Product Line for Remote U-Healthcare Smart Mobile Medical Monitoring Application

Regin Joy Conejar¹, Yvette E. Gelogo¹ and Haeng-Kon Kim¹*

¹School of Information Technology, Catholic University of Daegu
{regin, yvette}@cu.ac.kr
*Corresponding Author: hangkon@cu.ac.kr

Abstract

In the present day, connectivity is generally considered as a high-end innovation when regards to technology. Mobile connectivity will be a crucial ingredient in bringing together the different parts of the Remote U-Healthcare puzzle. It is the application of smart mobile technologies for improving communication among patients, physicians, and other health care workers. As smart mobile devices have become an inseparable part of our life it can incorporate health care more seamlessly to our everyday life. It empowers the delivery of precise medical information anytime anywhere by means of smart mobile devices. With smart mobile medical monitoring application, remote U-Healthcare services will not only be available in limited locations but virtually available in all smart devices by healthcare via technology. The Software Product Lines (SPL) approach seems to be an useful technique to support mobile application development. A way to make SPL more effective is automating the software components composition for building mobile applications. In this paper product line for remote U-Healthcare smart mobile medical monitoring application have the potential to transform health care by allowing doctors to diagnose patients with potentially life-threatening conditions outside of traditional health care settings, help consumers manage their own health and wellness, and also gain access to useful information whenever and wherever they need it using their hand held smart mobile medical application.

Keywords: Remote U-Healthcare, Smart Mobile, Product Line, Health Monitoring

1. Introduction

The place of our “digital” intelligence, i.e., the world of our digital data, knowledge, and functionality, is progressively moving from our desktop PC or laptop to our miniaturized mobile devices - such as smart phones, MP3 players, or PDAs. At the same time, in the physical spaces where we live – shops, museums, archeological sites, airports, fitness centers, town squares, we are progressively surrounded with digital information delivered via large public displays. Current technology enables us to integrate “the small” and “the large”, and opens a number of new possibilities for creating innovative, engaging user experiences [2].

The deployment of smart phones and tablets has altered communications, commerce, and entertainment, among other fields. Their occurrence has upgraded service delivery, empowered consumers, businesses, and entrepreneurs, and changed the way in which people access information and make transactions. Now this technology is poised to alter how health care is delivered, the quality of the patient experience, and the cost of health care. Mobile technology is helping with chronic disease management, empowering the elderly and expectant mothers, reminding people to take medication at the proper time, extending service to underserved areas, and improving health outcomes and medical system efficiency. Mobile apps will have a big role in healthcare worldwide going forward. Developing these applications will take a combination of healthcare expertise,
firm knowledge, and physician’s guidance and development experts who can translate that into useful mobile medical applications.

Remote monitoring devices enable patients with serious problems to record their own health measures and send them electronically to physicians or specialists. This keeps them out of doctor’s offices for routine care, and thereby helps to reduce health care costs. Further, demand for medical service specialization, diversification, and personalization is on the rise and the medical system is switching its focus from face-to-face treatment to preventative measures and personalized medical services.

Various intelligent decision support systems have been developed for physicians to support medical diagnosis and prescription management. These intelligent support technologies also support the development of more detailed rules for medical diagnosis since the real time data collected commonly combines case history data for current analysis and diagnostics.

2. Related Works

2.1. U-Healthcare

U-Healthcare is an IT based technique which enables the management of diseases, health, and life anywhere and anytime and also makes a healthy and safe life possible. The ultimate goal of u-Healthcare is “the pursuit of improvement of the quality of life.” And to realize it, future u-Healthcare based on the generalization of IT/infrastructure such as the improvement of ICT and establishment of network, etc. will rapidly change due to the occurrence of new diseases, aging of the population, increase of consumers desires of health, data development of mass processing and storage technology based on broad band network technology, sensor network development such as RFID, business extension of medical solution providers, governmental health promotion policies, etc. Health care in the ubiquitous society is predicted to evolve based on intelligent health care providing medical and health care based on information acquired by sensors [14]. U-Healthcare with the use of smart mobile health monitoring applications will emerge industry as a new medical service paradigm which uses internet, mobile, among other information communication technology (ICT) in the existing medical system providing medical health information, knowledge, services and products to the consumers.

2.2. Mobile Apps in Healthcare – FDA Issues “Final Guidance”

Back in September the FDA issued what it is referring to as “Final Guidance” concerning how medical device regulations will be applied to mobile medical applications. The push has been on to firm up how these will be regulated within the context of existing rules, primarily due to the focus on pro-active healthcare via technology. With the Affordable Care Act still struggling the healthcare industry is wasting no time in looking forward to how they can begin to drive better patient results now that they drive the system, a complete turnaround from when it was the insurance companies that set the standards.

Multiple organizations now exist for the sole purpose of promoting more communications technology solutions for patient care. Many of these were started by the insurance providers, particularly those in the category of known as “provider of last resort”. Non-profit companies like the Blue Cross Blue Shield Network were among the early supporters of efforts like this.

