

Requirements and Ethical Issues for Sensor-Augmented Environments in Elderly Care

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Abstract. The analysis of the potential for technological innovations to contribute to the prolongation of the independence of the elderly in the care context needs to be situated against a background of change which presents a set of challenges, opportunities and risks. The challenge is to ensure an optimal quality of life and equitable treatment for the growing elderly population. Technological innovations present significant opportunities for meeting these challenges. However, there are also some potential risks associated with the application of technology in this domain. Starting from this apprehension, the paper deals with physical environments and needs of elderly in relation to technical implications and ethical considerations. Two pilot projects in the field of “Ambient Assisted Living” are outlined, dealing with the development of an electronic user terminal and a safety assistant for the elderly.

Keywords: Assistive technologies, elderly, physical environments, user needs, ethical considerations, pilot projects.

1 Introduction

Today, western society is confronted with a profound demographic shift, moving from a world with a predominantly young population to one with a significant proportion of people aged over 65 years [8]. This shift means both, a challenge and an opportunity for the design and development of intelligent technologies. The dramatic increase of the number of elderly people as compared to active workers raises concerns about the society’s capacities to maintain existing social and healthcare systems. This also means that there will be fewer young people to help older adults to manage daily life.

In order to cope with this emerging situation, assistive technologies can be introduced to support elderly persons as well as human caregivers and consequently to improve the quality of life of the involved individuals. Technologies, which should be developed according to the needs of their users, will support ageing in place as well as independent living of the elderly. It is obvious that technology can not replace the human factor, which is certainly more important than anything else in the support of elderly people. But technology can provide complementary support, give new opportunities, like homecare and support to mobility. By identifying the needs of elderly people and the derived requirements to support systems, the ways in which

technology can be integrated into their lives is to be addressed in corresponding research and development activities.

2 Environments, Needs and Independence of Elderly

The World Health Organisation's view of health provides an appropriate framework within which to analyse needs and the meaning of independence in the elderly population [5]. The first section of this framework element comprises the view of health as a state of physical, mental and social well-being and not merely the absence of disease. This definition recognises the importance of social, environmental and cultural factors in the maintenance of health. The second section defines health as the extent to which an individual or group is able to realize aspirations or needs and to change / cope with the environment. The physical environment, in its broadest sense, is seen as equally important in the promotion and maintenance of health.

In planning of "good" and "age-friendly" living environments, it is necessary to take into account the inter-individual heterogeneity of the elderly. This can be observed especially in the areas of needs and motives. As resulting questions it can be asked, what environmental criteria must be met for the individual to be satisfied with living conditions? To what extent is the individual striving to adapt the environment to his or her goals in life ("proactivity")? It is an important task of environmental gerontology to encourage planners and technicians to be more sensitive to the influence of living environments on competence, well-being and social integration in old age. Creating age-friendly living environments can be understood as a key element of subsidiarity.

In a study of opportunities and limitations of independent living in old age the relation between physical environment and functional competence was analyzed. The analysis showed that greater independence (and thus fewer care needs) was correlated with better housing conditions [7].

For the majority of elderly persons, better housing conditions mean ageing in place, with appropriate changes of living environments supporting independence and enhancement of quality of life. Changes of the living environment are frequently connected with the integration of technical aids and in the near future intelligent technologies for assisted living are discussed as promising (electronic) support for the elderly. To what extent and in which context referring technical systems will be in the position to care for human beings and to provide expected results, is still a matter of investigation.

Preparatory works have been started in various laboratories but only a few of them deal with this matter in "real environments", i. e. in living arrangements occupied by elderly persons. The Austrian Research Centers GmbH - ARC have started a pilot project in assisted living environments, applying a sensor network for activity monitoring as well as intelligent care environments. Preliminary results from these projects (see chapter 3.1 and 3.2) are to provide a basis for planning and design of user-specific assistive technologies, considering given environments and requirements / needs of the regarding elderly persons.

