

Component Architecture of mHealth Service Platform

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Abstract. The area of mobile healthcare (mHealth) is expected to expand from disease treatment to various areas, such as disease prevention, telemedicine, and universal health promotion. Under such vertical and horizontal medical industry expansion, the mHealth concept for the improvement of the quality of medical services, such as telemedicine and medical record automation, will become the keyword of the industry while mobile devices and networks will be advanced. In this paper, architecture of mHealth is suggested for multi-product, small-quantity production and a majority constitution by small manufacturers.

Keywords: Mobile health service · Architecture · Software platform

1 Introduction

The mHealth, a medical healthcare service that utilizes mobile technologies, is attracting much attention because it can create new service values by combining the existing healthcare areas with IT and mobile technologies [1]. Major advanced countries are implementing various policies to activate the mHealth industry as well as U-Healthcare, and they are developing services, such as telemedicine, management of patients with chronic diseases, and medical video conferencing, by combining the medical field with ICT to reduce medical expenses. In the mHealth area, devices, software, and services are combined in various forms. Therefore, various stakeholders participate in the area, and thus, convergence based on standard technologies is required [2]. In addition, even non-experts should be able to develop easily services customized to various consumers. The considerations for activating the development of mHealth mobile apps are as follows: ① the applications must be connected to various types of bio-signal measuring instruments, ② the bio-signal measuring instruments must perform accurate and efficient measurements at home or on the move, ③ the measured data must be linked seamlessly to the integrated mHealth service center, ④ the measured data must be analyzed using various techniques to provide results that are easy to see, and ⑤ non-experts in programming must be able to develop mobile apps if they have service planning capabilities.

As for the necessity for a development platform in consideration of the characteristics of the medical device manufacturing area for mHealth, the medical device manufacturing industry, an essential mHealth element, is characterized by multi-product,

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small-quantity production and a majority constitution by small manufacturers. In addition, there are various items to be dealt with. Owing to these characteristics, it is difficult to derive specialized assistance for each device manufacturer, which is required for the development of mHealth mobile apps and capable of developing various business models. ISO/IEEE standards were established for pulse oxymeters, blood pressure monitors, thermometers, scales, blood glucose meters, and activity meters. The optimal data exchange protocol area between devices and managers was adopted as a standard in the transmission area. Basic channel electrocardiograms, respiration rate, blood coagulation test, insulin pumps, and cardiovascular fitness meter are under progress for standard establishment. Based on these standards, the interoperability between devices must be performed by providing the mHealth service platform and linkage methods between the standards and each device. There is a necessity for platforms that can support monitoring and consulting services among the mHealth areas since they are expected to create the highest demand in the next five years. In these service areas, it is necessary to develop a platform that can support the development of apps that meet Time-To-Market and stable service quality. Environments that support the development of mobile apps for non-experts in programming are emerging. The examples include open and commercial tools, such as App Inventor, Rud Dev, and MobiCart. Since they are environments that support the development of general-purpose mobile apps, effort is required to develop devices for mHealth services, elements that can provide linkage with mHealth servers, and process analysis results; therefore, they are not suitable for mHealth service planners and developers to use. Based on the environmental concept that supports the development of the existing general-purpose mobile apps, mobile app-developing environments specialized for mHealth are required. This study aims to analyze the characteristics of mobile apps specialized for mHealth in terms of architecture and to propose the architecture that can support such characteristics. In Sect. 2, the characteristics of mobile medical services are examined. In Sect. 3, architecture drivers required to provide mobile medical services are defined. In Sect. 4, the required architecture design results are explained. In Sect. 5, conclusions on future utilization methods and verification are presented.

2 Related Research

“Telehealth Project” of the U.S., “Telecare Project” of the UK, “iN2015” of Singapore, “AAL Project” of EU, and “u-Japan Project” of Japan are the representative examples of such policies. While the area requires a high level of expertise, the market is growing due to the combination of healthcare and mobile IT technologies, the demand for mobile applications, and the rapid increase in related products. In particular, the importance and growth of mHealth based on mobile applications can be expected. That the FDA announced guidelines on medical mobile applications is proof. Over 13,600 consumer healthcare applications are registered in application stores, and their average price is USD 2.05. There are approximately 40,000 applications that support multi-platforms, 70% of which are related to personal health and fitness, and 30% are

