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Fast care

Real-time capable sensor data analysis-framework for intelligent assistance systems

Abstract: The project fast care is working on a real-time capable sensor data analysis-framework in the fields of "Ambient Assisted Living" (AAL), "Human-Technology Interaction" (MTI) and "eHealth". The aim is to provide a medical valid - integrated real-time picture of the patient's situation by using an ad hoc interconnected sensor – actor infrastructure with a latency period of less than 10 ms.

1 Introduction

Assistance systems in Ambient Assisted Living and in medical care have to recognize relevant situations, that require fast assistive intervention. Former projects in this field like tecla [1][2][3] or PAUL[4] have been focused on the application of the new AAL-technologies in AAL test beds to get information about the acceptance level [5], [6] of the technologies and the different new applications for the patients. Additionally, business models [7] [8] have been drafted to realise a successful AAL business area in future.

The clinical established measurement technology for diagnostic, monitoring and risk stratification does not translate directly to the outpatient area (ambulant or domestical environment). The key challenge is, that many relevant situations are only noticeable, when various sensor modalities are merged – such as for discrimination between pathological, emotional or stress induced increase of the heart rate. This is only possible by the use of the combination of multiple different sensors. The same applies to the analysis of joint kinematics of everyday activities, which requires more and inertial sensors with higher accuracy.

Sensor data analysis-frameworks are needed to analyse the conditions of real-time identification and subsequently provide a medical valid corresponding assistance.

1.1 Solutions and implementation

The basis of a medical valid - integrated real-time picture of the situation is an ad hoc interconnected sensor infrastructure. Its latency period should be less than 10 ms to fulfill the boundaries of a haptive working network. Here, physiological, cognitive and kinematic information of a patient are captured with the help of intelligent sensor data fusion. These information combined will provide an integrated picture of the patient's physical and mental situation. In this way, it should be ensured that the framework can be used for applications, in which feedback has to be embedded synchronically. This can be realised in visual, auditive, tactile or proprioceptive string of perception, such as in the field of support of motor function and kinematics for the rehabilitation and for active prosthetics and orthotics.

This will form the basis for high-end assistive technologies. Fast care will *create* the technical requirements to protect humans from damage in their natural environment. The next generation of medical technology should be perceived as a non-contact, integrated system to support the user with technology that is reliable, preventive and easy to handle (see **Figure 1**).

The challenge of a distributed, real-time medical sensor technology and signal processing is to be processed by means of sensor-based data processing and sensor hubs, optical sensors, hardware system optimisation, the development of distributed systems as well as by interface network sensors. The focus of the project is on the intelligent fusion of sensor

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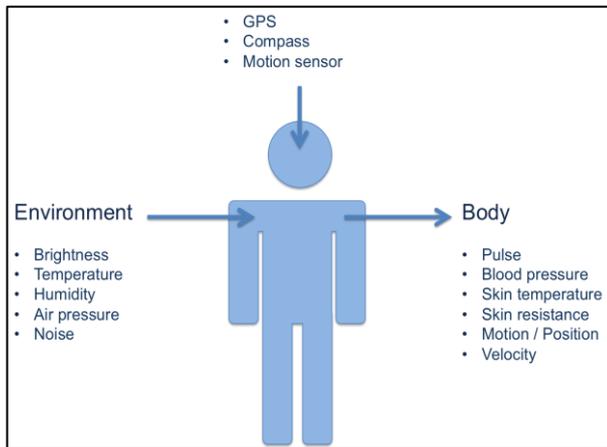
Figure 1: Environmental and non-environmental measurements

Figure 2: MTI-Lab of the Harz University

A: sensors on the walls: pulse, blood pressure, skin temperature, skin resistance, motion / position, velocity

B: eReha

C: real-time controller

D: telephone

E: touchscreen

F: sensefloor

G: scale with bluetooth

H: bluetooth modem

I: smart sleep system

J: blood pressure monitor

K: asina tablet

L: tv set with top box

and actuator data as well as the evaluation and delivery in real-time. In order to meet this objective, the following researches will take place in the MTI-Lab of the Harz University of Applied Sciences in Wernigerode (see **Figure 2**):

 – Analysis of requirements
 – Data acquisition
 – Data analysis
 – Data fusion
 – Acceptance analysis
 – Situation detection and assistance in real-time

Rapid and intelligent sensors and actuators, an improvement of motion pattern recognition and intelligent algorithms for real-time network integration in three demonstrators of the MTI-Lab serve as solution approaches. Within the fast care project, a real-time network integration with demonstrators is to be carried out at the MTI-Lab of the Harz University. The various partial results of the project partners will be collected and integrated in the MTI-Lab. The integration at the MTI-Lab will be performed with the focus on user friendliness and the interaction with him by means of a show flat. **Figure 2** illustrates the planned structure of the MTI-Lab with various elements for a monitoring and evaluation of the measured values.
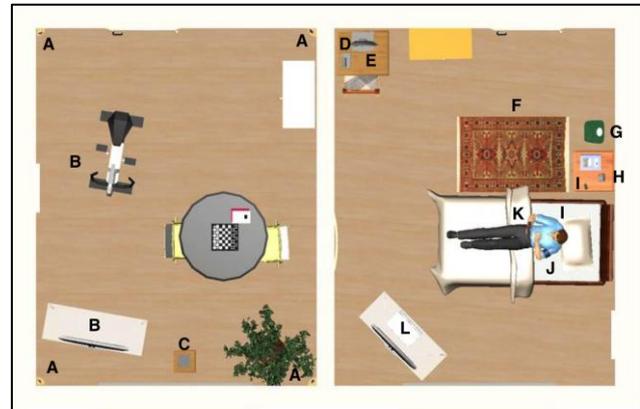
1.2 System concept

