Improvement of Mobile U-health Service System Using Feces and Urine Sensing U-Care Scheme

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ABSTRACT

This paper presents a novel method to design and implement mobile u-health system by defining the essential elements of mobile healthcare services. We choose common service elements for the proposed u-healthcare scheme and design the service platform. Especially we focus on automatic feces or urine sensing u-care scheme to prove the effectiveness of our platform. We construct the system with sensing part with a manikin and a diaper, wireless communication part with feces or urine sensing data, and coordinator system based on the u-health platform defined in this paper. Experimental results show that our scheme is useful in the area of u-care service for the handicapped, the elderly, and patients who can hardly move by themselves. In addition the designed scheme offers a realized u-care scheme with the purpose of advanced developing tools for application or service developers.

Key words: *U-health Service System, Mobile Service Platform, U-Care Scheme.*

1. INTRODUCTION

In recent, social concerning about u-health industry is rapidly growing because our society has been highly aging status and requirement for health and welfare will be continuously increased. In terms of government budget, rate for health and welfare will be gradually increased [1]. Therefore various health-care services will be generalized in our modern society and models and systems for these services can be one of the hottest research topics in the near future. For example, LG and Samsung announce products for health-care checking blood-sugar or body-fat using a cell phone connected to biomedical sensors [2].

But we cannot decide that the era of u-healthcare begins in good earnest, although there have been a few simple instances of u-care mentioned above. These services are limited to a simple off-line care through a terminal with corresponding programs and connected sensors. We expect that u-healthcare scheme will be much more complex and useful system than simple terminal. We can store, manage, and analyze the physical data from various sensors using mobile terminal, and we ultimately get distance clinic throughout these on-line services and mobile handsets [3].

On the other hand, we can offer healthcare services such as blood sugar, body fat, heart rate, stress, and fatigue management using mobile terminal. We can also get various

bio data such as ECG, pulse rate, blood sugar level, and body fat ratio through existing sensors [4].

In this paper, we propose a new approach for design of mobile u-healthcare system by defining an essential service group of mobile healthcare services. In addition we choose common service elements for the proposed u-healthcare and design the service platform. Especially we focus on automatic urine sensing u-care system to prove the effectiveness of the service platform.

The rest of this paper is organized as follows; Section 2 briefly describes u-healthcare services in general point of view and defines the service elements for our new approach in this study. Section 3 offers the structure of platform using common service applications. Section 4 proposes a mobile u-healthcare scheme by automatic urine sensing u-care system and explains its usability. Finally Section 5 gives our concluding remarks and future studies.

2. MOBILE U-HEALTH SERVICE

2.1. Definition
Although there can be different definitions for mobile u-health service according to their points of view, we define a real-time service that can be obtained from a mobile terminal while we are moving. In other words, we can get, store, manage, and analyze the mobile bio data to apply the corresponding user to do a proper follow-up at proper time or directly cure the disease as an advanced service. In addition, mobile u-health system is defined as an integrated scheme including bio sensors,

terminal, and related software and hardware, which needed to provide mobile u-health service defined above.

In this opening section of the paper, we treat the essential elements of mobile u-health service or system in view of the service framework or platform.

2.2. Elements of Mobile U-health Service

Mobile u-health system generally consists of the following core elements and their corresponding technologies, although there are other kinds of systems in our initiative u-health world [5];
- Framework for collection of bio data
- Framework for storage and management of bio data
- Framework for analysis of bio data
- Framework for mobile u-health service

Based on these cores, we pictorially present our structure of mobile u-health service as shown in Fig.1.
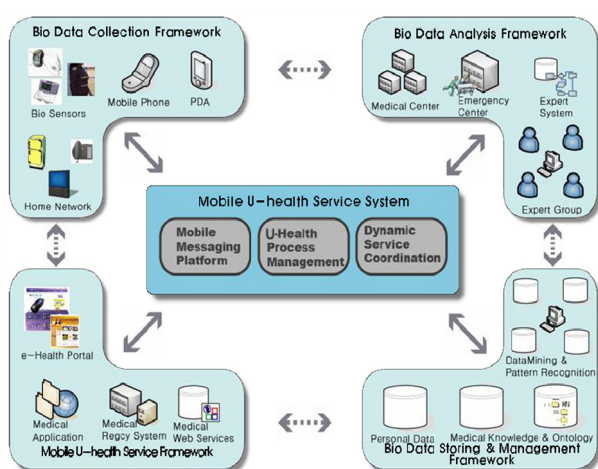