applications for medical experts (source: APEC Health Forum, 2012). While mHealth has the benefits of reducing health monitoring costs and improving efficiency as well as medical accessibility, there is still no specific business model. Although the mobile health apps market has a high growth potential due to its benefit of not restraining consumers, the difficulty in forming consumers is a limitation. At the moment, selling apps through app stores is the only business model, and it does not have a significant value in terms of revenue. The most realistic alternative to overcome this situation is to develop mHealth apps in connection with device manufacturers. Developing various app functions based on the accurate understanding of devices and measurement contents is presented here as a business model. The necessity, barriers, and success factors of the development of mHealth apps are as follows. Previously, the largest barriers were the vulnerability of data security, a lack of standards, and the inaccuracy of discovery, but it is now expected that these problems can be addressed by the distribution of smart devices, an increase in user demand, and the development of patient-customized care medical methodology (source: reserch2guidance mHealth App Developer Economics survey 2014, n = 2032). Remote patient management systems are provided to large hospitals, such as Pusan National University Hospital and Gyeongsang National University Hospital, and over 200 small hospitals. The mobile diabetes management service (high care) for managing health through mobile phones or internet is provided to patients. Isoo UBcare Co., Ltd. developed MDoctor (Mobile Healthcare solution) and began the mobile diabetes commercial services for general patients. Healthpia began the diabetes measurement service in 2004, and its "diabetes phone" co-developed with LG Electronics and Infopia in July 2006 received an approval from the FDA in the U.S. Humana launched "GoldWalker," a 99-cent mobile game. This game was classified into a fitness application because the game continued only when the gamer actually walked. In Japan, Fujitsu developed a technology for checking the pulse in real time using the face photograph taken by a camera built in smartphones and tablet PCs. eHealth Aces Pvt in India developed an app service that connects users to doctors and released it in Google Play. It is provided in a price range from 9 to 2,49 rupees, and it can be linked easily to other medical services provided by eHealth Aces Pvt. [3] introduced most popular app for mHealth. Recent studies show that mobile devices and apps can support a variety of routine medical tasks including clinical reference, drug dose calculation, patient education, accessing medical records, and clinical decision support [4, 5].

3 Architecture Driver

In this study, an architecture was developed for the mHealth mobile platform, which can identify components for mHealth services (sensor component, measurement data analysis component, patient care guideline component, inference component, and visualization component) and create mHealth mobile apps based on scenarios that may activate their development. For this, architecture drivers were identified as shown in Table 1 by analyzing the current mHealth services and technical trends.

Table 1. Architecture driver

Trends and Goals	Description
1. Service creation possibility	• Generation of visual programming environment so that non-experts in programming can easily develop mobile apps if they have creative mHealth service plans • Creation of visual development tools that provide methods for intuitively developing desired mHealth services • Services can be developed by assembling common and product-specialized components from the mHealth service platform
2. Scalability of the care guidelines	• The increasing importance of evidence-based medical services, which provide better health performance, expand the uniformity of the quality of treatment, and suppress the growth of healthcare expenses by providing patients with more effective and safer interventions • The essential application of evidence-based medical services as technical innovation for reducing the costs of acquisition, storage, processing, and searching of various data to be utilized in mHealth services • The defining of the potential range of evidence-based medical services in mHealth services is necessary, considering medical law and clinical environments • The nursing protocol for providing evidence-based mHealth services must have a form (CIP: Computer Interpretable Protocol) that can be understood by computers • Forms suitable for the CIP definition are defined based on various forms following the existing nursing protocol • For the evidence-based care service customized to patients, the nursing protocol must be created in accordance with the forms for CIP
3. Visualization of analysis information	• The commonly required visualization methods in mHealth services are Chart, Graph, and Gauge • Components for visualizing the analysis information are expanded based on the existing open source components
4. Analysis of accumulated information	• Various forms of analysis must be supported by defining basic analytical features as the functions for sensor-based data analysis • Avg, SD, Rec, Sm, Int, PSD, MF, MPF, FFT, RMS, Wavelet
6. Data collection from medical sensors	• Development of sensor modules for measuring bio-signals, such as ECG, EMG, EEG, ENG, EOG, and ERG, as well as sensor modules for measuring temperature, blood pressure, respiration, and pulse
	• Design that enables the implementation of high-precision filter circuits and channel expansion
	• Design of a circuit capable of implementing signal amplification and attenuation functions

4 Component Identification for mHealth Architecture

4.1 Builder Component and Visualization Framework

This environment can add contents required for mHealth based on JS/HTML 5 and Open Source Code. It implemented the visible component based on the common component modeling method and design the screen generator component through web authoring tools based on the HTML 5 technology. The detailed component design is shown in the Fig. 1.

4.2 Care Guideline Framework

This component can easily create the nursing protocol for mHealth. It defines the service range and method, taking into consideration the legal regulations of mHealth and risk elements from the medical perspective. They are defined by the range of services provided by the Clinical Decision Support Service (CDSS), which constitutes an axis of the existing medical information system, and the technical and legal restrictions of mHealth. As the nursing protocol must be defined in the CIP form for evidence-based services in mHealth, the framework contains the procedure and methods required for CIP creation. The framework is defined in the following figure as the nursing protocol for processing hypertension and metabolic syndrome, which are the most representative chronic diseases, so that it can be created and used as a reference model in the future for the scalability of the knowledge. Figure 2 show the several example of care guidelines.

