional networks. An individual node failure is not an issue because of the large scale deployment of these nodes and normally the target area is monitored by several nodes. Primarily these sensors are used for data acquisition and are required to disseminate the acquired parameters to special nodes called sinks or base-stations over the wireless link as shown in Fig.1. The base-station or sink collects data from all the nodes, and then analyzes this data to draw conclusions about the on-going activity in the area of interest. Sinks or base- stations being powerful data processors can act as gateways to other existing communications infrastructure or to the Internet where a user can have access to the reported data.

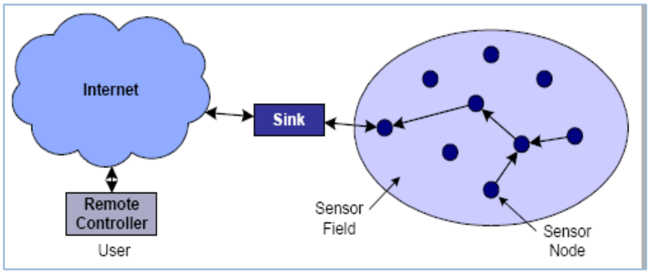

Figure 1. Sensor Network Architecture [6]

A wireless sensor network (WSN) consists of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants and to cooperatively pass their data through the network to a main location. The more modern networks are bi-directional, also enabling control of sensor activity. Today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and so on. Typically, a sensor node is a tiny device that includes three basic components: a sensing subsystem for data acquisition from the physical surrounding environment, a processing subsystem for local data processing and storage, and a wireless communication subsystem for data transmission. In addition, a power source supplies the energy needed by the device to perform the programmed task [7]. This power source often consists of a battery with a limited energy budget. There are different Sensors such as pressure, accelerometer, camera, thermal, microphone, etc. They monitor conditions at different locations, such as temperature, humidity, vehicular movement, lightning condition, pressure, soil makeup, noise levels, the presence or absence of certain kinds of objects, mechanical stress levels on attached objects, the current characteristics such as speed, direction and size of an object. Normally a sensor node combines the abilities to compute, communicate and sense.

Communication in wireless sensor networks is affected by many factors such as environment, network topology, and transmission power. Hence, packet delivery performance may vary dramatically. Researchers have tried to get a quantitative understanding of communication patterns by performing a set of experiments in an office building, a natural habitat, and an open parking lot [8]. Performance of packet delivery at both physical and MAC layers was measured. At the physical layer, controlled variables were signal strength, coding scheme, and distance from the transmitter. It was found that up to a certain distance from the transmitter (about 20 m indoors using high transmission power), packet reception rate is consistently high (between 90 and 100%); after a certain distance (about 30 m indoors using high power transmission), the packet reception rate is consistently 0%. However, for any distance in between (from 20 to 30 m indoors using high power), packet reception rate is highly unpredictable. This range is referred to as a “gray area.” The size and the starting point of this “gray area” depends on (1) the environment (e.g., it is similar for indoors and outdoors, but the “gray area” is very large in the natural habitat), (2) the transmission power (lower transmission power actually performed better due to reduced likelihood of interference), and (3) the physical layer encoding scheme.

At the MAC layer, controlled variables were density of deployment and work load. Two metrics were used: packet loss rate and packet delivery efficiency (the ratio of distinct packets). The results indicated that 35% of the links at the low traffic load (less than one packet per second) and 50% of the links at the high traffic load (more than one packet per second) had 50% or more packet loss rate. The efficiency was found to be 50 and 20% for the low traffic load and the high traffic load, respectively. Another important observation was the asymmetry of the links: even indoors more than 10% of the links had a packet loss difference of more than 50% for packets traveling in different directions on the same link.

In addition, empirical studies [4] found that links with very high or very low reception rates tend to be highly symmetrical, while links with intermediate reception rates appear to be much more asymmetric. Monitoring network health in wireless sensor networks, as in any traditional networks, provides a fundamental support for efficient network management. The captured network status can be used by network administrators to detect or even predict abnormal behaviors and take remedial actions. Generally, we can divide all the monitoring techniques into active and passive monitoring. Active monitoring typically injects probes into the network, and network-internal performance can then be inferred from the measurement parameters. In addition to the techniques purely based on probing, other active monitoring relies on event reports from the managed nodes. Probing packets or event reports can overload the network; therefore, careful calibration of probing frequency and selection of parameters are often needed for active monitoring. In contrast, passive monitoring observes the traffic already present and then infers network condition. We next discuss how node conditions, link status and network congestion level are monitored in sensor networks without incurring significant overhead.

