Ziefle, M., Röcker, C., Kasugai, K., Klack, L., Jakobs, E.-M., Schmitz-Rode, T., Russell, P., Borchers, J. (2010). eHealth – Enhancing Mobility with Aging. In: M. Tscheligi, B. de Ruyter, J. Soldatos, A. Meschtscherjakov, C. Buiza, W. Reitberger, N. Streitz, T. Mirlacher (Eds.): *Roots for the Future of Ambient Intelligence, Adjunct Proceedings of the Third European Conference on Ambient Intelligence* (AmI'09), November 18 - 21, 2009, Salzburg, Austria, pp. 25-28.

eHealth – Enhancing Mobility with Aging

Martina Ziefle[1], Carsten Röcker[1], Lars Klack[1], Kai Kasugai[1], Eva-Maria Jakobs[2], Thomas Schmitz-Rode[3], Peter Russell[4], Jan Borchers[5]

[1] Human Technology Centre (HumTec), RWTH Aachen University, {ziefle, roecker, klack, kasugai}@humtec.rwth-aachen.de
[2] Technical communication, RWTH Aachen University, e.m.jakobs@tk.rwth-aachen.de
[3] Applied Medical Engineering, RWTH Aachen University, smiro@hia.rwth-aachen.de
[4] CAAD, RWTH Aachen University, russell@caad.arch.rwth-aachen.de
[5] Media Computing Group, RWTH Aachen University, jan@rwth-aachen.de

Abstract. The paper describes the program 'eHealth – Enhancing Mobility with Aging', an interdisciplinary research project at RWTH Aachen University. The program started in January 2009 as part of the Human Technology Centre, a newly established project house, funded by the Excellence Initiative of the German federal and state governments. The program aims at designing adaptive immersive interfaces for personal healthcare systems and develops novel, integrative prototypes for the design of user-centered healthcare systems. This includes new concepts of electronic monitoring systems within ambient living environments, suited to support persons individually (according to user profiles), adaptively (according to the course of disease) and sensitively (according to living conditions).

Keywords: Ambient Intelligence, Living Lab, Ambient Assisted Living, Smart Healthcare Environments, Intelligent User Interfaces.

1 Motivation and Starting Point

Due to increased life expectancy and improved general health states of citizens, more and more old and frail people will need medical care in the near future [1]. At the same time, considerable bottlenecks arise from the fact that increasingly fewer people are present, who may take over the nursing [2]. In order to master the requirements of an aging society, innovations in information and communication as well as medical engineering technologies come to the fore, which offer novel or improved medical diagnosis, therapy, treatments and rehabilitation possibilities [3, 4].

Though, recent research shows that acceptance barriers are prevalent, which might be due to the fact that development praxis predominately focuses on technical feasibility, while the "human factor" in these systems is fairly underdeveloped. In order to fully exploit the potential of e-health applications, acceptance and usability issues of e-health applications need to be considered, especially for older users, who have specific needs and requirements regarding usability and acceptance issues [5,6,7]. As the knowledge about the antecedents of e-health acceptance and utilization behavior is restricted, it is necessary to explore acceptance and the fit of e-health technology within homes and private spheres [8,9,10].

2 Interdisciplinary Research Approach

Due to the complexity of the topic the interdisciplinary research concept includes three complimentary strategies: *(1) Methodological Strategy:* The project bridges competencies of different disciplines in order to develop a truly interdisciplinary approach for a human-centered development of future healthcare technologies. *(2) Spatial Strategy:* As a continuous exchange of ideas is needed, and the disciplinary perspectives have to be transformed into an interdisciplinary methodology, a new research house, the Human Technology Centre, was created that allows the teams to research under one roof. At the same time, researchers maintain close relationships to their "home" institutes, enabling continuous exchange of disciplinary and interdisciplinary knowledge. *(3) Educational Strategy:* Through its integration into the academic context, the e-health program offers young academics the opportunity to participate in interdisciplinary research quite early in the educational process. In addition, new teaching concepts, as, e.g., the interdisciplinary school of methods, foster holistic education concepts and form the next generation of researchers.

3 Research Scope

The three-year research plan focuses on homecare solutions for patients with chronic heart disease as a key application with high clinical demand, recurrent hospital stays, high morbidity, and mortality. Due to ageing, incidence and prevalence is considerably increasing [11]. The project follows a multidisciplinary approach regarding the development of user-centered smart healthcare technologies, which integrate perspectives of different disciplines, including computer science, medicine, engineering, psychology, communication science and architecture.

The research duties aim at age-sensitive concepts for technical devices within living environments enabling old and ill patients suffering from chronic heart disease to live independently at home. Devices should be perceived as personally helpful, supportive, safe, and secure and should evoke feelings of trust and reliability, while at the same time respect patients' desire for intimacy, independence, and dignity. In addition, the way devices are communicating with their owners must be easily understandable at any time. Devices are conceptualized as context-adaptive, smart and immersive. Thus, they are not only communicating with patients, but also with the environment (furniture, walls, floor), family members, doctors or emergency personnel.

The main issues addressed within the project are the systematic evaluation and consecutive optimization of the interrelation of medical, environmental, technical, communicative, psychological and social factors and their consequences for the design, use and acceptance of personal healthcare systems.

