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IMPROVEMENTS OF THE PERSONAL HEALTH DATA IDENTIFICATOR APPLYING STANDARDIZED DATA TRANSFER AND RFID TECHNOLOGY FOR PERSONALIZED TELEHEALTH SERVICES

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Abstract
This paper shows the improvements and outcomes reached by the development of a wrist wearable device called "Personal Health Data Identifier (PHDI)" which is the successor system of last year's project achievement called "Health Data Hub (HDH)". The main goal of this project is the identification of data streams in telemonitoring usecases in multiuser environments. The PHDI fulfils this by delivering the user's id to the data streams sent by PHDs using a separate data transmission utilizing RFID and ANT+ technologies. An Android Tablet acts as the application hosting device (AHD) and further relays data from the Personal Healthcare Devices (PHD) and the PHDI to the server. The identified measurement data is then fed into the user's electronic health record utilizing appropriate IHE profiles. The PHDI is equipped with a specialized voice output feature for communication with the PHDI-User.

***Keywords** – telemonitoring, personal health device, health service, interoperability*

1. Introduction

In the application environment of vitality and wellness hotels, nursing homes, mobile care service providers as well as home use and sport activities, many vital signs are acquired by means of electronic devices (PHDs and sports activity devices). Mobility and accuracy of those PHD infrastructures is a key factor for successful telemonitoring applications. Further research and development efforts in the field of PHDs are also driven by technology design contests [2].

Additional processing of the gained data is often done manually and with media disruption. Manual processing is a major error and cost factor, which may be reduced by the use of standardized and automated data transfer between PHDs (e.g. blood glucose meter) and Application Hosting Devices (AHDs, e.g. iPad, Android tablet or Mac, PC, Server). The ISO / IEEE 11073 standard family, according to the guidelines of the Continua Health Alliance [1] is used for wireless transmission via Bluetooth in the health area. An alternative to this is the transmission of data with the ANT+ protocol, which is commonly used in fitness devices. To complete the path from data source to data sink the IHE profiles Device Enterprise Communication (DEC) and Cross Enterprise

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Document Sharing (XDS) out of the Patient Care Device Domain (PCD) and IT Infrastructure Domain (ITI) [7] are used to transfer data from PHDs to the server environment. Using a standardized data protocol enables interoperability between devices and systems [3] and eases data transfers.

A serious problem that arises from automated data transfers in a multiuser environment is the assignment of the correct patient-ID to the generated data streams [8] due to a missing user identification possibility on the PHD itself. Therefore the Personal Health Data Identificator (PHDI) has been introduced. The PHDI advanced from the Health Data Hub (HDH) [9] and allows Device/User mapping using RFID identification of a PHD. Beside the PHD and the PHDI a typical setup would include an optional Android Tablet-PC or data server. Last year's achievements showed that it is favorable to develop self-made hardware solutions for patient worn experimental devices to be used within healthcare applications. This is due to limitations of interfaces of existing smartphone devices (e.g. missing ANT-modules), rapidly changing operating systems and complicated graphical user interfaces. The gained experience also showed that self-made developments can be tailored better to the needs of the specific application (like interoperability with multiple PHDs, miniaturization or energy efficiency). The commercially available PHDs however are valuable in that they provide a well defined and reliable function.

The general experience from the previous project is that a very simplistic approach is favorable for data collection, in order to achieve optimal ease of use. A basic feedback of successful measurement is necessary without the need to display values on the PHDI itself because our approach assumes that the measured value is displayed on the PHD. Data protection is not targeted in this approach, although it needs to be addressed in the future.

This funded research project wants to demonstrate the possibilities of standards based interoperability within healthcare-system with the implementation of pilot projects and new developments of software and hardware components.

2. Methods

Our approach for this research project was to build devices which are usable in multiple application fields (e.g. fitness area, telemonitoring of the elderly). In an environment like a spa or a nursing home, where multiple users are monitored on the same set of PHDs it is imminent to distinguish between particular devices of the PHD-infrastructure and also between the users of the devices. This is necessary to link the wirelessly transmitted vital-parameters with their corresponding personal electronic health records correctly, so that users will be able to control and manage their own health information [4]. The further processing of the resulting data e.g. for alarm purposes, is not in focus presently.

