u-Healthcare: The Next Healthcare Service Paradigm

Ronnie D. Caytiles and Sungwon Park*

Hannam University, 133 Ojeong-dong, Daeduk-gu, Daejeon, Korea
rdcaytiles@gmail.com, sungwon@hnu.kr
Correspondent Author: Sungwon Park (sungwon@hnu.kr)

Abstract

This paper presents a study of the comparison of different healthcare services to identify the characteristics and of a pervasive and ubiquitous healthcare system which is described as the healthcare provided for home based and moving patients that could enable remote and continuous monitoring and medical services anywhere and anytime. The study has identified the different classification of healthcare services such as the traditional healthcare service, location-based healthcare service, the home and mobile healthcare service and the ubiquitous healthcare services. The important characteristics required in ubiquitous medical service management systems in order to get some clues for ubiquitous healthcare service system architecture design are identified.

Keywords: WSN, LBS, ubiquitous healthcare systems

1. Introduction

Ubiquitous Healthcare Systems are interactive interoperation of pervasive and ubiquitous consumer technologies and healthcare provider's information systems that monitor and exchange patient medical information. These systems have enabled people to receive medical services beyond time and distance. Advances in telecommunications technology made possible data transmission over the wireless systems. The rapidly increasing use of handheld devices and the deployment of wireless-based solutions have accelerated the development of such services, especially in areas where a wire-line infrastructure is minimal or impractical. People are now capable of self-monitoring or manage their own health without consulting health experts and providers. Computerized medical information systems and resources have provided people with efficient medical services

The concept that location influence people's health have allowed better presentation of the distribution of health and healthcare needs and Internet resources answering them across a geographical area, providing users with better support for informed decision-making. The development of sensing, networking, processing and embedded system (system on chip) technologies enabled health monitoring devices more intelligent and smaller that are able to measure various bio-signals and exchange information through connected networks. These technologies have enabled remote patient monitoring which collects disease-specific metrics from wireless biomedical devices used by patients in their homes or other settings outside of a clinical facility. The remote monitoring devices typically acquires health information from people's natural daily living in home, company and exercise and transmits to a central server for storage and analysis by healthcare professionals. Health information delivery to various devices can now be easily achieved making health information instantly whenever it is needed and anywhere.

This paper provides an overview of the traditional healthcare systems, the location-based services, technologies for detecting user location (including IP geo-location), and their potential applications in health and healthcare, and the home and mobile healthcare systems.

The criteria and qualities of an ideal home based and mobile healthcare system are also identified as the basis for the design of a truly ubiquitous and pervasive healthcare service utilizing the current state of the art technologies primarily on wireless sensor networks and mobile IP. Furthermore, a numerous benefits for utilizing ubiquitous healthcare services and technologies are identified.

This paper is organized as follows; Section 2 discusses the different healthcare systems, Section 3 describes the ubiquitous healthcare systems and its benefits, and Section 4 concludes the study.

2. Healthcare Systems

A healthcare system is an organization of people, institutions, and resources to deliver healthcare services to meet the health needs of target populations. A wide variety of healthcare systems are available around the world. Healthcare systems are provided to promote good health, responsiveness to the expectations of the population, and fair financial contribution.

Healthcare is provided by institutions or individuals providing health care services. Individuals including health professionals and allied health professions can be self-employed or working as an employee in a hospital, clinic, or other health care institution, whether government operated, private for-profit, or private not-for-profit (e.g. non-governmental organization) [11].

2.1 Traditional Healthcare Systems

Traditional healthcare systems are based on independent autonomous physicians. The traditional healthcare systems cannot respond effectively to the current challenges of medical services. Independence and autonomy have characterized physician practice and defines the organization of care they can deliver. These could promote devastating results to patients and could suffer from inadequate safety, uneven effectiveness and responsiveness, and escalating costs.

The traditional healthcare system is ill suited for the delivery of health promotion and preventive services that require significant coordination, a well-developed infrastructure, close links to the communities, and effective learning systems to permit continuous improvement and effectiveness. It relies on the physician operating out of his or her own office with limited reliance on skilled non-physician professionals, limited investment in information/communications/knowledge management infrastructure, and lack of outreach into the community. Traditional health care solutions can provide care that costs more and delivers less than modified organized systems.

2.2 Location Based Healthcare Systems

LBS usually aims at increasing older people's autonomy and self-confidence by developing a wearable light device capable of measuring specific vital signs of the elderly, detecting falls and location, and communicating automatically in real-time with his/her care provider in case of an emergency, wherever the older person happens to be, at home or outside [1, 2].