3.1 Monitoring Node Status

Since energy is the most scarce resource for sensor nodes, residual energy level provides a good indication of possible node failures. eScan [8] is an active monitoring technique that monitors remaining energy levels using localized algorithms for in-network aggregation of local representations of energy levels. The algorithm starts with each node creating a local scan of its residual energy level expressed as a range of (min, max) instead of a single value. When a user requests a global view of residual energy, individual local scans are transmitted back towards the sink. Reports from neighboring nodes are aggregated en route to the sink if they have similar approximations of residual energy. As a result, the user receives an energy level map of the sensor network. eScan requires the user to issue the request first, which limits the ability of this monitoring tool. In fact, the nodes can be programmed as event-driven and notify the user when energy level drops suddenly for any unpredicted and undetected reasons. In addition, there is an eScan update after each major sensing event, which suggests that each major sensing event would be twice as expensive for transmission of event data and the eScan update.

Alternatively, a prediction based approach has been proposed for generating an energy map [9]. Each node sends the parameters of the dissipation model to the sink. The sink uses this information to locally update the energy level at each node. Nodes will send an update to the sink only if the difference between their actual energy level and the predicted value exceeds a certain threshold. Not having to constantly update energy levels yields great energy savings, however, it comes at the price of lower precision and higher computational overhead on the nodes.

3.2 Monitoring Link Quality

Link quality can be measured by the percentage of undamaged packets received. Tracking the quality of channels at the link layer may enable higher level protocols to adapt to changes in link quality by changing routing structures. One technique designed for link quality monitoring is based on snooping [2], by passively listening to the channel and inferring the loss and success rates via tracking of link sequence numbers. This method does not require any extra messages to be exchanged. However, it does involve overhead in listening to the channel. With recent advances in low-power listening technologies, it is possible to keep the cost of snooping low.

3.3 Monitoring Congestion Level

Congestion can be one of the causes for packet loss. A straightforward policy is to evaluate the growth rate of the buffer length [19]. If the sum of the current buffer level and the increment in buffer length during the last time period is higher than the buffer capacity, congestion is detected. Alternatively, CODA [20] uses a combination of the present and past channel loading conditions, and the current buffer occupancy to infer accurate detection of congestion at each receiver with low cost. Listening to the channel at all times may incur high energy costs; hence, in order to minimize overhead, CODA only activates local channel monitoring when buffer levels suggest that congestion may be present.

3.4 Discussion

Sensor network monitoring should not be limited to just one metric such as residual energy level, link quality, or congestion level. Other metrics such as buffer occupancy level, topology changes, etc., are equally important and should also be tracked. We cannot rely on an administrator to discover and repair failures; instead, sensor network monitoring should be more adaptive and self-configurable. In other words, sensor networks should be able to respond to a certain observed degradation of the network conditions on a local level. Furthermore, the control data packets used for network monitoring should not add substantial additional overhead, so it may be desirable to piggyback as much control data as possible on top of application requested data.

An issue related to network monitoring is “response implosion”, when a large number of nodes respond to a monitoring request simultaneously and thus create bottlenecks in the area of the sink. Three policies are suggested to address this problem: (1) sampling for densely populated sensor networks, where the sink sends a probability p with the diagnostics query, and each node decides whether to report or not with probability p; (2) self-orchestrated operation that schedules responses from all the nodes for sparse sensor networks; and (3) diffused computation where readings are aggregated as the responses move towards the sink. Out of these three suggested methods, diffused computation outperforms the other two in terms of the number of responses received and the overhead incurred.

4 Application of WSN

Healthcare has always been a big concern for a country since it ensures the well being of its citizens. It is always said that prevention is better than cure and thus a continuous monitoring of a patient is what is necessary for any early signs of health problems. Health monitoring is always performed in the traditional manner of patient going to the doctor and periodic monitoring is performed only by the regular visits to or by the doctor [6]. The healthcare applications that are provided by the wireless sensor networks allow in-home assistance, smart nursing homes for observations and for research growth.

