Chapter 115
Performance Analysis of Smart Healthcare System Based on ISO/IEEE 11073 and HL7

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Abstract We suggest smart healthcare system using smart phone depending upon current trend. This system was designed and implemented on the environment of IEEE11073 and HL7 standard. Smart gateway supports the standard connection of Personal Health Device (PHD) thru Bluetooth Health Device Profile (HDP) and user can exchange information using HL7 standard medical information structure. PHD by Bluetooth wireless communication and smart phone gateway make healthcare service easier as it supports ubiquitous environment that is relatively free from the restriction of place and time. Thus it can be expected development and supply various type of PHD. For the more it could help revitalization of U-healthcare industry in the long term period.

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115.1 Introduction

Existing U-healthcare service is focused on chronic illness of neglected class of people and the aged class. However, most of the aged and chronic illness class are not familiar with IT devices, how to use it and also having low burden of expense capability. Existing Personal Health Device (PHD) for the U-healthcare service is developing by their own software [1]. As it does not shared among those production company, it is almost impossible to inter-connect among various type of PHD [2]. Thus, there are lot of restrictions to extend the service to the ordinary citizen who has interest in wellbeing, wellness. Because of these problems, there is a few medical service model except remote consulting service although considerable time passed away. We will suggest smart gateway technique using smart phone which is healthcare gateway platform and it could overcome existing problem of U-healthcare.

Smart gateway proposed on this thesis support the connection for various type of PHD [3] as it follows ISO/IEEE 11073 Bluetooth protocol [4]. Also it could inter-operate via HL7 transformation among different kinds of information for medical application developed by stakeholder like user, supplier.

115.2 Design of Smart Healthcare System

Smart Healthcare System implemented in this thesis is composed of Bluetooth standard PHD [5], and smart gateway, Decision Support System for Home Healthcare (DSSH) shown in Fig. 115.1.

115.2.1 Smart Gateway

Smart gateway is information conversion gateway which gathers medical data from PHD and exchanges information based on HL7 standard [6]. Software module of smart gateway is composed of Bluetooth HDP manager and HL7 standard message creation function, HL7 converter. They inter-connect with DSSH via HL7 message exchange and it is shown in Fig. 115.2.

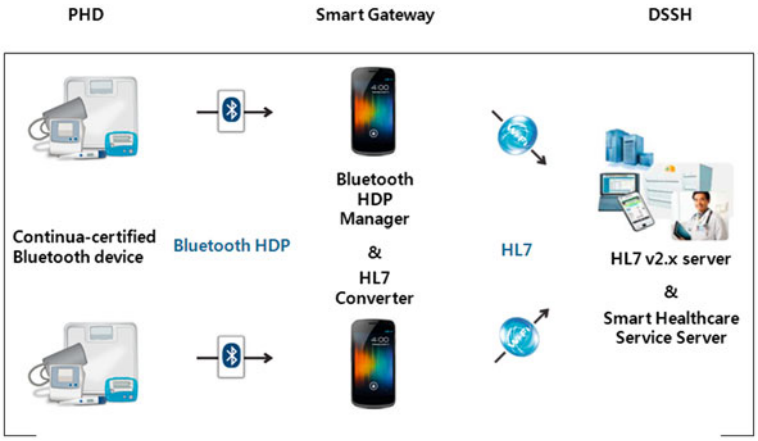
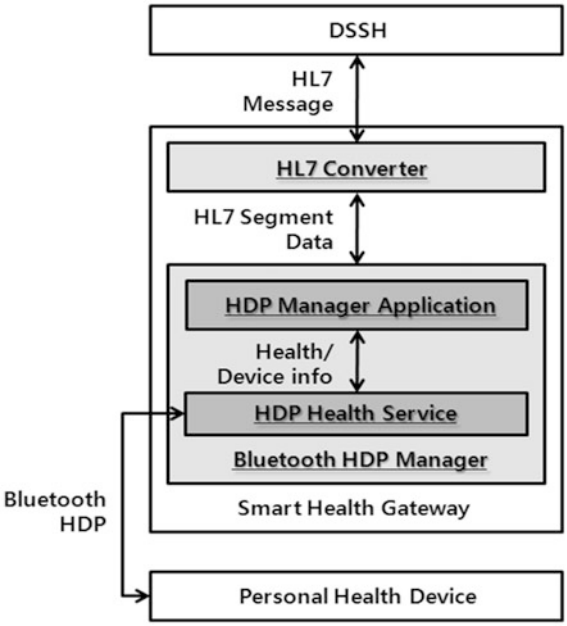