Location based healthcare services offers a delivery of timely information and services for every user's changed location. It finds for the nearest and most accessible hospitals or clinics provided by an online healthcare facility locator service based on their location and health needs, and even provide them with driving directions and real-time traffic information. Ambulance and rescue teams can quickly respond and precisely track people in need of a medical emergency, injured, or lost, and also for ambulance fleet management. A secure web-based patient record is accessible anywhere for mobile patient monitoring and automated

emergency calls with very precise information on patient location if the system detects any medical problem requiring intervention. It can also send cautions or alarm messages to mobile patients for environmentally irritated or polluted areas [2, 3].
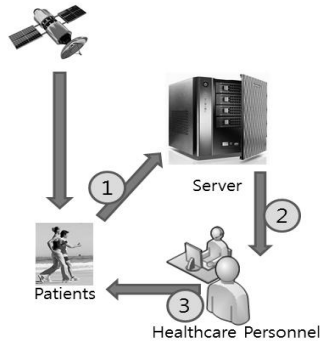

Figure 1. Location-based Healthcare Service

LBS usually focus on the following areas for development:

- The Roaming Monitoring System intends to monitor the older person when carrying out his/her daily activities in an independent way, both in the home and outdoors. Several vital signs besides falls will be measured and automatically communicated together with his/her geographic position to the Central Care Service in case of emergency, so that a rescue unit can be dispatched in a timely manner.

- The Home Monitoring System intends to extend the monitoring in the home environment, integrating other monitoring devices and sensors, as well as to integrate home automation devices in the system.

- The Central Care Service and Monitoring System will receive alerts from subscribed elder persons. This monitors received alerts like emergency (fall, stroke, etc.), reminders to take pills, activity and scheduled visit reminders, e-visits, etc.

Current issues and limitations of the location-based/GPS features:

- Failure to establish a GPS fix in difficult environments such as urban canyons/foliage/coated windshield environments, and indoors/inside buildings (e.g., inside a shopping mall). Also, location-based services must take into consideration the input and output characteristics of different user devices by carefully choosing, personalizing and formatting the content to display on such devices [4].

- Privacy issues. Location capability poses service providers with the challenge of responsibly handling consumers' personal privacy [5]. This is particularly important with tracking services that continuously monitor and log user's location.

Figure 1 shows a typical architecture for a Location-based healthcare service. In LBS, three main types of metadata have to be collected and processed: information resource descriptions, user profiles (including user location profile which directly affects user health), and user device descriptions. Older people's autonomy (duration of independent living) and self-

confidence can be greatly increased by wearing a light device that can measure vital signs, detect falls and location, and automatically raise an alert to their care centre in case of an emergency. These information are sent with the patient's location to the healthcare system server. The server then notifies the healthcare personnel of the location and map of the particular patient that needs medical attention or care.

Delivering real-time, location-enhanced and personalized information (i.e., information that is *immediately relevant* to users) can help consumers and providers accelerate and optimize their decision-making process in many medical/health situations and problems.

Location-based medical/health information services allow better delivery of healthcare needs as the Internet resources answering them across a geographical area, with the aim to provide users with better support for informed decision-making.

2.3 Home and Mobile Healthcare Systems

Home and mobile healthcare are primarily designed to patients of heart, glucose and dementia disease, and elderly people at home or mobile environment. Sensors around users measure their various bio-information like blood, pulse and glucose, which enables patients to do self-management as shown to them on a mobile device. The bio-information are measured and collected by implantable, wearable, portable sensors, and transferred to a mobile device with wireless networks like Bluetooth and Zigbee or to a central server with mobile and wired networks. Patients could be managed by a central healthcare center with continuous monitoring data transferred from sensors. Home-based healthcare is defined as the care or support provided in a person's home to improve or maintain the person's health status and wellbeing which includes the provision of equipment or services [7].

The Home based and Mobile healthcare System could accelerates the flow of medication, minimize cost, and minimize inaccuracy in traditional medical flow.
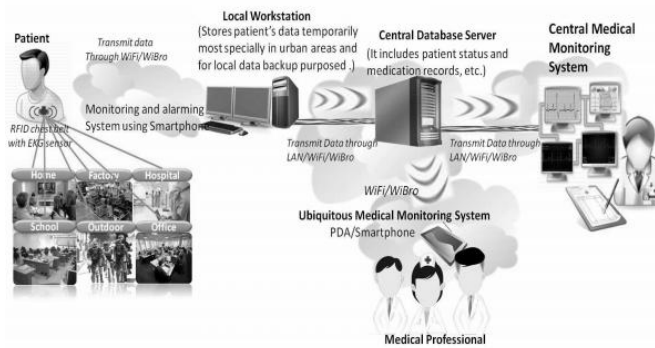

Figure 2. RFID-based u-healthcare monitoring system architecture over WSN [6]

Home and mobile healthcare systems can be applied in private and public hospitals, homes, offices, and even while travelling. The system is designed for fast and accurate healthcare service by integrating RFID and WSN technology as shown in Figure 2. The system consists of five major components: (1) RFID chest belt with EKG sensor for health monitoring, activity monitoring and patient information and location tracking, (2) a Smartphone functioning as a local processing unit or monitoring tool, (3) a local workstation functioning as a local database server for temporary storing patient data's, specifically in urban areas which are far from the hospitals, (4) a central database server which is the central storage of patient's medical records, (5) a central medical monitoring system which functions is for the medical professionals to study and analyze patient's status, and also we have ubiquitous medical monitoring system

using Smartphone/PDA for checking and analyzing patient's status while travelling or out of the hospital [6].