4.1 Medical Sensing and Sensor Networks for Health Observation

There is a long history of using sensors in medicine and public health [13, 14]. Embedded in a variety of medical instruments for use at hospitals, clinics, and homes, sensors provide patients and their healthcare providers insight into physiological and physical health states that are critical to the detection, diagnosis, treatment, and management of ailments. Much of modern medicine would simply not be possible nor be cost effective without sensors such as thermometers, blood pressure monitors, glucose monitors, electrocardiography (EKG), photoplethysmogram (PPG), electroencephalography (EEG), and various forms of imaging sensors. The ability to measure physiological state is also essential for interventional devices such as pacemakers and insulin pumps.

Medical sensors combine transducers for detecting electrical, thermal, optical, chemical, genetic, and other signals with physiological origin with signal processing algorithms to estimate features indicative of a person's health status. Sensors beyond those that directly measure health state have also found use in the practice of medicine. For example, location and proximity sensing technologies [15] are being used for improving the delivery of patient care and workflow efficiency in hospitals [16], tracking the spread of diseases by public health agencies [17], and monitoring people's health related behaviors (e.g., activity levels) and exposure to negative environmental factors, such as pollution [18].

There are three distinct dimensions along which advances in medical sensing technologies are taking place. We elaborate on each of the three in the paragraphs that follow.

- Sensing modality: Advances in technologies such as microelectromechanical systems (MEMS), imaging, and microfluidic and nanofluidic lab-on-chip are leading to new forms of chemical, biological, and genomic sensing and analyses available outside the confines of a laboratory at the point of care. By enabling new inexpensive diagnostic capabilities, these sensing technologies promise to revolutionize healthcare both in terms of resolving public health crisis due to infectious diseases [19] and also enabling early detection and personalized treatments.
- Size and cost: Most medical sensors have traditionally been too costly and complex to be used outside of clinical environments. However, recent advances in microelectronics and computing have made many forms of medical sensing more widely accessible to individuals at their homes, work places, and other living spaces.

Examples of these are as follows:-

- The first to emerge [2] were portable medical sensors for home use (e.g., blood pressure and blood glucose monitors). By enabling frequent measurements of critical physiological data without requiring visits to the doctor, these instruments revolutionized the management of diseases such as hypertension and diabetes.
- Next, ambulatory medical sensors, whose small form factor allowed them to be worn or carried by a person, emerged [2]. Such sensors enable individuals to continuously measure physiological parameters while engaged routine life activities. Examples include wearable heart rate and physical activity monitors and Holter monitors. These devices target fitness enthusiasts, health conscious individuals, and observe cardiac or neural events that may not manifest during a short visit to the doctor.
- More recently, embedded medical sensors built into assistive and prosthetic devices for geriatrics [78] and orthotics [18] have emerged.
- Finally, we are seeing the emergence of implantable medical sensors for continuously measuring internal health status and physiological signals. In some cases, the purpose is to continuously monitor health parameters that are not externally available, such as intraocular pressure in glaucoma patients [20]. The goal in other cases is to use the measurements as triggers for physiological interventions that prevent impending adverse events (e.g., epileptic seizures [62]) and for physical assistance (e.g., brain-controlled motor prosthetics [47]). Given their implantable nature, these devices face severe size constraints and need to communicate and receive power wirelessly.

- Connectivity: Driven by advances in information technology, medical sensors have become increasingly interconnected with other devices. Early medical sensors were largely isolated with integrated user interfaces for displaying their measurements.

> Subsequently, sensors became capable of interfacing to external devices via wired interfaces such as RS 232, USB, and Ethernet. More recently, medical sensors have incorporated wireless connections, both short range, such as Bluetooth, Zigbee, and near-field radios to communicate wirelessly to nearby computers, personal digital assistants, or smart phones, and long range, such as WiFi or cellular communications, to communicate directly with cloud computing services. Besides the convenience of tetherless operation, such wireless connections permit sensor measurements to be sent to caregivers while patients go through their daily work life away from home, thus heralding an age of ubiquitous real-time medical sensing. We note that with portable and ambulatory sensors, the wired or wireless connectivity to cloud computing resources is intermittent (e.g., connectivity may be available only when the sensor is in cellular coverage area or docked to the user's home computer). Therefore, such sensors can also record measurements in nonvolatile memory for uploading at a later time when they can be shared with healthcare personnel and further analyzed.

Fig.2 shows the different body sensors that are used for the observations. These sensors do not harm the patient at all and are thus human friendly. The different sensors from the body directly provide the required signals. These sensors are wearable and they also enable mobile health which is also known as m-health. Thus an individual can use these sensors even while working and doing his daily activities. The simplest kind of physiological sensors includes Electrocardiograms (ECG), Electromyogram (EMG) and the motion sensors.