Fig. 115.1 Structure of smart healthcare system

Fig. 115.2 Smart gateway software module



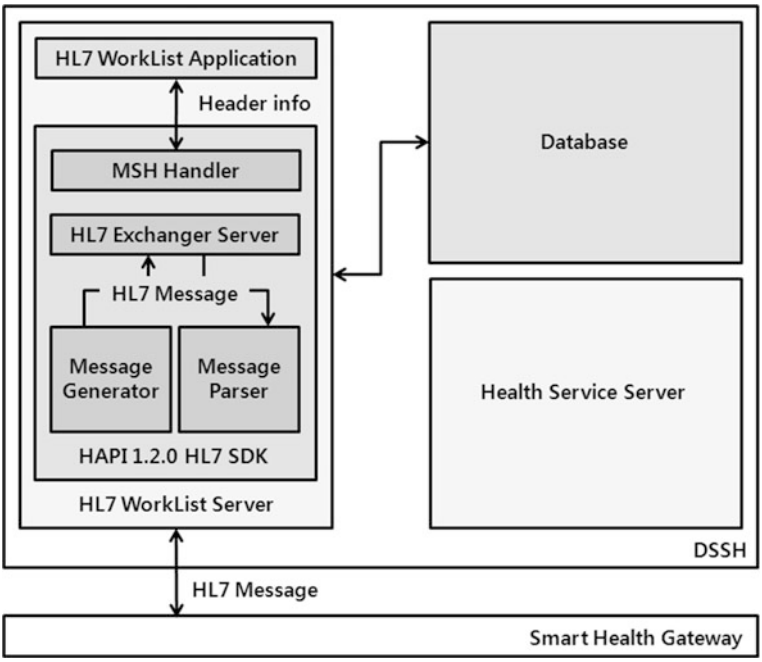


Fig. 115.3 Structure of HL7 converter and DSSH

HDP health service module connects with PHD using Antidote stack API function proposed on this thesis. HDP Manager Application is a application program which provide Bluetooth HDP function to the user. HL7 converter converts IEEE 11073 into HL7 and vice versa. It also exchanges messages of worklist server in DSSH and HL7 v2.x Message.

115.2.2 HL7 Converter and DSSH

HL7 converter module is composed of various type of remote system like medical treat system, healthcare management system and so on [7]. We designed and implemented HL7 worklist server which exchange HL7 standard message and Health Service Server which manage user health information in DSSH structure shown in Fig. 115.3.

HL7 worklist server is a socket communication server based on TCP/IP protocol. It confirms HL7 v2.x standard message from smart gateways and manages database. Message Generator creates message and Message Parser parses received message. MSH Handler classifies message type and make it database, manages message received from smart gateway.

Fig. 115.4 Operating screen of HDP manager application

115.3 Implementation of Smart Healthcare System

115.3.1 Smart Gateway

Implemented function of smart gateway which supports above the Android 4.0 ISC smart phone level is as follows.

- Function of Bluetooth HDP Manager
- Information conversion of IEEE11073 and HL7
- Application Environment: Android 4.0 ISC smart phone level
- Implementation Device : Samsung Galaxy S3
- Connect to the remote DSSH via WIFI
- Information exchange among HL7 worklist server of DSSH and HL7 v2.x message

Figure 115.4 shows captured screen which measured value of 'Nonin Onyx® II 9560 Pulse Oximeter'.

After receiving healthcare information from PHD, the HDP Manager Application outputs APDUs (Measurement) which is IEEE 11073-20601 standard. It also outputs System ID (MAC address) and measured health information, pulse frequency [8].