Fig. 1. Structure of Mobile U-health Service

System periodically gets user's bio data and transfers them to the server using the framework for collection. The sensing output from the independent sensor installed in terminal are transferred to the server through the terminal gateway. Although the method of direct transferring from sensor to server is possible, it cannot be practical because of the sensor cost and the sensor's capability limit.

We can effectively store and manage the collected bio data using the framework for storage and management. In this scheme, we use temporal data management skill for the framework because the bio data are generated periodically and continuously.

Framework for analysis decides whether there are abnormal symptoms in user's body by the prepared analysis method applying to new bio data obtained from frameworks described above. In order to analyze bio data, we apply data mining technology to detect possible abnormality or index of health. We use pattern matching method, expert system concepts, and supporting method for decision making.

Finally, framework for mobile u-health service is a kind of middleware supporting the integrated service including data collection, storage and management, and their analyses. Therefore, the elements of u-health service described above and

various corresponding technologies are integrated to a Hub, which is named as mobile u-health service framework. In addition, the framework offers the environment for developing services and makes services to be operated on the framework.

Fig.1 shows a typical model of mobile u-health service which consists of the core element frameworks mentioned above. Real-time bio data for a user obtained from mobile utilities are stored in database and analyzed. Most of the time, analyses of bio data are fulfilled by the help of an expert system which collects bio data into two parts between normal group and patient group so that the accuracy of decision can be higher. Moreover the expert system continuously advances by studying the new data as its proper learning data.

3. MOBILE U-HEALTH SERVICE PLATFORM

In this section, we present the architecture of mobile u-health service platform with its core elements and their roles. We explain the capabilities of the platform in connection with applications, expert system, and their related databases. Fig.2 shows the structure of mobile u-health service platform offered from this point of view [6].
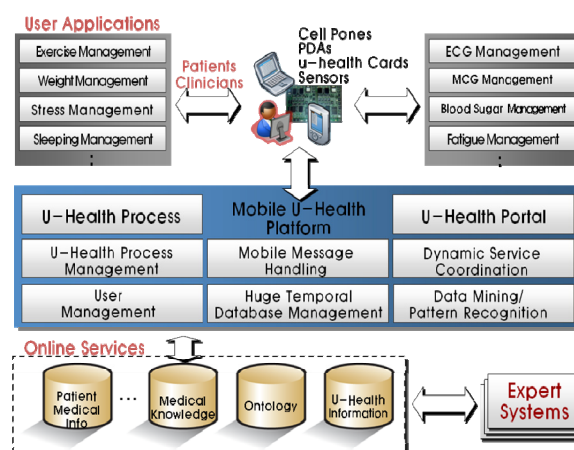

Fig. 2. Mobile U-health Service Platform

The platform receives bio data as type of messages from various terminals and hands them over to the database management module to be processed. In other words, mobile message processing module connects between the moving client and the server. The bio data transferred through the mobile message processing module to the framework will be stored and managed by a large scale temporal database management system, in which the bio data may be separated according to their users, services, and sometimes by their types of treatments.

Stored data will be used for detecting necessary health indices by applying data mining or pattern matching methodology, and then offer direct or feedback information to the expert system. Close relations between expert system with data mining or pattern matching module and temporal database management module are necessary because structure of database varies with kinds of application services.

On the other hand, corresponding u-health application service has to be defined by a process format in order to develop the application service using the mobile platform. As shown in Fig.2, all the mobile u-health services are to be considered possible as processes for obtaining, storing, analysis, and informing the result. In addition mobile u-health application services represented by corresponding processes will be operated and controlled by the process management system, in which operational services and their monitoring steps for control will also be supported.

The user management module supports personalized service control to manage all the personal information. This module can be used in connection with the user management scheme installed in the process management system.

