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Linking Smart Phones with PHDs based on Bluetooth HDP

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Abstract. The standardization and interoperability become central issues among researchers and the business market in Personal Health Monitoring and U-Health support systems. In this paper, we developed a HDP Manager that can be used for personal health monitoring with smart phones based on Bluetooth HDP through HDP agent simulator based on ISO/IEEE 11073 PHD. The system is designed for applying to all PHDs based on Bluetooth HDP authorized by CHA (Continua Health Alliance). While there has been a great amount of efforts and corresponding results in this area after ISO/IEEE 11073 data standards and Bluetooth HDP are announced, Android smart phone systems allow only after ICS version announced in 2012 thus this effort is to enhance the interoperability between HDP and smart phones.

Keywords: HDP Manager, Personal Health Device, ISO/I, EEE 11073, Android Smart Phone, Blue tooth HDP

1 Introduction

In recent days, progresses in mobile healthcare technologies have notably increased. Development of mobile applications and equipments are particularly draw great interest to the healthcare community such as ho me healthcare or health monitoring for elderly people. The expectation of U-Health era is coming very fast with developments of smart equipments and person al health devices (PHD) are coming true in t he very near future [1]. In typical u-healthcare service architectures, patient health data is measured on a P HD and transferred to external devices. Thus, standardization and interoperability become central issues among researchers and the business market and the ISO/IEEE 11073 (or referred as X73) that specifies a set of joint standards addressing complementary organizational and technological aspects [2] becomes more and more important.
Another noticeable development in this area is the release of t he Bluetooth Health

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Device Profile (HDP) that defines and specifies Bluetooth based communication among PHDs and data management equipment like smart phones to achieve interoperability among wireless devices [3]. Even if it refers to the ISO/IEEE 11073 protocol specification, it enables a range of additional functions such as exact data synchronization between several Bluetooth connected sensors or transference of different medical data in parallel through Bluetooth interface [4]. Thus, recently there are researches under ISO/IEEE 11073 and Bluetooth HDP on the design of middleware for heterogeneous sensor integration[4], performance evaluation of smart healthcare systems[5] but due to no standardization implemented in this part yet, there also exists non-PHD healthcare devices implementation under ISO/IEEE 11073 as well[6].

Therefore, the aim of this paper is to develop a smart phone HDP manager using ISO/IEEE 11073 as data standard and Bluetooth HDP as the communication standard to increase data reliability and interoperability between HDP and smart phones. Especially, Android smart phone systems allow only after ICS version announced in 2012 as a note.

2 Implementing HDP Manager

2.1. System Configuration and Environment

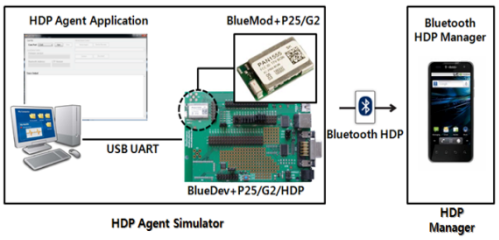

Fig. 1. System Configuration

Figure 1 shows the overall architecture of our system implemented. The HDP manager is designed to provide personal health monitoring based on Bluetooth HDP through HDP agent simulator based on ISO/IEEE 11 073 PHD. The system is designed for applying to all PHDs based on Bluetooth HDP authorized by CHA (Continua Health Alliance). The software i s developed with BlueDev+P25/G2/HDP development toolkit and tested under Windows 7 PC. The health monitoring uses Signove Antidote ISO/IEEE 11073 stack library for all Android ICS OS 4.0 and after supporting Android HDP SDK.

2.2 HDP Agent Simulator

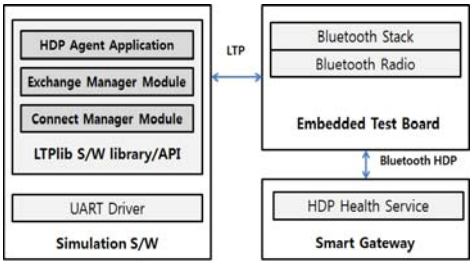

Fig. 2.Configuration of HDP Agent Simulator

Embedded Test Board is a client that has a role of MDC (Medical Device Controller) under LTP protocol and communicates with HDP Agent Application through LTP. HDP Agent Application consists of Connect manager and Exchange Manager using FSM (Connection Management, Data exchange Management) in LTPlib API and controls Embedded Test Board through FSM. Then it also controls BlueDev+P25/G2/HDP thus Bluetooth HDP connection is operated as desired.