Home and mobile healthcare systems was developed mainly for elderly persons or patients with chronic diseases living at home and in urban areas. It measures patient activities, while working, exercising, travelling, and even while sleeping. This context information helps to provide further insight into the natural cause and progression of the patient's condition and enhances the accuracy of early symptoms detection.

3. Ubiquitous Healthcare Services

The provision of convenient health facilities at a low cost for patients and the elderly has always been a great challenge for health service providers. Devising a cheaper and smarter way of providing healthcare to persons having age related diseases is always been an issue. In addition, emphasis has to be paid on providing health monitoring in out of-hospital conditions for elderly people and patients who require regular supervision, particularly in remote areas. Future trends in national healthcare services are expected to include shorter hospital stays and better community care.

Thorough studies in order to find solutions to this problem have been conducted and building a remote u-healthcare monitoring system that can continuously, automatically, accurately, and cost effectively monitor patient's condition such as ECG and vital signs in order to provide a fast and efficient medical analysis and medication is very important.

A Ubiquitous healthcare system must perform such important functions and applications outlined as follows: (1) an individual's personal information with his current health data is collected with IP enabled WSN. Various bio-signals are checked through sensors as blood sugar, blood pressure, pulse, active mass, weight, muscle quantity, body fat quantity, body fat rate, basal metabolic rate, body mass index, etc. These sensors are wearable devices, which denotes a degree of integration with a piece of clothing or clothing accessory that goes beyond that of mobile computing devices, up to a degree where its computer nature is hardly noticed by the user. (2) the health data that are collected through sensors are amplified and transmitted through IP enabled WSNs; (3) the transmitted health data are stored, updated, interpreted and analyzed based on the medical relevant facts; (4) the healthcare system real-time monitors the individual's health status based on his/her personalized health plans and it subsequently renders medically-relevant advice to maintain a healthy lifestyle, remotely; (5) the healthcare system also must provide reminders for scheduled therapy and appointments and can electronically schedule medical appointments; (6) the healthcare system also alerts healthcare agencies whenever an emergency situation is detected. It should provide monitoring services for depression, hypertension, diabetes and cardio-vascular related diseases. Staffs who are monitoring bio-signal at the healthcare center call emergency service in case abnormal symptom appears and then visit patients and check their state directly.

Health data are collected using IP enabled wireless sensor networks, and then collected health data are transmitted to the analyzing layer for storage, analysis and monitoring. Healthcare personnel are alerted and notified with the status of monitored patients and efficient medical services based on patient's status and conditions are provided pervasively and ubiquitously.

Ubiquitous healthcare users will send out data from various sources, receive real-time medical information, knowledge, and relevant expertise and can search out relevant and useful information.

The pervasive and ubiquitous healthcare system can provide healthcare services with the following performance: improved patient care and safety, minimize or even eliminate medical errors, cost saving, increased efficiency and productivity, eliminate manual based documents,

time efficient for medical services, it will be pervasive, connecting devices, and embedded in such a way that the connectivity is unobtrusive and always available. It will also be context-aware, linking changes in the environment with computer systems. It is mobile, using technology while moving, and it will be ambient, working in concert to support people in carrying out everyday life activities, tasks and rituals in an easy, natural way using information and intelligence that is hidden in the network connecting these devices.

4. Conclusion

The study has identified the different classification of healthcare services such as the traditional healthcare service, location-based healthcare service, the home and mobile healthcare service and the ubiquitous healthcare services. Communication among patients, physicians, and healthcare providers will be improved by the widespread deployment of wireless networks. Delivery of accurate medical information through these wireless devices anytime and anywhere can reduce and possibly eliminate errors and improving access will result to provision of wide range of timely and efficient medical healthcare services for people in need. Thus, the potential of delivering improved quality of service and reduced long term cost for ubiquitous healthcare is near attainable.

Ubiquitous healthcare systems are designed to present new capabilities for both remote and real-time monitoring of patients. The important characteristics required in ubiquitous medical service management systems in order to get some clues for ubiquitous healthcare service system architecture design are identified. The ubiquitous healthcare system keeps track, manage, and interpret an individual's health history and offer health maintenance advice and service tailored accordingly. Thus, automatically interfacing with different diagnostic devices, gathering contextual data through patient interaction, and storing readings in the patient's lifelong medical record, the ubiquitous healthcare system is a comprehensive solution that can significantly improve the effectiveness of a ubiquitous healthcare and the quality of life of patients.

Acknowledgements

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