4. DESIGN OF THE U-CARE SERVICE PLATFORM

In this section, we design and implement a u-care system which automatically senses feces and urine of patients and informs to their guardians through mobile text transmission service based on the concept of mobile u-health service platform represented in the last section. We also present that the system can realize functions such as patient monitoring, informing abnormal phenomena, communication between bio terminal and server, receiving the messages and analyzing them to achieve the original purpose of u-care system [7], [8].

We show the structure of our u-care scheme based on mobile u-health service platform in Fig.3. The system consists of 4 kinds of frameworks for the purposes of bio data collection, storage and management, analysis, and mobile service as described in Section 2.2.
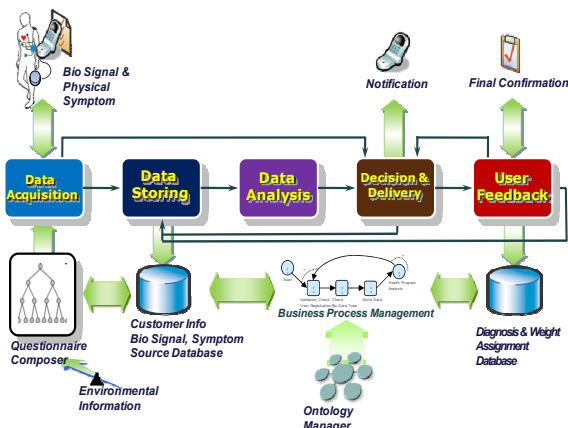

Fig. 3. Mobile U-care System Structure

Fig.4 shows the structure of framework for bio data collection. This framework periodically gets user's bio data(feces and urine sensing) and transfers them to the server. If the sensor attached at diaper detects a fecal phenomenon, the information obtained from the sensing will be transferred to the receiver as the patient's status. Sensing part consists of fixing clip to diaper, power supply line, current sensing circuits, processor for detected signal, and wireless transmitter which transfers sensing information to the mobile terminal.
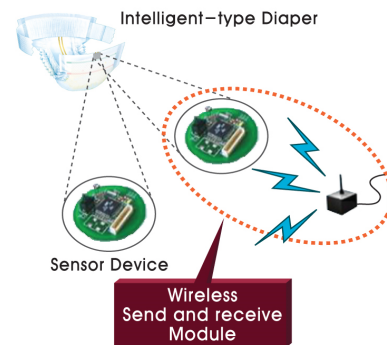

Fig. 4. Bio Data Collection Framework

Framework for storage and management of bio data is a central element to store and manage the collected data using the sensor and the data collection framework as shown in Fig.5. It processes u-health data, user related data, and service specification. In addition, we analyze disease related issues, symptoms, and their relationships using semantics representation model based on the u-health data ontology throughout the framework. We can offer a user friendly environment for development of various u-health services and contents in order to meet the modern requirements from users.
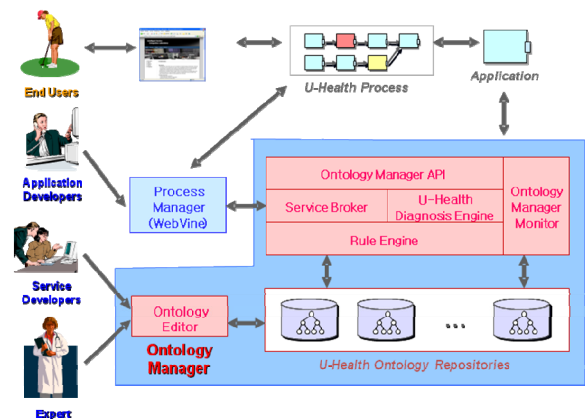

Fig. 5. Bio Data Storing and Management Framework

We can make professional service developers store his own services for various u-health applications using the ontology editor as shown in Fig.5. In addition, application developers can find the most proper service for his own u-health application by using the service broker of the ontology manager prepared in this scheme. Throughout these processes, we can offer personalized u-health services and a reliable developing environment for further or new application of advancing scheme.