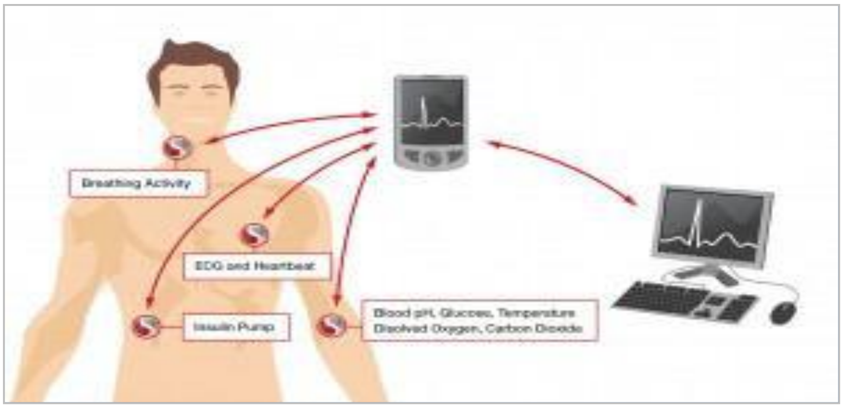

Figure 2: Different Body Sensors

All the data that is taken from the sensors is in the raw form. This data is sent to the processors usually the computers at a hospital or the nursing homes for observation (see Fig.3). After this the processed data is sent to the doctors or the relatives/care takers through a gateway. And this way a proper action can be taken within time. A personal server application can be run on the mobile phones also so that a care taker/relative can get the results directly from the processed data. The communication between personal server and internet gateway takes place using one of the standard data networks like cellular and/or WLAN. [3]

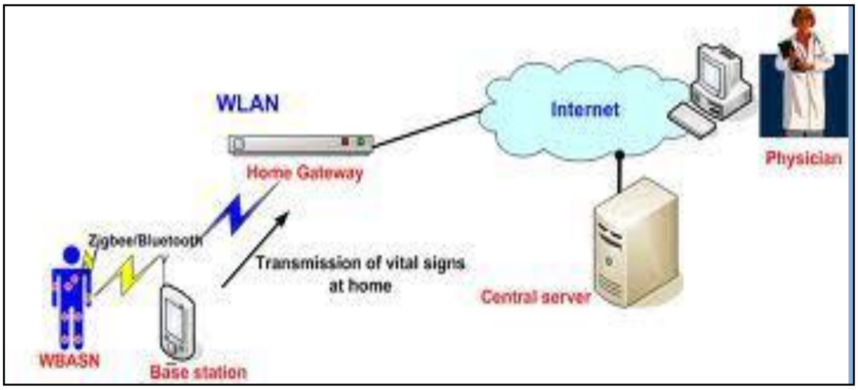

Figure 3: Data Processing stages across WSN

The technology of smart sensors is still in its basic level yet its use can be seen at increasing pace in some of the fields like ECG monitoring, stress monitoring, asthma, emergency response and the post operation period. For the continuous monitoring of the health the body sensors are deployed on the human body. They are the miniaturized wearable sensors for continuous monitoring. Also some researchers are working on such kind of body sensors that are able to recognize the body on which they are deployed [5].

5 Potentials and Challenges of WSN in Medical Applications

With the advancement of wireless technology, wireless devices can be used to reduce medical errors, increase medical care quality, improve the efficiency of caregivers, lessen the caregiver-lacking situation, and improve the comfort of patients. Although the technology has found ways into various fields, medical domain has very strict quality and assurance requirements, which causes many challenges that are faced when implementing and operating the systems. The following part of the paper will be reserved to identify potentials and challenges of healthcare system using wireless technology.

5.1 Potentials of Wireless Technology in Medical Applications

Wireless inside-body monitoring is a hot application of wireless network in patients' monitoring. Using WBAN technologies to transmit data from monitoring devices, such as Capsule Endoscope [Takizawa08], to outside body, these applications used to monitor the digestive organs such as the small intestine by video or successive image data. The system uses IEEE 802.15.6 and wearable WBAN to guarantee the quality of system. Details about Capsule Endoscope will be given in the later section of paper.

Operation assisting is very new application of wireless network [CIMIT]. In an operation, doctors have to monitor the patient's vital signs to have timely actions. These signs can be obtained by applying to the patient adhesive electrodes so that the signs are transmitted over wires to display monitors. The large number of wires used around the operation table prevents the medical team's access to the patient. Moreover, the adhesive can be detached from patient what is caused by strong enough impact to the wires. To help surgeons and medical teams operate more freely, the Smartpad [CIMIT] is presented. A device displays patient's signals without adhesives or wires.