Figure 115.5 shows the output of HL7 standard ORU^R01 message that is created thru HL7 converter of smart gateway. It shows transmission to the DSSH

Fig. 115.5 HL7 message creation screen of smart gateway

after creation of message which is the measured OBX segment data of Pulse Oximeter.

115.3.2 DSSH

DSSH is service provider based on TCP/IP communication server. Function and environment is as follows.

- Service provider including HL7 worklist server.
- Communicate with smart gateway for smart healthcare service information thru HL7 v2.x message.
- Utilizing HAPI 1.2.0 HL7 SDK for the implementation of HL7 standard.
- Using MySQL 6.0 server for database management server.

Figure 115.6 shows interface snapshot of HL7 worklist server in DSSH. It receives ORU^R01 message from smart gateway and outputs the segment value as 5 text fields. That text information is a sample of OBX segment information including Pulse Oximeter measured value like oxygen saturation and pulse measured value.

Figure 115.7 is also another interface snapshot of HL7 worklist server in DSSH. It shows accumulated oxygen saturation as chart form.

115.4 System Performance Analysis

OBX segment of HL7 standard method was designed to create one OBX segment per one observation value [6]. So the number of OBX segment is increased as the number of measured health information. Flexible data value of OBX segment is

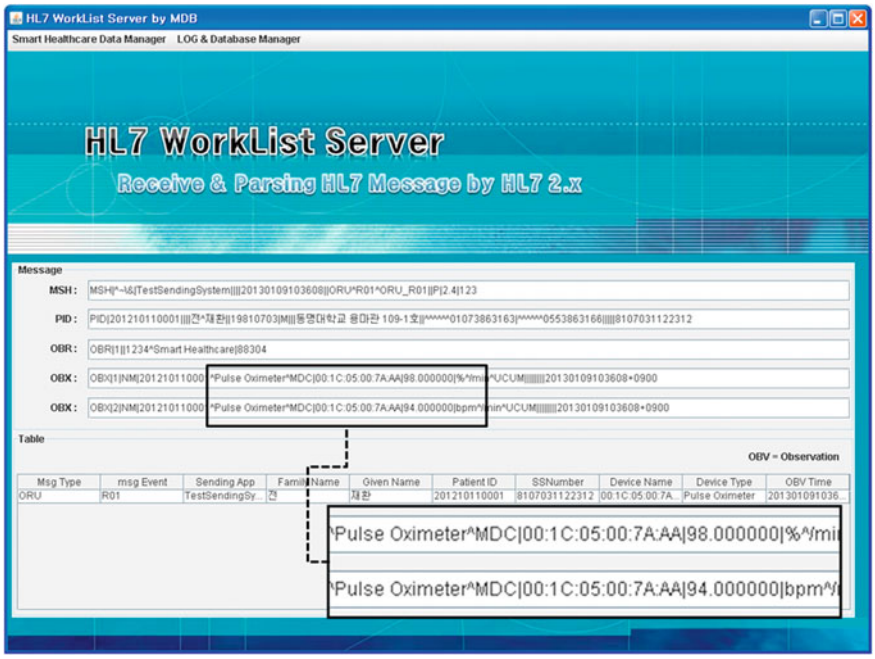


Fig. 115.6 Interface screen of HL7 worklist Server

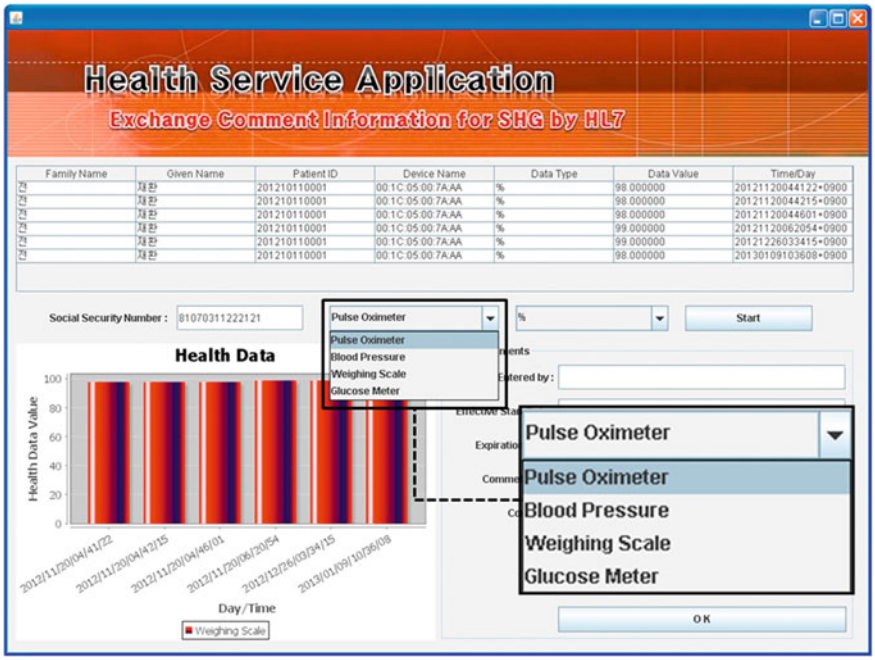


Fig. 115.7 Chart form interface screen of HL7 worklist Server

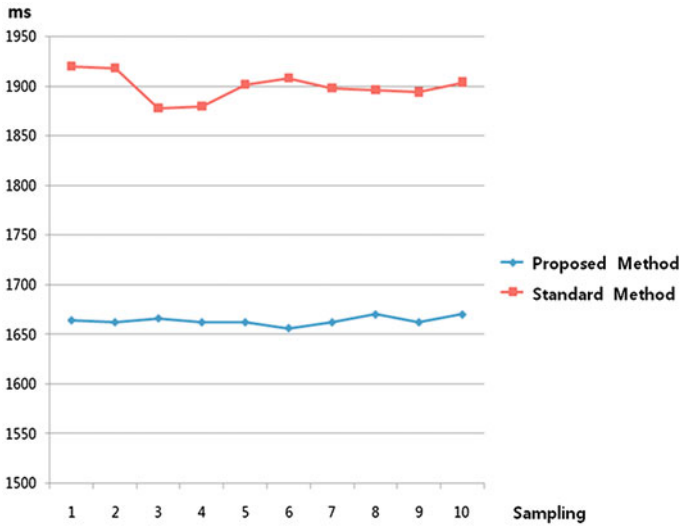


Fig. 115.8 Comparison of the event finishing time

'Observation Value' and 'Date/Time of the Observation'. In this paper, we applied VARIES (VARIES data type is no limit to length of the data) to 'Observation Value' and 'Date/Time of the Observation', and recorded in a single of OBX segment.

We compared the results as event finishing time which is the accumulated time of HL7 message creation, transmission time, parsing time, and user confirming time of health information.

- Assume to accumulate 100 healthcare information and measure event finishing time
- Make one group using accumulated 10 data and calculate the average of 10 measured data

Figure 115.8 shows the comparing result of event finishing time between existing methodology and this study as follows.

- There is no basis for the difference of message transmission time between existing methodology and this study as the data size is too small. However processing time of message creation and parsing is reduced about 15 % than before
- We could find out event finishing time is improved as the number of accumulated data is going a upward trend

115.5 Conclusion

We designed and implemented smart healthcare system which user or patients can choose PHD as he want and access actively.

For this task, we installed smart gateway and implemented DSSH for HDP Manager Application based on Bluetooth HDP standard including service providing. Smart healthcare system implemented on this thesis give the user chance to choose optimum standard device as the purpose of managing their health. For the more, it supports to link existing U-healthcare system and HL7 standard. Thus it improves the efficiency of medical service. Recently, healthcare service provided by smart phone application level could be linked with various type of service application. Thus adaptation of healthcare service become easier and extension could be expected more hopeful. We hope this study could contribute to the U-healthcare industry in the long run.

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