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USE OF WIRELESS SENSOR NETWORK TECHNOLOGY IN HEALTH MONITORING

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Abstract
In a hospital health care monitoring system it is necessary to constantly monitor the patient's physiological parameters. For example a pregnant woman parameters such as blood pressure (BP) and heart rate of the woman and heart rate and movements of fetal to control their health condition. This paper presents a monitoring system that has the capability to monitor physiological parameters from multiple patient bodies. In the proposed system, a coordinator node has attached on patient body to collect all the signals from the wireless sensors and sends them to the base station. The attached sensors on patient's body form a wireless body sensor network (WBSN) and they are able to sense the heart rate, blood pressure and so on. This system can detect the abnormal conditions, issue an alarm to the patient and send a SMS/E-mail to the physician. The main advantage of the monitoring systems is to reduce the energy consumption to prolong the network lifetime, speed up and extend the communication coverage to increase the freedom for enhance patient quality of life.

Keywords: Wireless Sensor Network, Patients, Health, Monitoring, Sensors.

1) Introduction

Recently, interest in wireless systems for medical applications has been rapidly increasing. With a number of advantages over wired alternatives, including: ease of use, reduced risk of infection, reduced risk of failure, reduce patient discomfort, enhance mobility and low cost of care delivery, wireless applications bring forth exciting possibilities for new applications in medical market. Portable devices such as heart rate monitors, pulse oximeters, spirometers and blood pressure monitors are essential instruments in intensive care. Traditionally, the sensors for these instruments are attached to the patient by wires; and the patient sequentially becomes bed-bound. In addition, whenever patient needs to be moved, all monitoring device has to be disconnected and then reconnected later. Now-a-days, all of these time-consuming jobs could be terminated and patients could be liberated from instrumentation and bed by wireless technology. These wireless devices could communicate with a gateway that connects to the medical center's network and transmits data to health data stores for monitoring, control, or evaluating in real time or offline after storage. With wireless continuous medical monitoring systems, patients' information such as blood pressure, heart rate, and electrocardiogram can be sent instantly to specialized medical centers to store and process properly. Medical emergencies can be detected sooner and proper treatment can be applied timely. Health care effectiveness in several situations is improved significantly with the present of wireless communication technologies. With the assistant of hand held devices in which wireless network integrated, the amount of time the doctors need to identify the problem, trace back the medication history of the patient and consult fellow doctors will be reduced significantly. Moreover, databases of patients that can be built up by continuous medical monitoring will be accessed and updated easily. As a result, the amount of paper works required and the duplication of patient record will be dropped down. [4]

2) Overview

Wireless sensor network research is being performed to address medical applications. In particular, a common vision found in the research arena is to provide sensing and wireless communication for assisted living facilities to improve lifestyle, to improve health care, and to support long term medical studies. The research work is solving WSN problems for real-time response, data association, reliability and dependability, security and privacy, and analysis via programs that determine circadian rhythms. The work is taking an end-to-end view from collecting the data to its analysis and use by doctors. As part of this research a WSN-based medical testbed are constructed partially.

The medical testbed focuses on continuous, automatic monitoring of physiological, environmental and activity data for residents in independent and assisted-living facilities. It employs a Wireless Sensor Network (WSN) which is an enabling technology for medical applications in this type of environment. For example, the WSN could detect epileptic seizures or strokes and provide smart homecare by collecting biometric and environmental data for analysis. If an event is detected, it may also provide real-time assistance by notifying emergency healthcare providers and family members. A few body network systems will be wearable on the patient and some will be placed inside the living space. Also, the multi-hop backbone of the new testbed will connect other traditional systems, such as PDAs, PCs, and databases. The databases will be used for long-term archiving and data mining. We will also be able to connect to large clusters for backend processing, e.g., to execute time consuming circadian rhythm programs. [5]