The unique identification of personal health devices is achieved by marking these devices with adhesive RFID tags. The RFID tags are associated with a single device within a database. Each individual person participating is equipped with and identified via the newly developed PHDI. Similar to the case of "single-user-PHDs" the PHDIs are also associated with their appropriate users within a database. In case a person in a multiuser environment intends to measure a certain vital-parameter, this person uses the PHDI to scan the RFID tag of the PHD the user is intending to use. The PHDI will then transmit the identification of the PHD to an AHD (which can be an Android Tablet or a Server) using the ANT protocol. After this event, the measurement of the vital parameters can be conducted, following the process steps given by the PHD manufacturer. When the measurement procedure is finished, the PHD will also transmit the gained data to the AHD. The PHDI provides voice feedback for ease of use and user acceptance. By using the previously transmitted context information of the device ID (from the RFID tag) and user ID (from the PHDI) the AHD is capable of linking and storing the data stream (including device ID) to the corresponding user's health record. Additional features of the PHDI are sensors for linear and angular acceleration measurements that are intended for movement monitoring or user interactions by gestures. These features are currently not used in this work.

The AHD is implemented as an Android application on a tablet PC similar to industry solutions [5]. The essential features of this App are the administration of the PHDI settings (e.g. the setting of time limits for alarms), the visualization of measured vital signs and the forwarding of data to a data repository. By implementing the required parts of the IHE profiles DEC and XDS the system has the capability to be integrated seamlessly into large scale eHealth environments.

3. Results

The current hardware and software development in the research project Healthy Interoperability includes a new device, the "Personal Health Data Identifier" (PHDI). The PHDI was designed to be worn on the wrist. It is equipped with various sensors such as gyro-, acceleration- and temperature-sensors. For user interaction the PHDI is equipped with several LEDs and a button. A display was deliberately omitted in order to achieve a highly compact design. Feedback from the PHDI to the user is made by voice output which is useful for many different reasons (e.g. reduces misinterpretation of visual messages) [6]. An essential feature of the PHDI is RFID tagging, which is enabled by a built-in RFID module. The identification of PHDs takes place by attached RFID tags.

