An Evolving Mobile E-Health Service Platform

Dongsoo Han, In-Young Ko, and Sungjoon Park
Information and Communications University, Daejeon, Korea

***Abstract*-- With the wide spread use of cellular phones and the increased interests in the well-being of people, many vendors of cellular phones start to embed a variety of e-health services in their cellular phones. In this paper, we propose an e-health platform on which e-health services can be systematically developed by utilizing various functions and features, and by following guidelines provided by the platform.**

I. INTRODUCTION

The popularization of cellular phones gives an incentive for providing services for well-beings of people using cellular phones. For example, the LG Company has started stress management service on their cellular phones. A heart rate variability (HRV) sensor is imbedded into the cellular phones for the stress management service. However, the mobile e-health service is still in an infant stage, and very limited services are currently available. Part of the reason is the lack of a common platform to develop various mobile e-health services such as weight management, stress management, blood sugar level management, and fatigue management.

In this paper, we propose a mobile e-health service platform on which mobile e-health service developers can systematically develop mobile e-health services by using various functions and facilities, and by following service developing guidelines of the platform. The proposed service framework and platform are unique in the sense that the service platform evolves as new mobile e-health services are developed on the platform. New common functions and services developed during the implementation of a new mobile e-health service can be identified, registered, and reused in the platform.

II. MOBILE E-HEALTH SERVICE PLATFORM

A mobile e-health service provides functions to advise or perform most timely and appropriate actions based on real-time bio signals such as pulse rate, ECG (electrocardiogram), blood sugar level, body fat ratio that are captured, stored, and analyzed by mobile devices. We have identified some of the core components of mobile e-health services which play essential roles in delivering the services. The core components of mobile e-health services can be grouped based on the steps or roles involved in the e-health process:

- Bio-data gathering and management
- Bio-data analysis
- Knowledge extraction and decision support

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The mobile e-health service platform provides bio data gathering, storing, managing, and analysis services in integrated manner. Diverse forms of mobile e-health services can be developed and run on the platform using various functions and services of the platform. In order to make the mobile e-health service platform reliable and powerful, the platform is equipped with a number of components providing various kinds of management services. Fig. 1 illustrates such components constituting the mobile e-health service platform and the connections with surrounding e-health framework.

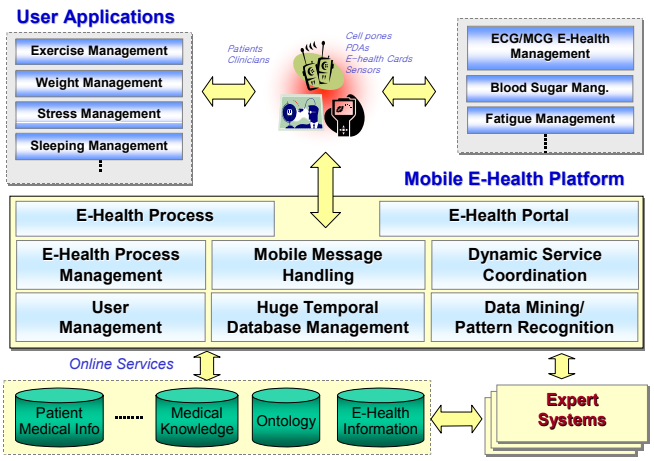

Fig. 1. Mobile e-health service platform architecture

As cellular phones play the role of gateway between bio sensors and servers, mobile message handling is essential in the platform. The mobile message handling module relays all the messages in between bio sensors and servers. Not only bio signal data but also service request messages are delivered by the message handling module. Sometimes, it contributes in filtering out noise signals from the received messages.

The bio data delivered to the platform are stored and managed by the huge temporal data management module. The bio data is stored in diverse forms according to the e-health services or applications.

Data mining or pattern recognition techniques are used to identify the health index for the accumulated bio data, and an external or internal expert system may refer to the data as feedback information. In this process, data mining or pattern recognition techniques and expert systems have to be closely related with the database schema of the temporal database.