The collaboration of eight project partners enables a successful project. Every partner takes part in a special way to meet the challenge of a distributed, real-time medical sensor technology and signal processing (see **Figure 3**). The different focal points of the project partners are:

 – Bosch Sensortec GmbH: sensor-based data processing and sensor hubs
 – HarzOptics GmbH, Technical University Dresden: optical sensor technology, cardiopulmonary performance
 – University Rostock, Exelonix GmbH: the estimation of cognitive condition, hardware system optimisation and the development of distributed systems
 – Harz University of Applied Sciences: interface network sensor technology and analysis of acceptance
 – Ottobock GmbH & Co. KG: application and development of intelligent orthopedic devices
 – Otto-von-Guericke-University Magdeburg: the motion analysis for rehabilitation

The objective of a distributed, real-time medical sensor technology and signal processing is to get an evaluation of the patient`s situation from the available data in real-time. The main application lies in the area of the application of orthopedic devices (prosthesis, orthesis: Ottobock). For example the optimisation process of the leg prosthesis` damping members and active foot positioning points shall be executed online. Currently, these parameters are performed offline and hand-made by orthopedic technicians with variable quality. This often leads to suboptimal adapted orthopedic devices, whose functionality and efficacy are correspondingly limited and therefore to an unsatisfactory rehabilitation outcome.

Another project section describes the online execution of the estimation of cognitive condition (University Rostock), the motion analysis for rehabilitation (Otto-von-Guericke-University Magdeburg) and cardiopulmonary performance (Technical University Dresden, HarzOptics GmbH).
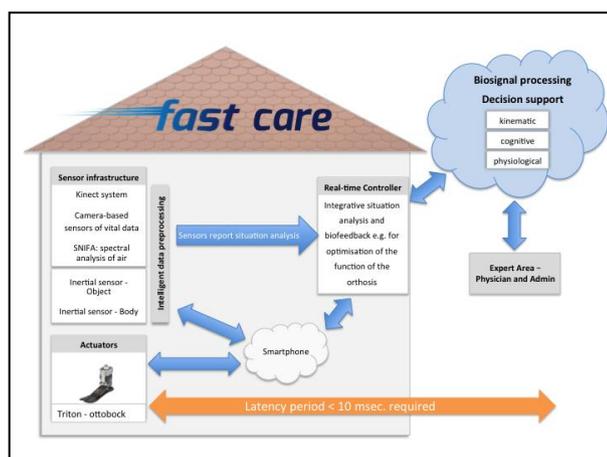

Figure 4: Hardware and software application areas in fast care

Figure 3: System concept of fast care

The fast care framework is the technical basis for the realization of the fast care project, which implements the fusion of heterogeneous sensors via heterogeneous networks. The basic idea of the fast care framework is to derive a condition from the past and the current states of the sensory data using the known physical rules. The fast care framework includes the following areas and interfaces (see **Figure 4**):

- Hardware
    - Sensors
    - Actuators
    - Real-time server, connected to moving cloud
- Networking
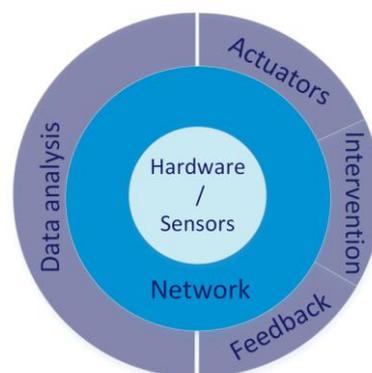- Data analysis
- Feedback and Intervention

In addition to the technical development activities, an analysis of acceptance will be executed at the MTI-Lab of the Harz University. As a result of the project, fast care wants to develop feasible products and create the medical fundamentals for an interaction (feedback) in real time.

Author's Statement

References

[1]   U. H. P. Fischer-Hirchert, "Anwendung von technikgestützten Pflegeassistenzsystemen in der Harzregion," *Gerontol. und Geriatr. Kongress 2014*, p. 1, 2014.

[2]   U. H. P. Fischer-Hirchert, "Anwendung von technikgestützten Pflegeassistenzsystemen in der Harzregion," in *Gerontologie und Geriatrie Kongress 2014*, 2014, p. 1.

[3]   U.   H.   P.   Fischer-Hirchert,   "Technische Pflegeassistenzsysteme - TECLA WZW," in *Fachtagung Gesundheitsregion Harz*, 2012.

[4] L. Schelisch and T. U. Kaiserslautern, "Wer nutzt eigentlich PAUL ? Erfahrungen aus dem Praxiseinsatz Who makes use of PAUL ? Empirical Findings on User Experience," 2014.

[5] S. Meyer and H. Mollenkopf, *Ambient Assisted Living (AAL) : Komponenten, Projekte, Services. Eine Bestandsaufnahme*. 2011.

[6] A. Kung and B. Jean-Bart, "Making AAL platforms a reality," in *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 2010, vol. 6439 LNCS, pp. 187–196.

[7] U. H. P. Fischer, K. Rost, and H. Harz, "Businessmodell zur Applikation von AAL-Userportalen zur Verbesse- rung der sozialen Teilhabe älterer Menschen in der Harzregion Business model for the application of AAL-user portals to improve the social participation of older people in the Harz," *AAL-Kongress*, 2014.

[8] J. Bauer and E. H. B. Technologiezentrum, "Optimierung der Datenvisualisierung von AAL-Serviceplattformen durch Usability-Tests Optimization of data visualization for AAL service platforms through usability testing Kurzfassung Einleitung Vorgehen," 2014.