This focus on using application development on devices that have historically not been used in patient care made it necessary for the FDA to give the firms a framework. The “guidance”, which is available, is described as containing “nonbinding recommendations”. It is very detailed in what parameters you will need to consider when developing patient targeted apps.
Despite the fact that it is described as “nonbinding” it will be taken by most in healthcare seriously nonetheless, particularly as “not following” the guidance could expose them to legal problems if a patient suggests they have been adversely affected by an applications use. The guidance covers both the device and the platforms that exist to support the app [13]. This smart mobile health monitoring application must need crucial and depth knowledge of the physician for the accurate result.

2.3. Remote Patient Monitoring Platform

Successful hospital readmission abatement programs require multiple, frequent measurements of the right data collected, stored, and delivered to the right clinicians, at the right time. Prompt access to larger volumes of data leverages the prescriptive authority of clinicians to make effective corrections in treatment earlier than possible without a monitoring program, averting otherwise preventable ER visits and hospital readmissions.

TeleMD360 uses top-quality A&D Engineering devices and the Healthcom Online platform in partnership with Alere Connect (formerly MedApps) to assist healthcare organizations develop and implement their own scalable remote patient monitoring programs as part of their hospital readmission abatement initiatives [15].

2.4. Regulation of medical software and mobile medical ‘apps’

Software is becoming increasingly important in medical devices; however, its rapid evolution, particularly in relation to mobile technology, presents new and complex challenges for the TGA and regulatory agencies internationally.

The following is intended to provide guidance on the regulatory arrangements pertaining to medical software and mobile medical apps by addressing some questions frequently put to the Therapeutic Goods Administration (TGA) [16].

2.4.1. Are Medical Software Products considered to be Medical Devices?

A software product is considered a medical device if it fits the definition in section 41BD of the Therapeutic Goods Act 1989 [16].

A medical device is:

A. Any instrument, apparatus, appliance, material or other article (whether used alone or in combination, and including the software necessary for its proper application) intended, by the person under whose name it is or is to be supplied, to be used for human beings for the purpose of one or more of the following:

1. diagnosis, prevention, monitoring, treatment or alleviation of disease;
2. diagnosis, monitoring, treatment, alleviation of or compensation for an injury or disability;
3. investigation, replacement or modification of the anatomy or of a physiological process;
4. control of conception;
5. and that does not achieve its principal intended action in or on the human body by pharmacological, immunological or metabolic means, but that may be assisted in its function by such means.
Software that satisfies this definition may include programs or operating instructions that control the functioning of an electronic device, such as:

- Smart phone apps that measure blood glucose levels and patient body temperature
- X-ray image-processing software
- Diagnostic software

Such software may be used with or in devices such as:

- Computers*
- Mobile phones*
- Tablets*
- Analysers used for pathology/detection of disease
- Patient monitors
- Pacemakers (which are medical devices themselves)
- Infusion pumps (which are medical devices themselves)

*NB a mobile phone, computer or tablet not intended by its manufacturer to be used for therapeutic purposes would not meet the definition of a medical device.

Not all forms of 'medical software' come within the definition of a medical device. A software product that is limited to managing and presenting information - such as a medical records management system or a dosage calculator - would not usually come within the definition unless it also incorporates a therapeutic or diagnostic function.

Many mobile apps are simply sources of information. The TGA does not have a role in regulating advice to health professionals or consumers other than when it relates to the advertising of therapeutic goods, or labelling and instructions for use.

However products that have a role in diagnosing or managing illness using software that analyses clinical data, such as the results of blood tests or ECGs, would, if they come within the definition above, be considered to be medical devices and would therefore be subject to TGA's regulatory oversight.

The TGA already regulates medical device software used for therapeutic purposes under the medical devices regulatory framework. Mobile apps would be considered within this framework [16].

3. Product Line Approach for Smart Mobile Medical Monitoring Application

Aided by the explosion of smart phones and wireless technology, the u-health revolution has helped people become more personally accountable for their lifestyle choices. Mobile applications (apps), engage people in a way that enables them take better care of themselves and manage ailments. The electronic or digital data gathered in real time is useful to motivate, inspire, track progress and reward effort, which is crucial to success. These gadgets and new app technologies have become more slim and lightweight to accommodate the longest run or walk around the park.

Development of software depends on operating system (OS) of mobile device. The emergence of various form of personal mobile device and associated various OS makes it important to make a smart choice based on the application requirements. This gives a patient the ability to carry an accurate physiological monitor anywhere, without additional hardware beyond what's already included in many consumer mobile phones. One of the advantages of smart mobile medical monitoring is that it allows patients to make baseline
measurements at any time. There are many applications for this technology, to help patients monitor themselves, and to help clinicians care for their patients.

**Figure 1. Product Line Approach**

**Symptoms** - Patient’s/Users will just input the symptoms. And the system will automatically provide the appropriate diagnosis based on the input symptoms. Enable the detection of early signs of health failure.

