Schreier G, Hayn D, Ammenwerth E, editors. Tagungsband der eHealth2011. 26.-27.Mai 2011; Wien. OCG; 2011.

ADVANCEMENT OF A WEARABLE HEALTH DATA HUB-PROTOTYPE FOR CONTEXT BASED TELEMONITORING USING STANDARDIZED DATA TRANSFER METHODS

Gerbovics F[1], Haller M[1], Bittermann M[1], Urbauer P[2], Frohner M[1], Pohn B[2], Sauermann S[1], Mense A[2]

Abstract

This paper shows the advancement and the outcomes of a wearable medical device called "Health Data Hub (HDH)". This telemonitoring system gives patients (e.g. elderly people) the option to provide information about their health context (example situation: elderly person walking up the stairs, therefore the pulse rate increases) to a monitoring station and to get help in case of an emergency situation. The primary health data being recognized by the HDH is the pulse curve measured by means of pulse oximetry. The device is capable of communicating with personal health devices (PHDs) using ANT+ and forwarding received data via Bluetooth to a monitoring station.

Keywords – telemonitoring, personal health device, context, health status, interoperability

1. Introduction

The European population aged above 65 is estimated to increase from 16.1% in 2000 to 27.5% by 2050 [8]. This increases the complexity of sustaining the health care system and the well-being of this age-group. The main factor to consider is the management of chronic conditions, like diabetes or cardiovascular-diseases. In order to reduce hospitalization and costs the home monitoring of people's health status is gaining relevance [7]. This is due to the fact that the number of health care providers will not rise as fast as the number of people who need health assistance. Alarm messages generated by telemonitoring systems can help to leverage the health status of the affected people [4]. Reactions to alarm messages can be maintained by business oriented monitoring call centers or relatives of the monitored people. An approach to face this challenging situation is the development of a wrist wearable health data hub (HDH) prototype, as a custom-built preproduction unit. This device is equipped with sensors to measure health data and transfer them via wireless technologies (WiFi, GSM/3G, Bluetooth, ANT+) to a remote monitoring person. This allows taking corrective actions fast and effectively in order to improve the patient's well-being.

1 Department of Biomedical Engineering, University of Applied Sciences Technikum Wien
2 Department of Information Engineering and Security, University of Applied Sciences Technikum Wien

2. Methods

The objective of the development and advancement of the health data hub-prototype is to assess the possibilities of the use of context based sensor data from telemonitoring. One of the built-in sensor units of the HDH is used to monitor the heart rate using pulse oximetry and to transfer the measured data to a monitoring station. To gain knowledge about the context of the monitored person's actual situation and health condition, the sensor data is under continuous surveillance with the help of dynamic algorithms. An example of a use case of this context based telemonitoring approach is when an elderly person walks up the stairs and therefore shows an increased heart rate. Without information about the context (climbing of stairs) of the monitored person, this rapid pulse increase could trigger an unnecessary alarm without a real emergency situation. By knowing that the monitored person is walking up the stairs an alarm message is not needed. This context information is provided by an integrated altimeter within the HDH. Additionally, the HDH is equipped with temperature sensors, gyro sensors and acceleration sensors, depending on the needs of the intended use case. The data flow from the sensors is handled by diverse algorithms within the HDH. Acquired data can be transferred to a monitoring station where trends and forecasts are generated [2].

3. Results

The Advanced-HDH prototype is based on the technology of a predecessor platform (Data Logger) which was developed in 2009/10. The improvements of the HDH, compared with the predecessor platform, are a complete hardware redesign and a newly developed software architecture. The Data Logger was designed to create a flexibly extendable hardware platform by usage of interconnectable hardware-modules. The advantages of the HDH are the redesign of the hardware to a wearable format and the newly designed data-model which is equipped with algorithms for health context handling and automatic alarm message generation with standardized communication interfaces. The current version of the HDH prototype, described in this paper, is equipped with a low-cost outline of hardware. It is composed of a pulse oximeter to measure the pulse rate, an OLED touch display to interact with the patient, an ANT+ -module to achieve connectivity to personal health devices (PHDs) utilizing this protocol, a Bluetooth-module for communication purposes, and a SD-card slot for storing data locally in case no connection is available. The device is designed to be worn on the user's wrist with the display in the position of a normal clock-face. The pulse oximeter sensor is flexibly positionable on the wrist of the patient.[6] PHDs equipped with ANT+ are able to send measured data to the HDH. Subsequently, the data is buffered on the SD-Card and forwarded via Bluetooth to a PC/monitoring station. The HDH uses the OLED-touch display to facilitate user interaction with the device. Information is generated by passing a sensor (e.g. ANT+) which is located at a certain point (e.g. the exit) of the person's residence. The HDH requests for personalized pre-registered feedback like going shopping, seeing the doctor, or going for a walk via the touch display. This data is then streamed to the personnel of a monitoring station of a professional organization or to members of the family to keep them updated about the location, intents and the well-being of the monitored person. Furthermore, the HDH is capable of communicating with PHDs utilizing the ANT+ protocol. Since the device is wearable and needs to conform to quality, usability, and ergonomic user-expectations the printed circuit board and the housing need to fulfill special requirements. The housing of the HDH is a customized print to fit the forearm of the monitored person in the best possible way.