Framework for analysis of bio data is shown in Fig.6. We can decide feces or urine about patient by analyzing new created data throughout the method prepared previously. As shown in Fig.6, service developers and application developers can perform their developing jobs on the link provided by the service broker of the scheme. After service developers generate service units and load them, application developers may construct corresponding service processes using recommended service units throughout the service broker. We can realize a large process using stored process elements through the process

template while we can directly realize any sub-process by bringing service units from the service pool.
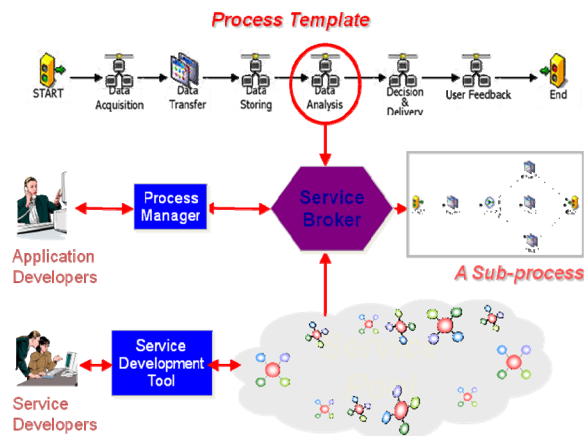

Fig. 6. Bio Data Analysis Framework

Mobile u-health service framework shown in Fig.7 is a kind of middleware software supporting services for data acquisition, storing and management, and analysis as an integrated service. This framework offers any kinds of application services loaded on our u-health platform not only to terminal but to the web service. Although there are some overlaps, we can assign elements such as client device tier, business logic tier, and data management tier to this framework as shown in Fig.7.
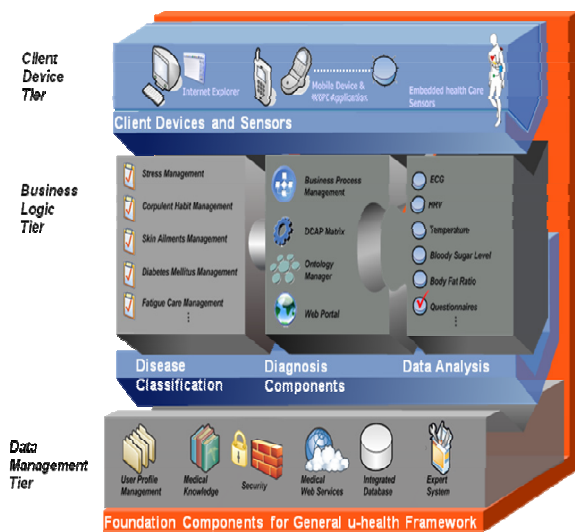

Fig. 7. Mobile U-health Service Framework

5. IMPLEMENTATION OF THE U-CARE SERVICE PLATFORM AND ITS EXPERIMENTS

We design and implement our u-care scheme as shown in Fig.8. The system consists of sensor part with a manikin and a diaper, wireless communication part with feces or urine sensing data, and coordination system based on the u-health platform described above.
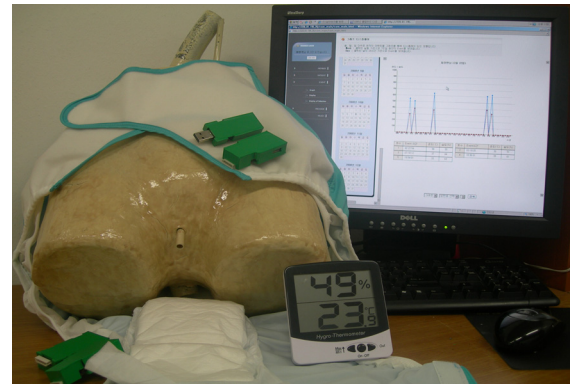

Fig. 8. Photo of U-care Experiment Scheme

Feces or urine sensing is realized by its temperature and humidity. The sensor is attached on the patient's diaper. In addition, detected data can be transferred to the coordinator by the wireless communication. Finally the platform analyzes and reacts according to detected data.