4 Methodology

To examine how patients communicate with walls, how they deal with invisible technology and how the information is to be delivered such that it meets the requirements of timeliness, data protection, dignity as well as medical demands, we need an experimental space, which enables to study patients "life at home". A full-scale prototype room as part of a smart apartment will be developed to test various smart healthcare systems. The room consists of a simulated home environment, which enables researchers to use experimental interfaces with test persons of different ages and health states. Out of validity reasons, the experimental space is of central importance, as patients and carers need to experience and "feel" the technology to be used, in order to fairly evaluate it [12]. Further, persons might overemphasize their sensitiveness towards privacy violations if judgments only rely on the imagination of using it [13].

Therefore, different evaluation methods and scenarios will be used, ranging from empirical and experimental procedures, psychometric testing, questionnaire methods and behavioral observations. In order to realize this ambient living concepts, which represent the daily situation of the patients at home, communication and interaction mechanisms as well as bio signals have to be integrated into architectural concepts and components (furniture, walls, floor).

The design follows several cycles in which the technological design is carefully harmonized and weighted with acceptance, and/or usability demands. Patients differing in gender, age, health status, emotional and cognitive factors, and severity of disease will be involved in the design cycles. In a first step, we concentrate on the two opposite ends of the design space, a small personal device ("a medical helper") and an interactive wall, with which patients can directly interact. In a second step, a smart floor will be included to complement the smart environment.

5 Conceptualization and First Steps in the Living Lab

Currently, first technical components of the intelligent home environment are built. As such, interacting mechanisms, cognitive ergonomic issues of the interface, but also spatial, architectonical and communication demands are discussed, conceptualized, realized and iteratively tested. Figure 1 shows a sketch of the living lab (left and right) as well as an application example, in which a patient at home consults his doctor, using the interactive wall as communication medium (middle).

Fig. 1. Sketches of the living lab.

From a medical-engineering perspective, a flexible, home-based therapy assistance system for people with different health and life conditions has to be created. The medical focus considers a broad range of disease states, ranging from persons with beginning coronary, ischaemic or hypertensive heart diseases, heart failures or congenital heart diseases up to high-urgency transplant patients. Though the medical focus is on chronic heart patients, the system is open for a much larger range of users. The sensoric part of the system consists of biosensors that acquire patients' vital data. A special middleware merges different data streams and analyses the data on a central processor unit. The actoric part provides therapeutic advises to the patient and, in case of blood pump patients, optimizes the performance of the mechanical assistive device based on patients' actual vital conditions. Our field studies [14] in leading heart centres (Bad Oeynhausen, Germany and Leuven University, Belgium) showed that four prominent vital parameters are essential: blood pressure, blood coagulation, body temperature, and weight. To achieve this, various state-of-the-art sensor technologies for non-contact or minimal invasive vital data monitoring will be evaluated in our living lab. In parallel, first studies regarding users' acceptance of medical home technology are currently running, which take users of different age, upcoming and health states into account.

References

1. Wittenberg, R., Comas-Herrera, A., Pickard, L., Hancock, R.: Future Demand for Long-Term Care in England. PSSRU Research Summary (2006)
2. Leonhardt, S.: Personal Healthcare Devices. In: S. Mekherjee et al. (Eds.): Malware: Hardware Technology Drivers of AI. Dordrecht, NL: Springer (2005) 349-370
3. Weiner, M. et al.: Using Information Technology To Improve the Health Care of Older Adults. Ann Intern Med. 139 (2003) 430-436
4. Warren, S., Craft, R.L.: Designing Smart Health Care Technology into the Home of the Future: Engineering in Medicine and Biology 2 (1999) 677-681
5. Melenhorst, A.-S., Rogers, W., Bouwhuis, D.: Older Adults' Motivated Choice for Technological Innovation. Psychology and Aging 21(1) (2006) 190-195
6. Zimmer, Z., Chappell N.: Receptivity to New Technology among Older Adults. Disability and Rehabilitation 21 (5/6) (1999) 222-230
7. Arning, K., Ziefle, M.: Different Perspectives on Technology Acceptance. In: A. Holzinger et al. (Eds.): HCI for eInclusion. Berlin:Springer (2009) 20-41
8. Wilkowska, W., Ziefle, M.: Which Factors form Older Adults Acceptance of Mobile Technologies? In: A. Holzinger et al. (Eds.): HCI for eInclusion. Berlin:Springer (2009) 81-101
9. Gaul, S., Ziefle, M.: Smart Home Technologies: Insights into Generation-Specific Acceptance Motives. In: A. Holzinger et al. (Eds.): HCI for eInclusion. Berlin:Springer (2009) 312-332.
10. Röcker, C., Feith, A.: Revisiting Privacy in Smart Spaces: Social and Architectural Aspects of Privacy in Technology-Enhanced Environments. Proceedings of the International Symposium on Computing, Communication and Control (2009) 201-205
11. Murray, D. et al.: Assessing Intervention Effects in the Minnesota Heart Health Program. Am J Epidemiol 139 (1994) 91–103.
12. Woolham, J., Frisby, B.: Building a Local Infrastructure that Supports the Use of Assistive Technology in the Care of People with Dementia. Research Policy and Planning 20(1) (2002) 11-24
13. Cvrcek, D. et al.: A Study on the Value of Location Privacy. In: Proceedings of the ACM Workshop on Privacy in the Electronic Society (2006) 109-118
14. Alagöz, F. et al.: Technik ohne Herz? Nutzungsmotive und Akzeptanzbarrieren medizin-technischer Systeme aus der Sicht von Kunstherzpatienten. Deutscher AAL-Kongress: Assistenzsysteme im Dienste des Menschen (in press).