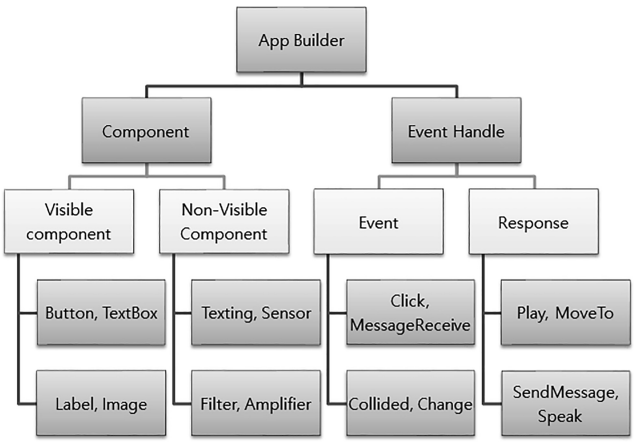


Fig. 1. Component of visual builder

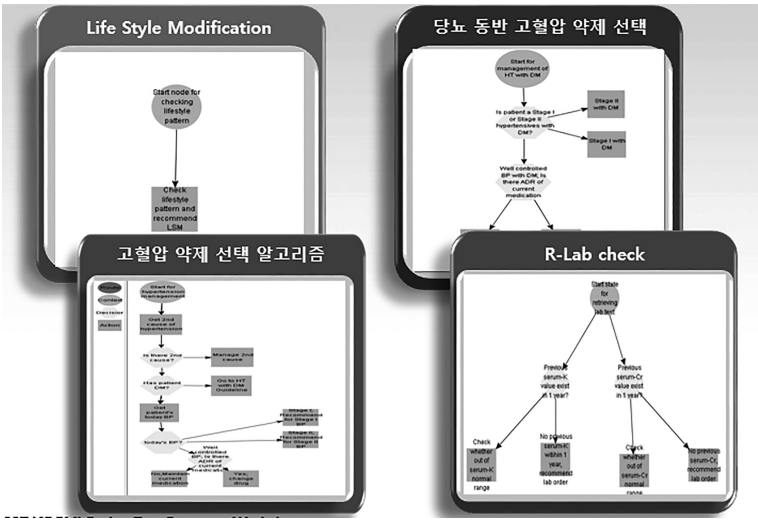


Fig. 2. Guideline components

4.3 Medical Sensor Framework

The bio-potential signal measurement sensor module and dms sensor module are built into the components to measure the ECG, EMG, and EEG signals from the human body so that the output of built-in sensors can be used easily. They are also designed so that the setting value of each sensor can be easily modified. Moreover, they are defined so that the Universal Sensor Interface function can be implemented. The Notch Filter and Band Pass Filter components are elements for implementing the digital filter function. They are designed to enable high-precision filter circuit implementation and channel expansion. A band pass filter is used to remove the power noise. The ECG, EMG, and EEG amplification modules are components constituting an amplification circuit capable of measuring signals, and they implement the amplification and attenuation functions. The Low Pass Filter and High Pass Filter modules enable high-precision filter circuit implementation and channel expansion. They remove the power noise using the Band Pass Filter, and the Low Pass Filter is used to remove the signal noise. It was verified that multiple biometric data, such as the heartbeat and pulse, can be easily monitored through bio-sensor nodes.

5 Conclusion and Future Research

This study proposed a mHealth service platform architecture capable of integrating the information obtained from medical devices with evidence-based medical services and supporting the co-development and co-brand-based construction of small-scale multi-product medical sensor manufacturers. It is expected that the mHealth service platform can be utilized as the basis of the co-marketing required of small-scale manufacturers to efficiently pioneer the market under global competition. The importance of evidence-based

medical services is continuously increasing as the importance of medical quality grows. The results of this study can contribute to the improvement of medical quality because the clinical decision support system (CDSS) can be first applied to the nursing department of the International St. Mary's Hospital. If the area is expanded to pressure sores and falls, based on the guidelines on hypertension and metabolic syndrome, which has been proposed as a reference model, the accuracy of care and patient satisfaction will be improved. Moreover, the results can be utilized as online training tools for creating customized mHealth services; they can be used in mHealth service planning and unit element development training for services for people majoring in biomedical engineering and nursing. In the future, it will be necessary to expand research to secure an entry into other Internet of Things (IoT)-based service areas. IoT is an intelligent infrastructure and service technology that exchanges information and performs communication between people and objects as well as between objects and objects by connecting all surrounding objects. In the future, there will be a Hyper Connected Society in which everything, including people, processes, data, and objects, is connected to create, collect, store, share, analyze, and predict information as the IoT era approaches. Therefore, it will be possible to secure a basis for the development of customized care services through an expansion to various targets other than medical sensors.

References

1. Kay, M., Santos, J., Takane, M.: mHealth new horizons for health through mobile technologies. World Health Organ. **64**, 66–71 (2011)
2. Estrin, D., Sim, I.: Open mHealth architecture: an engine for health care innovation. Science **330**(6005), 759–760 (2010)
3. Labrique, A.B., Vasudevan, L., Kochi, E., Fabricant, R., Meh, G.: mHealth innovations as health system strengthening tools: 12 common applications and a visual framework. Glob. Health Sci. Pract. **1**(2), 160–171 (2013)
4. Becker, S., et al.: mHealth 2.0: experiences, possibilities, and perspectives. JMIR mhealth uhealth **2**(2), e24 (2014)
5. Lewis, T.L., Wyatt, J.C.: mHealth and mobile medical apps: a framework to assess risk and promote safer use. J. Med. Internet Res. **16**(9), e210 (2014)