2.3 HDP Manager

Figure 3 shows the overall HDP Manager Module structure.

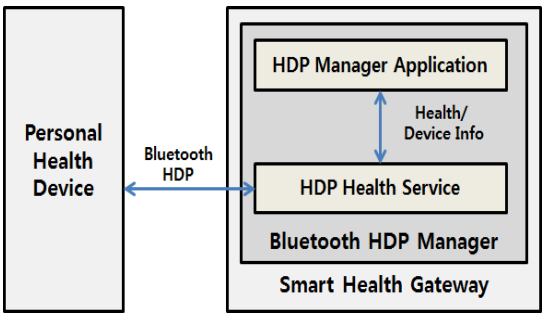

Fig. 3. HDP Manager Module Configuration

HDP Health Service is a Bluetooth HDP based Android service that provides Antodote stack to HDP Manager Application to connect with PHDs. In this paper, our HDP Manager does not use D-Bus due to the limited capability of smart phone Android Linux in that Android applications can not access Linux Bluetooth SDK BlueZ due to the unauthorization of u sing D-Bus. Instead, HDP Manager transfers information to Android-Activity of HDP Manager Application through HDP Health Service on Android Service and Android-Intent as the module configuration is shown as Figure 3. Figure 4 shows the health service connection structure.

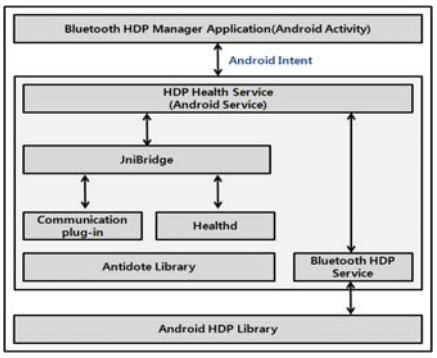

Fig. 4. Health Service Connection Structure

All callback functions through JNI transfer C coded Antidote stack functions to Kava based HDP Health Service through the low-level Java interface JniBridge. Then, HDP Health service interacts with APDUs through JniBridge having Java level synchronized multithreaded 'healthd_service.c' and 'Android-specifc communication plug-in' in Antidote stack API. Thus, the major attribute connection ID of ContextId is produced in hDP Health Service and the HDP communication is supported at the Java level.

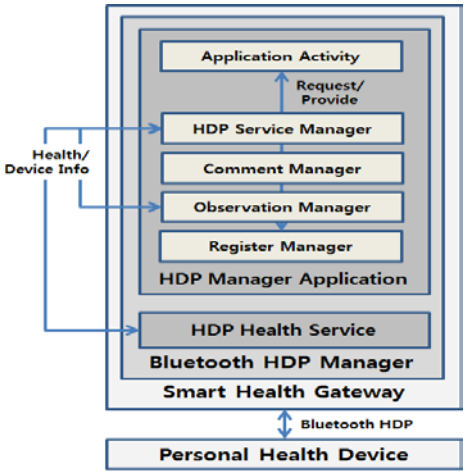

Fig. 5. Software Module Configuration in HDP Manager Application

Figure 5 shows the Software Module Configuration in HDP Manager Application. The procedure to obtain PHD information through HDP Manager Application is as follows.

1) Waiting for the connection call from PHD after connecting with HDP Health service through HDP Manager Application.

2) After PHD sends Connect message through Bluetooth Transfer Layer and HDP Service Manager gets the signal, transfer 'Connected' status to Application_Activity.
3) When PHD and HDP Service manager is at 'Connected' status, PHD se nds Association request message and transfer 'Associated' status to Application_Activity.
4) Ask PHD's configuration information through HDP Service Manager and finishes the connection for measurement after obtaining that information.
5) After connection is done and the targeted biomedical information is measured by PHD, send that information to HDP service Manager and parse the XML formatted health and device information and output them to Application_Activity.

3 Conclusion

In this paper, we introduce the design and implementation of HDP Manager using ISO/IEEE 11073 as data standard and Bluetooth HDP as the communication standard to increase data reliability and interpretability between HDP and smart phones. While it has the environmental limitations of Android smart phone functionality, the proposed HDP Manager for smart phone is successful to connect with Bluetooth HDP through HDP Agent application and Embedded Test board of HDP Agent simulator. .

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