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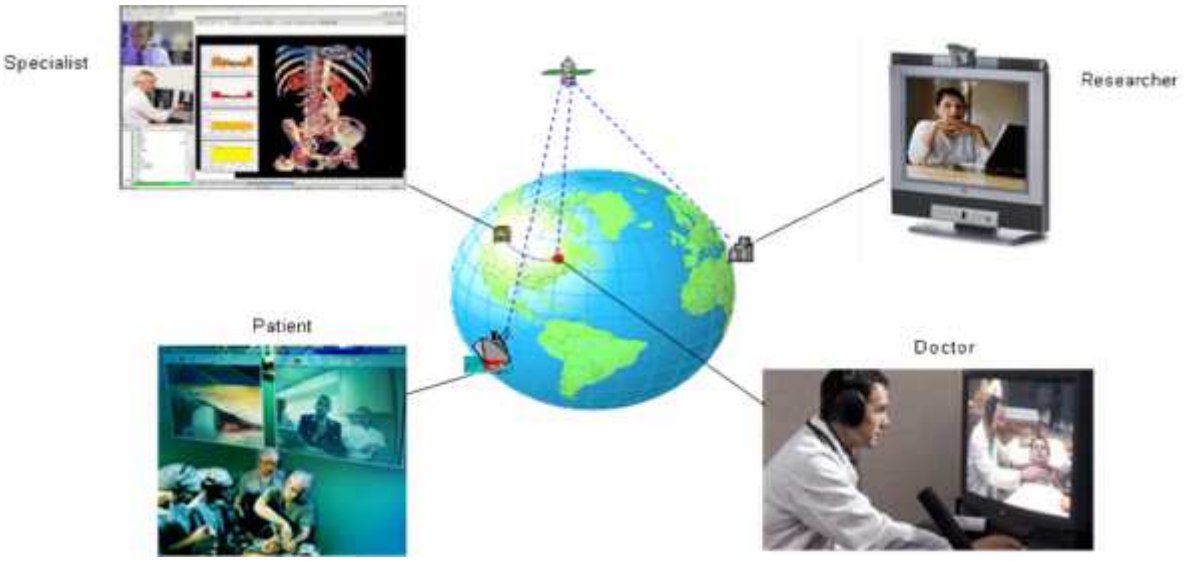

Figure1: overview of health monitoring application

3) The basic Monitoring Systems

In modern society, it can be hard for family members to find the time to stay at home and care for elderly or disabled relatives, but innovative home-based healthcare technologies which combine sensors, embedded systems, remote monitoring, wireless devices and intelligent software are all set to help make emergency responses and self-monitoring easier and quicker.

Mostly diabetes patients are senior citizens who do not find it convenient to attend hospitals so often, so if they can monitor themselves more effectively, it will reduce the frequency of their doctor visits. This situation has inspired the 'Smart home and Activities Monitoring' which features sensor-based and video-based monitoring.

