

eHealthGuard: A Personal Mobile Health Monitoring Platform

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1. Introduction

Traditional medical services are hospital-centric in which patients obtain the treatments mainly at the clinics or hospitals. Today people are willing to pay more attention to their health situation. More medical services are in need and exceed the potentials of this hospital-centric service model. Using advanced biomedical sensors, the body condition of patients and aging persons can be monitored at home. Through wireless communication, their doctors and families can monitor their body condition in real time remotely and take suitable treatment and clinical care. It is estimated that more than 200 million people in the EU and the US suffer from one or several diseases where mobile health monitoring can become a treatment option. In that case, they don't need to visit the hospital regularly, which saves a lot of time and money. Meanwhile, as continuous monitoring can discover symptoms earlier, it helps preventing the disease from growing severely. Therefore, mobile monitoring and remote healthcare can significantly improve people's life quality, especially for chronic patient and aging people.

Because of the importance and the profound effects of BodyNets to the healthcare, there is an increasing interest on BodyNet research. Many research works have also been conducted on the BodyNet adaptability, self-organization, middle-ware, signal processing, system reliability, and healthcare and monitoring [2][3][4][5][6]. However, most of them focus on the wireless body area network technique, without providing an integrated end-to-end home monitoring and mobile healthcare platform. Disease management and diagnosis after the signal transmission are not considered. However, this component is as important as the medical signal monitoring in remote healthcare.

In this paper, we will introduce our novel integrated personal mobile health monitoring platform, called eHealthGuard. eHealthGuard can monitor patients'

body condition continuously, transmit the health data in real-time, automatically generate alarm signal and allow the doctors diagnose remotely. It also maintains a comprehensive healthcare database for every patient.

2. System Architecture

The eHealthGuard platform consists of three key components, real-time medical data collection, remote health management and healthcare data center.

Medical data are observed and collected in real time by various biomedical sensors, which are attached to the human body or planted in the human body. The bio-sensors are interconnected through short-range wireless communication channels (e.g., Bluetooth) forming a body area network (BodyNet). They deliver the collected information to a nearby personal digital device such as the smartphones. These smartphones serve as a data forwarder and first-level analyzer. These medical data are transmitted to the remote healthcare data center. Remote health management system then read the data from the healthcare data center. Leveraging the remote health management system, the doctors and nurses can learn the patients' condition and diagnose remotely. They can also interact with the patient or his family by text, audio or video communication. The healthcare data center is a central database, where all the patients' monitoring data are stored and the treatment and medication records are saved. The healthcare data center also provides various operations on the database such as search, sort, and other statistic tools. Leveraging which, patients or doctors can easily trace one's health condition by viewing the medical condition during a long duration or derive certain relationships between certain symptom and the disease.

3. Real-Time Medical Data Collection

In eHealthGuard, portable body sensors are wearable to patients with sustainable battery power. The sensors vary according to the application demands such as the electrocardiogram (ECG), oximeter, blood pressure and blood glucose. The bodynets are used to collect the physiology data by wearable biosensors and carried by users, typically the elderly and outpatients. According to different application requirements, these sensors can be attached to the human body or planted in the human body. The biosensors have two basic modules, the sensing module and the communication module. The communication module will communicate with nearby gateway nodes to upload the sensory data.

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BODYNETS 2011, November 07-08, Beijing, People's Republic of China

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DOI 10.4108/icst.bodynets.2011.247784

In eHealthGuard, we use smart phone as the gateway node to form a star-topology connecting with various sensors. All the monitoring data are transmitted out of the body area network through the smart phone simultaneously. Bluetooth[1] technique is adopted as the transmission protocol between the monitors and smart phones. Compared with other techniques such as WiFi or Zigbee, Bluetooth consumes lower transmission power while supporting a high enough data rate. Low energy consumption and real-time data transmission are two basic requirements for healthcare monitor design. The monitor should work as long as possible in one power charging cycle. It should also be able to support sufficient bandwidth to transmit the monitor data in real-time. As WiFi has large power consumption, and Zigbee cannot support high enough transmission rate, Bluetooth is a suitable choice for monitor data transmission. As for the transmission from the gateway smartphone to the remote healthcare data center, GPRS or 3G technique are adopted. As mobile 2G/3G network is ubiquitous, such technique provide everywhere coverage of the remote monitoring system.

4. Remote Health Management

While the real-time medical data collection system transmitted the signals from the patient at home to the remote healthcare data center, the remote health management platform provides auto-alarm function as well as diagnosis and real-time interaction function between doctors and patients.

Remote health management can send auto-alarm signal when abnormal conditions happened. The platform reads original healthcare signals from the data center and analyzes them in real time. When abnormal conditions happened, it sends auto-alarm signals to both doctors and patients' family. It also provides both a web application and a smart phone application for them to check the patient's current status either on desktop computer or smart phone, helping to diagnose the disease.

The remote health management provides various kinds of interaction functions between doctors and patients. Patients can communicate with doctors about their symptom and the doctors can tell them the medication treatment. The communications are conducted either in text, audio or video phone.

By tracing the trends of the patients' physical condition, the platform can automatically provide disease management function and propose suitable intervention scheme for the patients. This is effective especially for chronic diseases. In that case, the patients no longer need to drive to the hospital time and time again. The platform can trace their physical condition in real-time and send to the doctors. The advices from the doctors can also be sent back to the patients in time. The

patients only need to follow the doctor's advice at home and visit the hospital when his condition goes severe.

5. Healthcare Data Center

eHealthGuard maintains a healthcare data center for all the patients. This is a distributed cloud-based database. For one patient, all its real-time monitoring data as well as the medication records, treatment records are stored. All the data can be accessed from cloud client such as smart phone, laptop or desktop anywhere.

The data center provides not only basic database operations such as search and sort, it also function as a data warehouse and provide huge amount of healthcare data for data mining and machine learning. Based on the information in this data center, using data mining technique such as Bayesian network, reasoning technique, certain unknown relationship between certain symptom and the disease can be found, which can facilitate future biomedical research.

6. Conclusions

In summary, eHealthGuard is an integrated personal mobile health monitoring platform. It provides various continuous body condition parameter monitoring and remote health management function. It maintains a comprehensive healthcare database for every user and analyzes the body conditions automatically. With the wide deployment of eHealthGuard system, more and more patients can obtain benefit from its superiority.

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