To allow developers to define a mobile e-health service easily, the platform provides a process-centric method. By using this method, developers can define a service template in a form of process containing steps like bio data gathering,

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storing, analysis, and result reporting. The e-health process block in Fig. 1 denotes a virtual set of mobile e-health processes derivable from the process template.

The e-health process definition tool is used for defining mobile e-health services. The e-health process management module provides not only enactment services but also monitoring and administration services for e-health processes.

The mobile e-health process management module and the e-health process definition tool play a key role in making the platform evolvable. When a new mobile e-health service is defined on the e-health process definition tool, reusable process templates, steps, and data structures are identified and registered to the modules for later use. Thus, the platform evolves as new services are developed and registered to the platform. Ontology-based technology is used for the identification of sharable services for various e-health applications.

The user management module is essential for providing personalized services to individual users. The user management module stores user profiles like their age, gender, occupation etc. Since a user is a participant in a mobile e-health process as well, this module is closely connected with the participant information in the e-health process management module.

The dynamic service coordination module is for providing reliable services by replacing a step with another when a fault occurs.

A data mining or pattern recognition technique may need to be developed for some types of e-health services. In addition, the expert systems engaged with e-health services may need to access the functions in the data mining/pattern recognition module.

III. Prototype Implementation

Fig. 2 shows the prototype of our mobile e-health process modeling tool. The tool is implemented in Java on the Eclipse Foundation's Eclipse platform. Note that customized user interfaces can be easily integrated using the plug-in-based software integration feature in the Eclipse platform.

Part (a) of Fig. 2 shows the canvas of the tool. Service process designers can design a service process either by manually defining each service of the process on the canvas, or by semi-automatically selecting one of the recommended services in part (b). In semi-automatic composition of services, when a user marks a service in a service process, the tool lists connectable services to the marked service.

Part (c) of Fig. 2 shows the service and data ontology hierarchies. At the beginning stage of a process design, one of the services in the service ontology may be selected. Then, the system lists service instances implementing the service function in part (b). An ontology editor is connected to part (c). When one changes the ontology on the editor, the change or update of the ontology is reflected to part (c) so that the change or update may be used immediately.

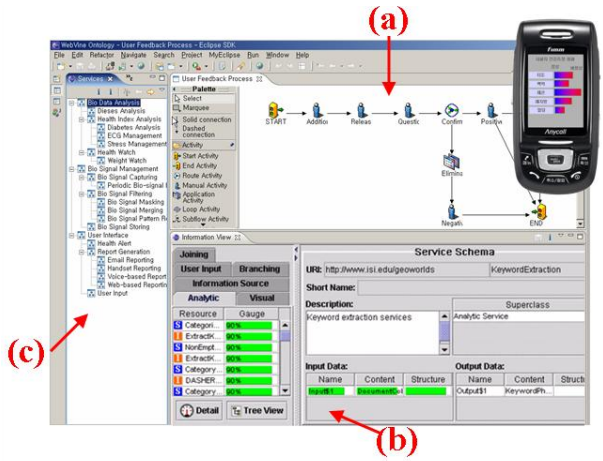

Fig. 2. A prototype of the semi-automatic services composition tool – (a) Visual business process editing tool; (b) Service recommendation tool; (c) Ontology-hierarchy browser

IV. Related Work & Conclusion

A significant amount of work has already been done in the e-health research area. Dokovsky et al. [1] have presented a Java based MobiHealth service platform for remote monitoring of patients using 2.5/3G wireless networks. Konstantas et al. [2] have introduced new mobile value added services based on 2.5 and 3G technologies by the integration of sensors and actuators to a wireless Body Area Network. Val Jones et al. [3] have presented in their paper two major applications supporting virtual trauma care and virtual homecare. Zhao et al. [4] have designed and developed a VitalPoll Telemedicine system using Bluetooth and Internet technologies with client server architecture.

Our approach is different from the usual approaches adopted by many of the researchers. In our approach, doctors or hospitals are not necessarily involved because the main aim of the service is to assess the user's body health condition in mobile situation. The proposed mobile e-health platform has a very unique feature in that the platform is updated and adapted as new e-health services are designed and implemented in the platform. The ontology-based service management and the process-centric service modeling are the keys to make the platform evolvable.

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