**Diseases** - Patient’s/Users will just input the disease that causes pain, dysfunction, distress, social problems, or death to the person afflicted, or similar problems for those in contact with the person. In this broader sense, it sometimes includes injuries, disabilities, disorders, syndromes, infections, isolated symptoms, deviant behaviors, and atypical variations of structure and function, while in other contexts and for other purposes these may be considered distinguishable categories. Based on the analyzed data and information from the data processing step, recommending appropriate stress solving program via mobile phone.

**Medications** - Provides medications information. Find relevant and reliable medical information on common medications. This will provide idea to the Patient’s/Users to early know what best medication suites to their ailments.

One of the key benefits of mobile medical tools is fostering a sense of patient efficacy. For medical professionals, more data is useful when helping a patient make informed health care decisions. Using smart phone medical application that checks other symptoms provides physicians with a wealth of clinically useful information. This is why medical monitoring application is one of the most important technological tools to promote ‘self-care’ and prevention of disease. This software product line is a set of software-intensive systems sharing a common, managed set of features developed from a common set application. On the other hand, this tool does not provide medical advice it is intended for informational purposes only. It is not a substitute for professional medical advice, diagnosis or treatment. Never ignore professional medical advice in seeking treatment.
4. Smart Mobile U-Healthcare Application Model

Mobile devices and their services play a significant and mounting part in a global world of computing. Software infrastructure that construct and establish application functionality, unified passage of reasoning among mobile devices and other environment, mobile devices software modeling, and scalability of the results should be transpire in order to create a quality of software infrastructure for mobile device. There is no standard model or rule to design and develop mobile u-healthcare applications. In order to support the medical specialists such as doctor, physician and therapist for developing personalized mobile u-healthcare applications, an application model for the mobile u-healthcare applications should be defined prior to the implementation of the workbench.

Remote u-healthcare smart mobile medical monitoring application development platform is implemented in the form of a workbench so that the medical specialists develop their own u-health services according to the guideline derived from the application model in the above. Where patient is the person whose medical condition is monitored by the health-monitoring system, who wears the sensors and carries the monitoring device; the monitoring device may be owned by the patient and used for other nonmedical purposes.

Mobile devices, such as smartphones, mobile internet devices and web-enabled media players, are becoming widespread. These devices possess limited resources, which motivates resource optimizations. Mobile devices are hawking the marketplace over their stationary counterparts. This involves Interaction- where mobile devices as control device either to play/suspend/ stop/resume time-based multimedia or to trigger operations, to navigate (hyperlink traversing). This conceptual framework which composed of four different dimensions namely the mobile device, mobile device management, mobile infrastructure management and mobile application delivery is linking the gap between the mobile application and the mobile devices users.

This application model focuses on the collaboration environment which includes the interaction of management server, patient and physicians. This approach is specified to be a decentralized approach; data is analyzed and decisions are made in each level to provide mobile patients with the crucial feedback of his/her health condition, temporary advice, recommendations and response to any emergency situation that may happen anytime at any place.
5. Software Framework

It is designed and implemented as software framework to be able to provide a set of generic functionalities that can be selectively utilized by application developers, thus providing application specific software focusing on monitoring of different health problems. As part of the framework, it offers a software library providing application programming interfaces (APIs).

![Software Framework for Smart Mobile Medical Monitoring](image)

Figure 3. Software Framework for Smart Mobile Medical Monitoring

Data Service manages record between platform and devices get the records used for retrieving patient records from personal devices, which could be health information systems or medical application servers. Medical services provide diagnosis and medication for all the symptoms given by the user generated from the health information system and medical application platform. Health information system provides information pertaining to the symptoms or disease given by the user. Personal self-monitoring and remote physicians provided proper medical assistance to the user. Software and hardware on mobile devices and smart phones make tracking one’s own health a part of everyday life. At the same time, researchers can mine these data streams to preempt future health problems, incorporating flags into the software to make individuals aware of possible problems in real time – long before they manifest themselves. This platform is responsible for communicating with external health information systems, connecting to medical devices that provide patient data and terminologies to the smart mobile medical monitoring application. It provides several modular patient health monitoring applications with the graphical user interfaces to allow patients to view their ailments and proper medication.

6. Conclusion

The rapid development of smart mobile device and its application brings an unmeasurable impact in the technology world. Therefore this product line for remote U-Healthcare smart mobile medical application supports and improves the faster ranging of medical technologies and it will target the broader population that is not as sick, and usually more mobile and out of the hospital. It will address this segment through the development of smart mobile applications and accessories, which will allow select smart
phones the ability to integrate with common retail medical and health monitors including scales, pedometers, blood pressure monitors and more.

In the future, we’re looking for more mobile medical application that can be used by healthcare professionals that will enable remote patient consultation, health monitoring and diagnosis and will provide the ability to transmit data from these devices directly to an electronic health record.

Acknowledgements

“This research was supported by the MSIP (Ministry of Science, ICT and Future Planning), Korea, under the CITRC (Convergence Information Technology Research Center) support program (NIPA-2014-H0401-14-1008) supervised by the NIPA (National IT Industry Promotion Agency)

“This research was also supported by the International Research & Development Program of the National Research Foundation of Korea (NRF) funded by the Ministry of Science, ICT & Future Planning(Grant number: K 2012057499)

References