2.1 Age Related Needs and Diversity

It is important to emphasise the heterogeneity of the elderly population independent of the particular place of residence. The elderly is not the homogenous group within any given society. There are large differences between the elderly at different chronological ages and, equally significantly, the variations in levels of ability or needs for a given age range amongst the elderly is much wider than at any other stage of the lifecycle. In other words, ageing of a cohort is associated with a widening variation along a whole range of dimensions. These common experiences of ageing can result in high levels of need among the elderly. Declines in physical health and functioning lead to increased needs for health and social services, especially within the long-term-care category. It is important to extrapolate from the current level of need amongst the elderly to the likely levels of needs in future cohorts.

2.2 Independence and the Elderly

The notion of independence tends to be central to most discussions of the needs of elderly. It is almost invariably expressed as a central aspiration by the elderly themselves and it is increasingly promoted at the policy and service delivery levels for cost reduction and / or quality of care reasons. Concepts of dependence and independence are highly relative and culturally determined. Technologically based interventions can impact on the social relationship, underpinning (in)dependence in various ways. One of the key challenges will be to apply useful technological solutions in a manner which is sensitive to the complexity of these relationships.

3 Implications of Technology

In recent years the debate on independence and self-sufficiency of the elderly has attracted considerable attention and resources. This developed thanks to the greater sensitivity towards the special needs and requirements of this growing segment of the population. The search for new solutions that can guarantee greater independence and autonomy has begun to exploit easily available state-of-the-art technology. Intelligent control and sensor systems, e.g. called “smart homes” or “smart environment system” would go far in simplifying the interaction between the elderly and their domestic environment. A great number of benefits would stem from their implementation: greater safety, autonomy and self esteem and consequently better relationship with others [6].

As it showed in a number of research projects, it was technically feasible to install and operate smart home solutions in laboratory settings. As soon as these solutions are to be operated in real environments of elderly persons, a number of problems emerge, mainly connected to low usability and low acceptance rates by prospective users. As mentioned in a previous chapter, there is a high heterogeneity amongst older people, regarding their needs in different stages of age. Thus, standard solutions for assistive technologies have only small chances for a useful function and for acceptance in households of elderly persons. Again, it should be stressed that the involvement of prospective users is a main prerequisite for planning and development of any technical systems for the support of daily living.

3.1 Electronic User Terminal

Dealing with this situation, the ARCS have been actively involved in a series of pilot projects in the field of Ambient Assisted Living (AAL), in a national as well as in a European context. Two recent projects deal with the acquisition and analysis of user needs and derived system requirements as applied in selected homecare environments. One of these projects puts the focus on designing and testing of a stationary user interface (“electronic user terminal”) for elderly persons, which is to be applicable for various purposes, like alarming, communication, structuring of the day, information etc. [2, 3].

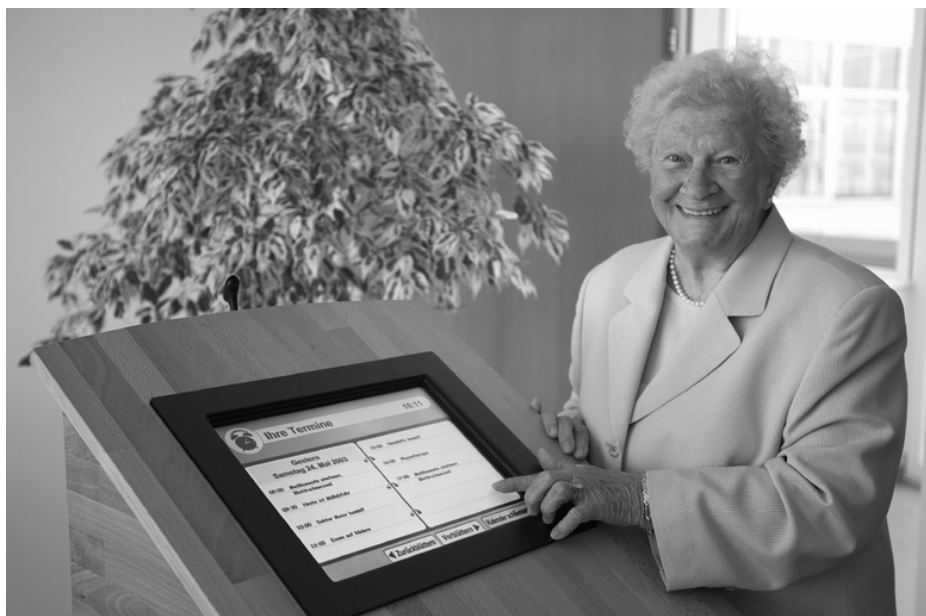


Fig. 1. Prototype of an electronic user terminal, showing the menu for a reminder function