Fig.9 shows an example of temperature and humidity information arrived at the coordinator from Zigbee sensor. We can measure proper temperature, humidity of the diaper and their changes using Zigbee sensor while traditional schemes can only detect whether there is soil or not by simple change of their colors. Therefore we can evaluate the measurement part of our scheme in a more accurate manner than others.
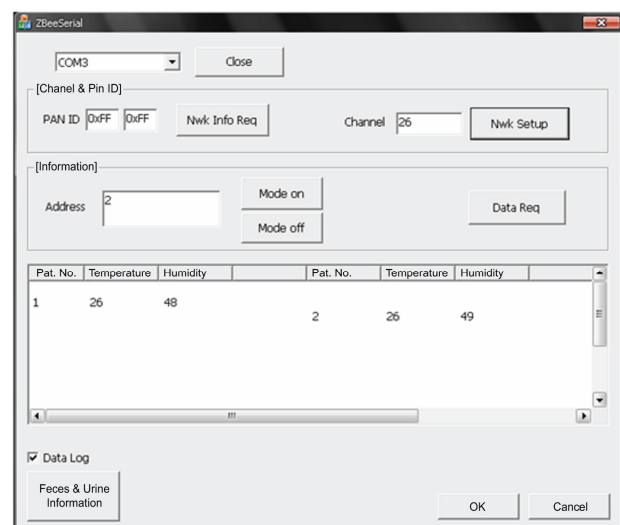

Fig. 9. Information from Zigbee Sensor

We construct database for the temperature and humidity information from coordinator linked to the server using MySQL an opened DB management system. We can monitor the bio data throughout the database as shown in Fig.10. In addition, we implement an interface to make the data shown as tabulated forms using PHP, FLASH, and JavaScript.
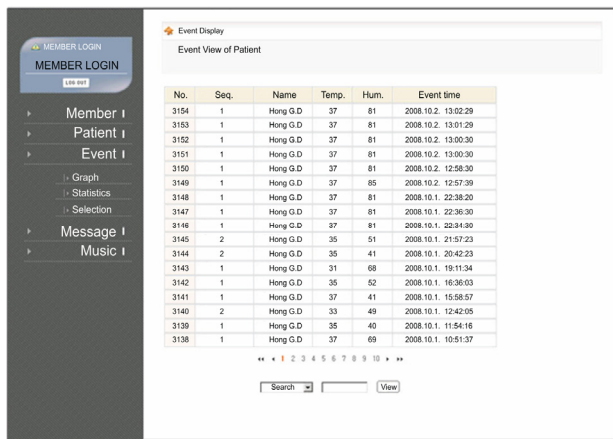
Fig. 10. Monitoring of Bio Information

Fig.11 shows a procedure of mobile u-health service when an event occurs. We can confirm the number of feces or urine, temperature, and humidity at any time we want through the system monitoring. And also the detected data will be accumulated in the database and we can manage them with a variety of manners. When an event occurs, the scheme announces the information to the coordinator by means of SMS characters, music, or display alarm and so on.
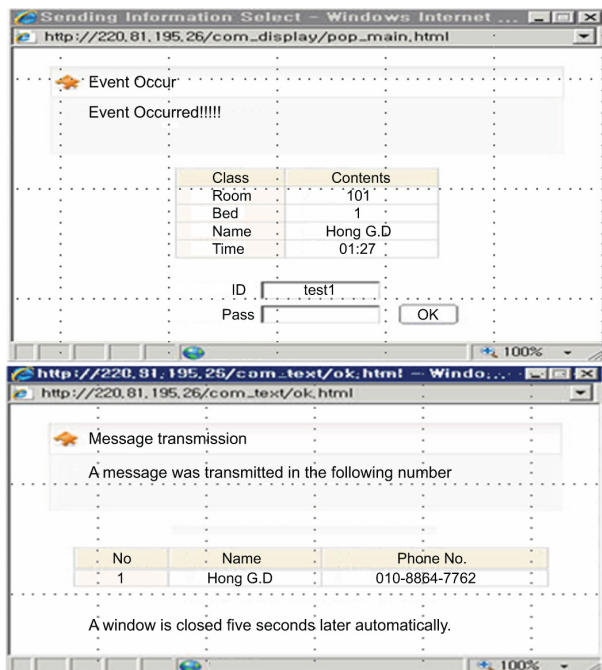

Fig. 11. An Example of Service When Events Occur

The frequency range used by Zigbee sensor is about 2.4(GHz), so it is difficult for the signal from the sensor to be transferred directly through obstacles. It is well known that the sensor signal can be transmitted about 200m in an opened area. Nevertheless we only depend on reflected or diffracted waves to receive the information from the sensor when there is an obstacle between the sensor and the coordinator [10].