4. Discussion

Since we wanted to concentrate on the main aspects, namely the measurement of the heart rate and the communication with medical devices, other components like an NFC-module have not been implemented yet, but further versions of the HDH will be equipped with these modules. During the implementation of the HDH multiple considerations have been accounted for: how to prevent data loss and connection errors, which standards need to be used to communicate with other parts of the infrastructure and which algorithms are applicable to gain context information from sensor data. The current version of the HDH uses a Bluetooth stack which limits communication capabilities to the serial port profile. In future versions we are planning to integrate the Bluetooth health device profile, enabling the HDH to communicate easily with Continua Health Alliance [1] certified PHDs. One possible way would be to include the HDP-libraries implemented by the Openhealth project (Morfeo) [5]. For the data transfer between the monitoring station and the HDH a refined version of the Healthy Interoperability-Framework Data Container structure will be used. Security and privacy issues [3] still need to be addressed in order to guarantee the safe exchange of medical data.

Parallel to the development of the HDH a telemonitoring-pilot project was conducted in cooperation with elderly people. The pilot project showed that it is a big challenge to convince this user group to use new technologies. This may change in future since the following elderly generations are socialized earlier with technology than the preceding and are therefore more interested to use the possibilities which technology gives them.

The use of new technologies can also bear new potential risks, like the infringement of privacy data caused by insufficient security measures. These problems need to be addressed appropriately.

5. Acknowledgements

We would like to thank our departments for supporting our development endeavour and the Healthy Interoperability Project Team for their assistance and their preliminary work. This project is supported by the Austrian Research Promotion Agency (FFG) within the “FHPlus in Coin” program and by the City of Vienna Municipal department 27 “EU-Strategy and economic development” following the “Fachhochschulförderrichtlinie” 2005.

6. References

[1] CONTINUA HEALTH ALLIANCE, Continua Health Alliance-Design Guidelines, http://www.continuaalliance.org/products/design-guidelines.html. Online: January 14, 2011.

[2] FRANCO, C, DEMONGEOT, J, VILLEMAZET, C, VUILLERME, N, Behavioral Telemonitoring of the Elderly at Home: Detection of Nycthemeral Rhythms Drifts from Location Data, in 2010 IEEE 24th International Conference on Advanced Information Networking and Applications Workshops, 2010, pp. 759-766

[3] GRUTESER, M, SCHELLE, G, JAIN, A, HAN, R, GRUNWALD, D, Privacy-aware location sensor networks, in Proceedings of the 9th Conference on Hot Topics in Operating Systems, Vol. 9, 2003, p. 28.

[4] KIM Y.-U., et al., Emergency recognition system based on multimodal information, Engineering in Medicine and Biology Society, 2008. EMBS 2008. 30th Annual International Conference of the IEEE, 2008 pp. 4342-4345

[5] MORFEO PROJECT, Openhealth Information, http://openhealth.morfeo-project.org. Online: January 14, 2011.

[6] PETERSON, W.D., SKRAMSTED, D.A., GLUMAC, D.E., Phoenix Ambulatory Blood Pressure Monitor Project Sub-project: Piezo Film Pulse Sensor, http://www.phoenix.tc-ieee.org/004_Piezo_Film_Blood_Flow_Sensor/Phoenix_PiezoPulse.htm Online: January 14, 2011.

Schreier G, Hayn D, Ammenwerth E, editors. Tagungsband der eHealth2011. 26.-27.Mai 2011; Wien. OCG; 2011.

[7] SHAH N.B., et al., Prevention of hospitalizations for heart failure with an interactive home monitoring program, American Heart Journal, vol.135, no. 3, pp. 373-378, Mar. 1998.

[8] SUMMARIES OF EU LEGISLATION: The future of health care and care for the elderly: guaranteeing accessibility, quality and financial viability,
http://europa.eu/legislation_summaries/employment_and_social_policy/disability_and_old_age/c11310_en.htm
Online: January 14, 2011.

Corresponding Author

Ferenc Gerbovics
Department of Biomedical Engineering, University of Applied Sciences Technikum Wien
Höchstädtplatz 5, A-1200 Wien
Email: ferenc.gerbovics@technikum-wien.at