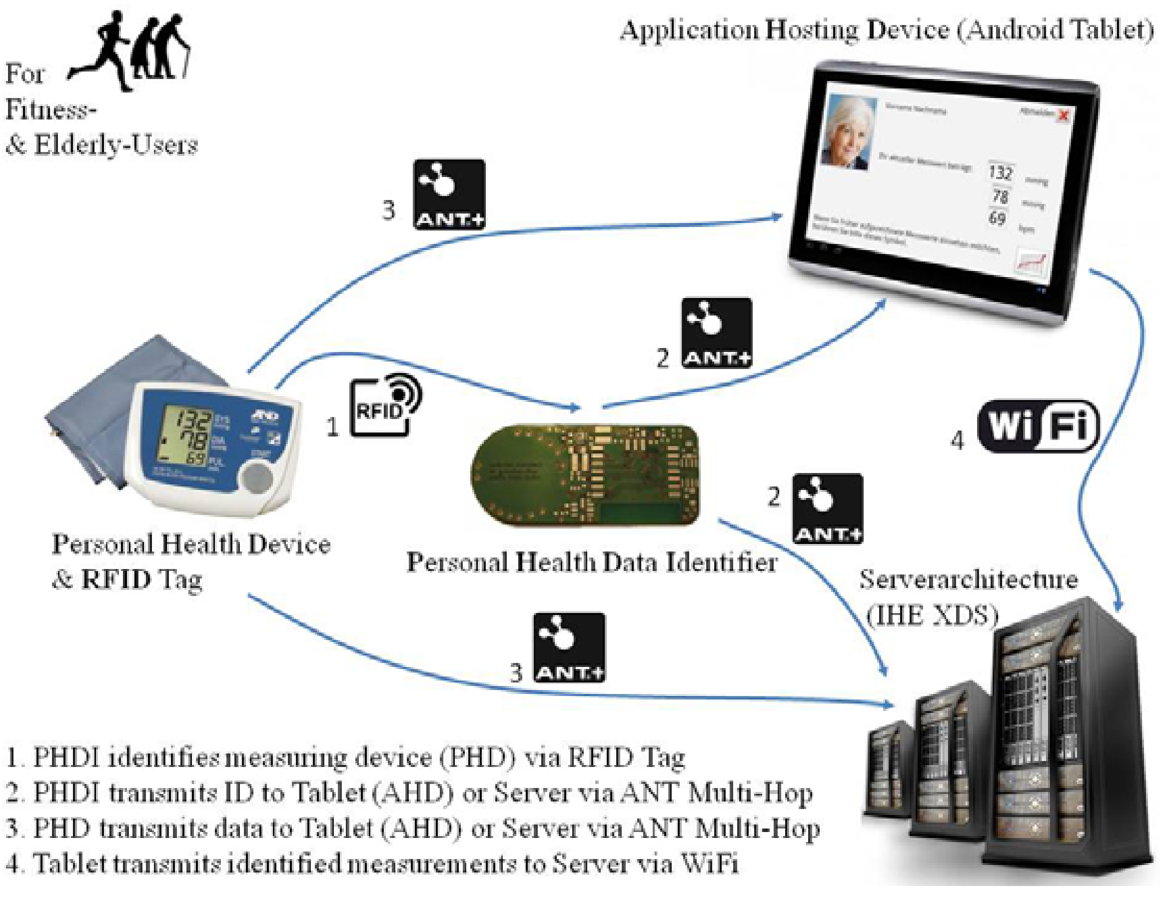

Figure 1: Personal Health Data Identifier, Infrastructure Overview

When unusual sensor data, from the build-in sensors, is acquired or deviations from the normal daily activity are noticed a voice output at the PHDI is triggered to request the user for an input by pushing the button on the device.

For data administration purposes an Android application is available which was used on Android equipped mobile phones and also tablet-PCs. This application communicates with the PHDI via ANT+ protocol. The functions of this administration-tool comprise simple administration functions for data presentation functions and forwarding and storage of data using appropriate interfaces (IHE DEC/IHE XDS). This kind of device and interaction possibilities with PHDs and the unique identification of persons and devices make it possible to create personalized telehealth services. These results can be used in fitness and also care-giving domains of eHealth and telemonitoring. The automatized and customized services enable the participants of the system to get a clear overview of measured vital parameters.

4. Discussion

Using the device and software developed in this project makes it possible to automate data transfers of measured vital signs in an environment with multiple users and many PHDs (e.g. “Vital Hotel/spa”). The elimination of media disruption throughout the direct digital transfer of the measured values from PHD to AHD and further on to electronic health records leads to a significant increase in the quality of the measured data. An important objective during the development of the PHDI was the cost-effective solution in compliance with user requirements which was reached sufficiently. This work successfully demonstrated the data collection and identification process from the PHD to the local server integrating RFID technology and the PHDI. The integration into the XDS infrastructure is being finalized and expected to be operational by May 2012. The multi-hop ANT transmission of data directly from the PHD and PHDI to the local server was not tested so far. This will also be completed by May 2012. Upcoming developments are concerned with further optimization steps, such as improved coordination of hardware modules, software algorithms and improved energy efficiency to achieve a longer battery life.
Significant difficulties were encountered during sensor data acquisition and interpretation for alarming events. Algorithm development for alarm detection is an ongoing task, since the thresholds for alarm events are to be set individually for each user of the wrist-worn device and therefore powerful algorithms are needed. Regarding the transmission of RFID data from the PHDs utilizing the ANT protocol there is still the need for using an USB-dongle at the AHD, since the availability of Android tablets with built-in ANT-modules is not given presently. The output of the voice messages is working appropriately with minor restrictions, due to currently unknown algorithm issues which sometimes cause delays in the output. Utilizing the implemented IHE profiles on the AHD the empirical knowledge shows that connection losses can occur in seldom cases.

By using the introduced infrastructure (PHDI+AHD+IHE XDS) further personalized telehealth services can be implemented in the future.

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