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Mobile Access to Healthcare Monitoring Data for Patients and Medical Personnel

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Abstract. The number of patients who want to keep track of their personal physical condition is increasing. The approach presented in this paper aims at tracking patients' vital signs using the telemonitoring solution i-Residence and transferring them to an Electronic Health Record in a standardized way, according to Continua Health Alliance guidelines. To access these vital signs, a highly portable mobile health application is developed to make personal health monitoring records and visualization available on smartphones and tablet computers for patients and medical personnel. The system is currently tested in two research projects with multiple patients, to examine impacts in real life application.

Keywords: Telemonitoring, personal health monitoring record, mobile application, Continua Health Alliance, Integrating the Healthcare Enterprise

Introduction

The number of patients requesting access to their health data is rising constantly. For example they want to follow and have feedback on their vital data and exercise programs. Thus, mobile monitoring of patients' health and fitness is of prominent use and the market for mobile health applications is estimated to quadruple by 2016 [1].

The research work described in this publication has two objectives: the standardized transfer of vital signs (e.g. blood pressure, blood glucose and weight) to an Electronic Health Record (EHR) according to the Continua Health Alliance (CHA) guidelines [2] and the development of a highly portable mobile health application for patients and medical personnel to access vital signs available in the EHR.

1. Methods

The research project is based on the plug & play telemonitoring (TM) solution i-Residence [3]. Advanced and Adaptive Network Technology (ANT) enabled Personal Health Devices (PHD) like a scale, a blood pressure meter or a glucose meter are part of a sensor network and transfer vital signs to a middleware (JFrogman). JFrogman is

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responsible for filtering (if required) and forwarding the measured values, e.g. to a TM center. Using ANT+, the sensor network can be extended with any ANT-enabled PHD, e.g. a pedometer. As PHDs are often used by more than one person, the system uses radio-frequency identification (RFID) chips to distinguish between patients.

The standardized transfer of vital signs to an EHR is implemented according to the CHA guidelines (see Figure 1). As CHA currently doesn't support the ANT protocol, the transfer of measurement values up to JFrogman remains proprietary and is done pseudonymously. Before vital signs are sent over the WAN interface, the RFID is mapped to a patient identifier and a HL7 v2.6 ORU^R01 message is created using the HAPI framework [4]. The WAN interface is compliant to the IHE profile Patient Care Device (PCD) and transfers the HL7 message to a TM center.

The TM center uses the communication server Mirth [5] which supports the automatic transformation and forwarding of HL7 messages. Measurement values are mapped to a persistent CDA document according to the HL7 Personal Healthcare Monitoring Report (PHMR). Subsequently, the Open Health Tools (OHT) [6] implementation of the IHE profile Cross-Enterprise Document Sharing (XDS) is used to integrate the PHMR into an EHR.

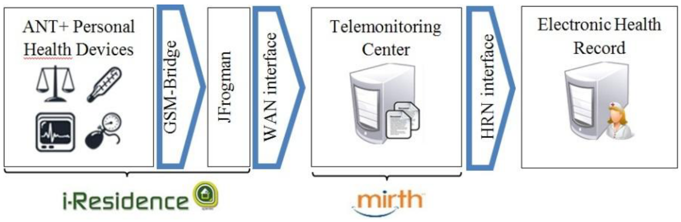

Figure 1. Standardized transfer of vital signs to an EHR

2. Results

The mobile application aims to make PHMR data and visualization available on smartphones and tablet computers. The main use case describes how medical personnel can use the mobile application. After authentication, the user can search for a patient or choose a recently viewed patient. A patient is selected and one can choose between visualizations of the patients' vital signs. The selected data is displayed as an interactive chart and can also be viewed in tabular form. The user is able to change the time frame for the displayed data as well as the vital signs. The amount of user input required is minimized by using reasonable assumptions (e.g. initial time frame is set to a time span that actually contains data and limited to two weeks) and by storing user preferences (e.g. a nurse wants to display blood glucose values by default).

Technically, the mobile device communicates over a Representational state transfer (REST) interface with JavaScript Object Notation with padding (JSONP) messages with a server-side component. This component requests the required data via the OHT from the EHR which responds with the requested PHMR documents (see Figure 2). In addition, the documents are parsed and conditioned on the server to avoid expensive processing tasks on the client. Finally, the information is sent back in a compact data structure. In the future, the server component will be integrated into the i-Residence solution.

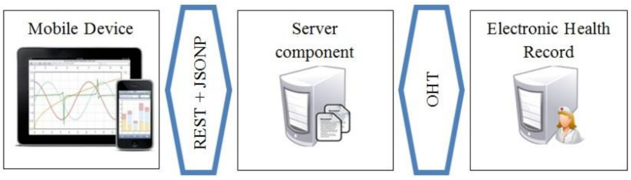

Figure 2. Access vital signs with the mobile application

To achieve a high degree of platform independence, the framework PhoneGap [7] was chosen. It provides a container that consists of a browser and interfaces to native device features (e.g. file access, notifications). The implementation is done with a set of standardized web technologies (HTML5, CSS3 and JavaScript – JS). Native functions can be called from JS and are dealt with by the executing container. The JS frameworks jQuery Mobile [8] and flot [9] are used on top of PhoneGap to facilitate user interface visualization, charting and client-server communication. The system is fully based on open source tools.

To set up the entire system, one needs i-Residence with any supported ANT device, any mobile device with the installed mobile application, the server-sided component and an IHE-compliant EHR.

3. Discussion

The usage of a mobile application to keep track of one's personal physical condition as described above involves a lot of advantages for patients and medical personnel. The described system is a work in progress and the testing phase and the subsequent evaluation will be completed by the end of June 2012. Up to now potential users showed great interest and had many additional feature requests for the application.

Currently, we run two research projects to examine advantages in real life application, where we recently started the testing phase with multiple patients. The first project, TeleMoniCare (tmc.fh-ooe.at), deals with home care services, where nurses can use the mobile application to keep track of their patients' health status. The second project, PIN (pin.fh-ooe.at), supports cardiac rehabilitation and enables patients to use the mobile application to monitor their vital signs. Especially patients with a chronic disease benefit from a system that helps them to track their vital signs automatically.

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