Although real-time patient monitoring field is not a new topic in wireless medical applications, researchers and industries are investing a lot of effort and money to it. These applications basically use biomedical sensors monitor the physiological signals of patients such as electro-cardiogram (ECG), blood oxygen level, blood pressures, blood glucose, coagulation, body weight, heart rate, EMG, ECG, oxygen saturation, etc.

Home monitoring systems for chronic and elderly patients is rapidly growing up in quantity and quality [Otto06]. Using the system can reduce the hospital stay of patient and increase patient safety and mobility. The system collects periodic and continuous data and then transmits it to the centralized server. Patients' information is accessed by physicians remotely. These applications save large amount of time for doctors as well as patients. The doctors can monitor several patients simultaneously which is cannot be done by traditional monitoring, in which the patients are monitored directly by the doctors. The patients are no longer required to be present at the hospitals periodically. Wireless sensor network can be applied to medical applications to build up databases for long-term clinical uses [McLoughlin06]. It also can be used for emergency medical care [VitalDust] and many other applications. The section presented the fields that wireless networks can contribute. The following part will identify challenge of deploying wireless networks based solutions in medical care.

5.2 Challenges of Wireless Technology in Medical Applications

The use of wireless technologies in medical environments is bringing major advantages to the existing healthcare services. However, these have several key research challenges such as various types of network communication infrastructure[VitalDust], fault-tolerance, data integrity, low-power consumption, transmission delay[Natarajan07], node failure, etc. Reliability is one of the most important factors in a successful healthcare system. To ensure this factor, system designers have to care about adaptation of nodes when its location, connection and link quality is changed [Soomro07]. Different network communications infrastructure should be used in appropriate situation. For example, with high-risk patients, the services with higher QoS should be used. The integrity of distributed data system and fault-tolerance should be given a proper consideration also. Every device can operate differently at different times, especially sensor-based devices. One node in a system can be failure at anytime for number of reason including natural issues, human-related issues or batteries exhaustion. Ensuring a seamless service during life time of the system could be a big challenge. How to manage the transmission delay of various types of communications in the system is an undoubted challenge. With the system using WBAN or wireless sensor network, data must go through a number of hops before it reaches the sink. In addition, these hops are sometime located in very critical conditions, such as magnetic field or areas bearing interference of radio waves. As a result, various delays occur and require extra effort of system designer to synchronize the whole system. In many mission critical applications, it is vital that devices do not fall into battery exhaustion. As the mater of fact, most wireless network based devices are battery operated; therefore, the design of a system must not require devices to expend excessive energy. The developers have to consider the longevity of the devices and extend it by using such scheduling algorithms and power management schemes that energy consumption should be shared over the whole network, rather than having a few devices or nodes carrying the whole network's load. The mentioned challenges are associated with technical implementation [Stankovic05]. However, there are many other challenges associated with deployment of a new technology. Specifically, the new system should be low cost and not interfere with existing infrastructure. So managing interference between the old system and the new one and using spectrum properly are challenges of wireless technology applied to medical applications. From patient's aspect, one of the most important issues is how comfortable they feel when using these new applications. Therefore, the applications must be not only helpful but also unobtrusive, specifically small, lightweight, etc. Last but not least, patients' information must be private and secure, but remain accessible to authorized persons [Townsend05]. Power and process availability of wireless-based network is very limited while to ensure privacy of information, extra power and computation must be used to encrypt transmitted data. Thus guaranteeing information security can be an issue and challenge for system developers. Many challenges for wireless medical system designers and developers are discussed in this section. These issues could be a motivation for developers to create the better solutions. The next section of the paper will be reserved to discuss standards used in wireless medical applications.

6 Conclusion

In the light of above presentation in this paper, it is concluded that wireless sensor technology is very helpful in medical application in different scenario by taking some examples. WSN can play important role to contribute so many things for improving life of patients with the reduction in cost. Although wireless medical applications have been successfully implemented not only in research but in practice as well, there are still many challenges for developers and researchers. Potential of wireless technology in medical domain cannot be exploited completely when mentioned challenges are not solved, which required a long term effort of researchers and investors. In this survey paper we discussed advantages of wireless medical devices and challenges involved in this technology.

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