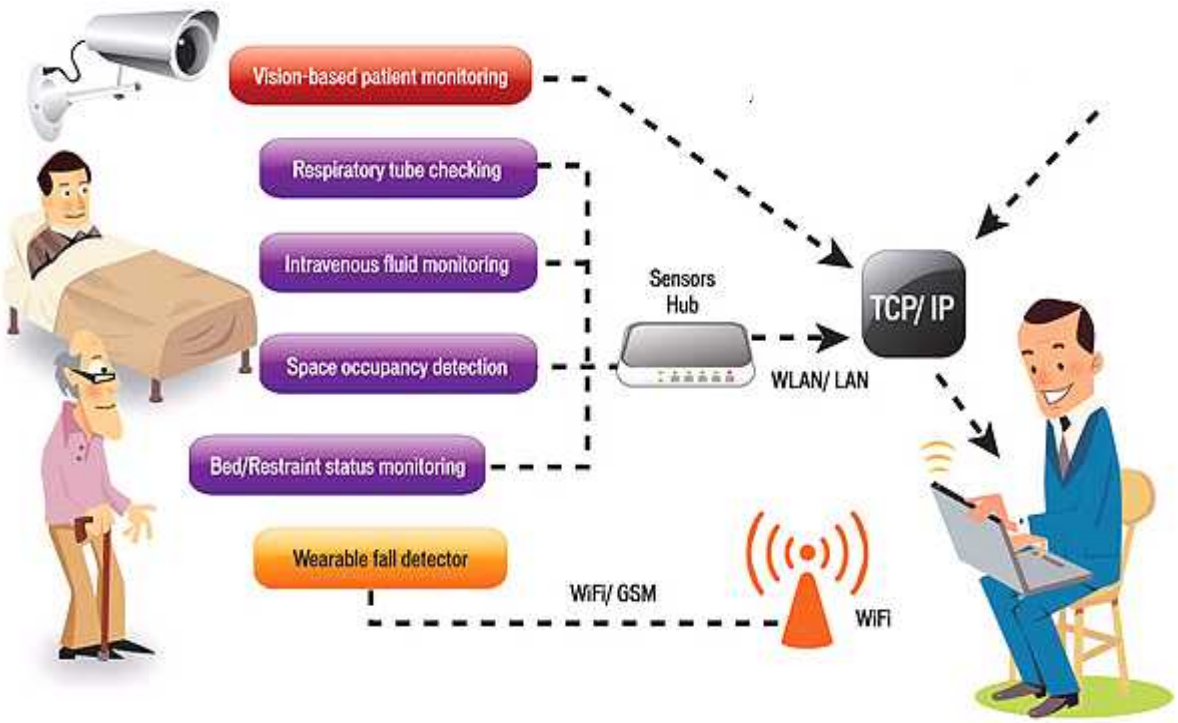

Figure2: Basic monitoring System

In the room with less light, video may not work well, so sensor can help to cross-check the movements. Or, in cases when a patient is concerned about privacy, sensors may help to avoid the use of video. Sensor-based monitoring can help reduce patient risk, especially from unwanted movements such as patients falling out of bed or getting up without permission, or for monitoring space occupancy detection, bed status and sleep patterns. Optical/pressure sensors can be installed at the leg of a bed. The technology can also help monitor patients who are taking fluids intravenously and automatically adjust their doses when necessary. For example, an optical sensor could detect drops in fluid levels and adjust flow rates. Meanwhile, the acoustic sensor can monitor respiratory rates. When unwanted movements, errors or malfunctions are detected, the system will alert the nurse centre, and if the nurses are on the move, it can alert them by mobile phone. Combining the monitoring technology with medical expertise will encourage new preventive health monitoring services. [3]

4) Envisioned Missions for Health Monitoring

a) **Sleep apnea:** Every night, monitor blood oxygenation, breathing, heart rate, EEG, and EOG using on-body sensors to assess severity and pattern of obstructive sleep apnea. Home network monitors agitation (movement) and stores and reports sensor data. Network alerts provider and patient if oxygenation falls below a threshold. Monitoring can continue while treatment efficacy is assessed.

b) **Journaling support:** Journaling is a technique recommended for patients to help their physicians diagnose ailments like rheumatic diseases. Patients record changes in body functions (range of motion, pain, fatigue, sleep, headache, irritability, etc), and attempt to correlate them with environmental, behavioral, or pharmaceutical changes. The homecare network can aid patients by: providing a time-synchronized channel for recording and transmitting the journal (PC, PDA, “dizziness" button); recording environmental data or external stimuli (temperature, barometric pressure, sunlight exposure, medication schedule); and quantitatively measuring changes in symptoms (pain, heart-rate, sleep disruption).

c) **Cardiac health:** Cardiac arrhythmia is any change from the normal beating of the heart. Abnormal heart rhythms can cause the heart to be less efficient, and can cause symptoms such as dizziness, fainting, or fatigue. Since they are sometimes very brief, it can be difficult to properly characterize them. Cardiac stress tests attempt to induce the event while the patient is wearing sensors in a laboratory. In a homecare setting, wearable EKG sensors can monitor for the condition continuously, over days or weeks, until the event occurs. The recorded data is promptly sent to the physician for analysis. If the event is serious enough, the emergency communication channel may be used to call for help, or it may be dispatched automatically. Other sensors in the home may be able to record environmental data to help identify the cause (side-effect of medicine, little sleep, etc.).[2]