We measure range of communication when the sensor and the coordinator are both in a floor with some small obstacles. And also we check the result when the two parties are separated

in another floor. Fig.12 shows the range of communication when they are located on the same floor with some obstacles while Fig.13 shows the result when they are located on up- and down-floors. As we can easily expect, the range of communication is far longer when transmitter and receiver are located on the same floor though some obstacles are hindered.
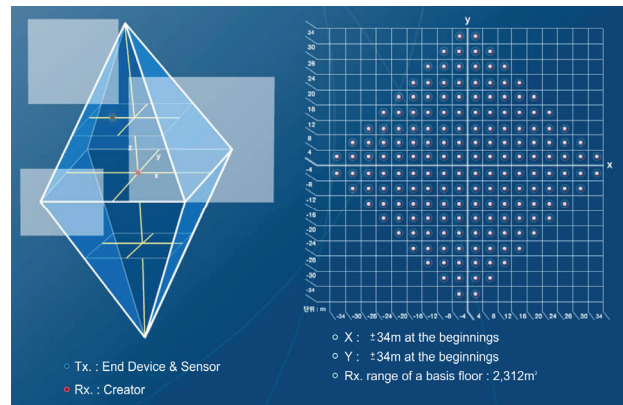

Fig. 12. Measured Results When Tx. and Rx. Are Located on the Same Floor
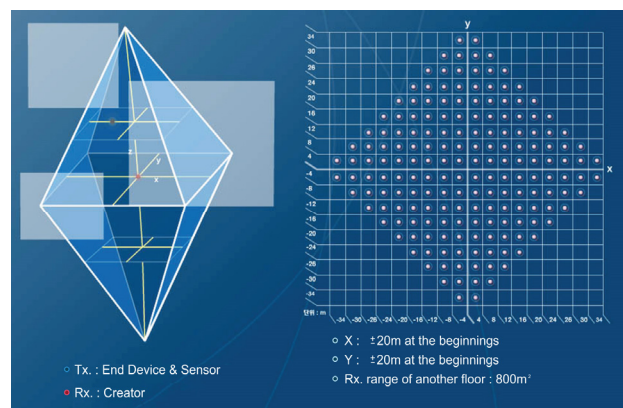

Fig. 13. Measured Results When Tx. and Rx. Are Located on another Floor

Other experimental or measured data are arranged in Table 1. We conclude that low power Zigbee sensor should be a competitive short term wireless communication device for our applications of temperature and humidity sensing environments. Moreover the proposed 4 kinds of core elements for constructing u-health service platform can be useful in an environment listed in Table 1. We can also detect feces or urine, body temperature, blood pressure, and other bio data at the same time. We expect that the proposed scheme will be used in an area of u-care system for the handicapped, the elderly, or patients.

Table 1. Experimental Results for the U-care Scheme

Measurement Item	Measurement Value
Modulation method	DSSS (Digital Sequence Speed Spectrum)
Communication Distance	10m

Transmission speed	200kbps
Channel	11 ~ 26
Power	5uA
Sensibility	-85dBm
Sensing Node	10 >
Meta Data info.	100%
Sensing info.	95% >

6. CONCLUDING REMARKS

We proposed a new scheme of u-health service platform and we designed and implemented our u-care scheme based on feces and urine sensing capabilities in this paper. We also prove that the propose scheme is useful in the area of u-care system for the handicapped, the elderly, and patients.

In addition we offered common service elements for mobile u-healthcare and the service platform. Especially we focused on automatic urine sensing u-care system to prove the effectiveness of the service platform. Experimental results show that our system can be used for the real world u-care purpose with the advanced developing tools for application or service developers.

We can expect a higher usability of the mobile u-health or u-care system if they are connected with the corresponding expert systems. This is our future research topic.

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