5) Requirements for Wireless Sensor Networks in Body Monitoring

Wireless medical sensors should satisfy the following main requirements such as wearability, reliability, security and interoperability:

a) Wearability

To achieve non-invasive and unobtrusive continuous monitoring of health, wireless medical sensors must be lightweight and small. Size and weight of sensors are mainly determined by the size and weight of batteries. But, a battery’s capacity is directly proportional to its size. We can expect that further development of technology and advances in miniaturization of integrated circuits and batteries will help developers to improve medical sensor wearability and the user’s level of comfort.

b) Reliable Communication

Reliable communication in WBANs (Wireless Body Area Networks) is of paramount importance for medical applications that rely on WBANs. The communication needs of different medical sensors depending on the need of sampling rates, from less than 1 to 1,000 Hz. One approach to improve reliability is to move beyond telemetry by performing processing of the sensor signal. For example, instead of sending raw electrocardiogram data from sensors, we can perform feature extraction on the sensor, and transfer only information about an event. In addition to reducing the high demands on the communication channel, the reduced communication requirements saves on total energy expenditures, and consequently increases battery life. A careful trade-off between communication and computation is crucial for optimal system design.

c) Security

Another important issue is the security of the entire system of WBANs. The problem of security occurs on all three levels of a WBAN-based telemedicine system. At the lowest level, wireless medical sensors must meet the requirements of privacy provided by the law for all medical devices and should ensure data integrity. Although the key establishment, authentication and data integrity are difficult tasks in limited resources of medical sensors, a relatively small number of nodes in a typical WBAN and communication ranges make these tasks achievable.

d) Interoperability

Wireless medical sensors should allow users to easily build a robust WWBAN (Wearable Wireless Body Area Networks) depending on the user's state of health. Standards governing that interaction of wireless medical sensors will help vendor competition and eventually lead to more accessible systems. [1]

6)Benefits of Smart Homecare

The wireless sensor network architecture for smart homecare that possesses the essential elements of each of the future medical applications, namely:

- Integration with existing medical practices and technology
- Real-time, long-term, remote monitoring
- Miniature, wearable sensors
- Assistance to the elderly and chronic patients

It extends healthcare from the traditional clinic or hospital setting to the patient's home, enabling telecare without the prohibitive costs of retrofitting existing dwellings. Currently, patients visit doctors at regular intervals, self-reporting experienced symptoms, problems, and conditions. Doctors conduct various tests to arrive at a diagnosis and then must monitor patient progress throughout treatment. In smart homecare, the WSN collects data according to a physician's specifications, removing some of the cognitive burden from the patient (who may suffer age-related memory decline) and providing a continuous record to assist diagnosis. In-home tasks are also made easier, for example, remote device control, medicine reminders, object location, and emergency communication.

Smart homecare benefits both the healthcare providers and their patients. For the providers, an automatic monitoring system is valuable for many reasons. Firstly, it frees human labor from 24/7 physical monitoring, reducing labor cost and increasing efficiency. Secondly, wearable sensor devices can sense even small changes in vital signals that humans might overlook, for example, heart rate and blood oxygen levels. Quickly notifying doctors of these changes may save human lives. Thirdly, the data collected from the wireless sensor network can be stored and integrated into a comprehensive health record of each patient, which helps physicians make more informed diagnoses. Eventually, the analyzing, diagnosis, treatment process may also be semi-automated, so a human physician can be assisted by an "electronic physician."

The patients benefit from improved health as a result of faster diagnosis and treatment of diseases. Other quality-of-life issues, such as privacy, dignity, and convenience, are supported and enhanced by the ability to provide services in the patient's own home. Family members and the smart homecare network itself become part of the healthcare team. Finally, memory aids and other patient-assistance services can restore some lost independence, while preserving safety. [2].

7) Conclusion

The role of Wireless sensor networks in medicine and health care can be further enlarged. In the near future, the use of sensors will increase because smart spaces will be enabled with wireless sensor networks which can sense environmental conditions and take preventive actions based on the presence of humans is those spaces. The system can therefore reach ubiquity, where each individual would have a computational module able to seamlessly interact with the smart space's system and prevent health problems. 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.

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