In the framework of a qualitative study, prospective users were confronted with a prototype of the terminal, displaying the different functionalities as well as cognitive training software. During and after their active contact with the terminal, users were invited to a dialog on their experiences with the new tool, based on a semi-structured concept of questions. The same experiment was carried out together with caregivers and relatives of potential users. One of the rather surprising results of the trials was that the majority of elderly users had a more positive valuation of the terminal’s usability as their caregivers. To get to the bottom of these finding further studies will be conducted.

3.2 Safety Assistant for the Elderly

The second project deals with activity monitoring of elderly persons, living in assisted homes. For this purpose experimental sites have been set up, composed of various sensors (infrared / IR, contact, touch, temperature etc.) for the detection of motions, opening and closing of doors / windows, leaving the bed etc. This system constitutes a sensor-augmented environment, which is unobtrusive for the users. They are living in their homes “as usual”, carrying out regular activities, without worrying about the technical installations [4].

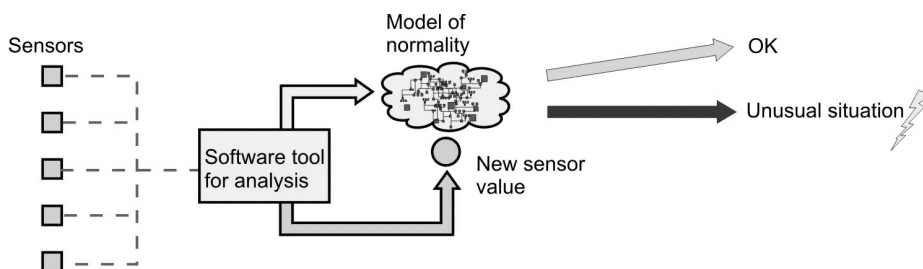


Fig. 2. S.A.F.E. Safety Assistant For the Elderly

The system features several functionalities, which are not activated yet but which are analysed referring to a users' typical activity or behaviour in his living environment.

- *Safety alarm*: in case of critical situations in the household, the activated sensors should trigger out an alarm warning the person on duty of an imminent danger. It corresponds to the management of hazards brought about by abnormal situations in the patient's setting and / or the behaviour of the aged (running away ...).
- *Presence / absence*: in case of elderly people having repetitive habits in their daily life, the system can discover and learn the habits (e.g. the time table, etc) in order to give the alarm to the professionals whenever any abnormality happens on the elderly people's activity.
- *Mobility study*: it relies on the use of IR motion sensors so located as to cover the whole room in different areas to monitor the elderly person. By acquisition and calculation of referring data, the paths followed by the patients are built up so as to be listed and stored. Any abnormality on the elderly's mobility can be diagnosed to warn professionals.

The “learning” principle is used to account for the changes in the elderly patients' behaviour, in their physical environment and social setting. The multi-sensor system is installed in her / his apartment to detect presence, motion or walking in / out. The data reflecting the repetitive and representative habits of the user can be identified in a non-intrusive manner without disturbing daily life. These data are recorded as soon as the system is turned on and special software tool are applied ex post for the interpretation of data. In order to get more details for the analysis of users' behaviour within her / his living environment, it is planned to integrate additional sensor

systems, like RFID readers or bio sensors. As a result it should be possible to determine where a person is staying or what household object she / he has used, as well as to get a general sense of her activity level.

For both projects the underlying philosophy is to work in cooperation with end-users and to consider their needs first and foremost. In this framework it is the users themselves who determine which assistive technology to include into their living environment with what priority and the best way to integrate them into the system. In order to satisfy the often conflicting requirements, it is necessary to design modular systems that can be customised in different configurations for different needs. Both projects are intended to contribute to the investigation of questions about human behaviour, among others:

- What influences behaviour of people in their homes?
- How can technology be effective in the home context for long time periods?
- To what degree can activity monitoring contribute to create new computer applications for the home?
- What influences how people adjust to new environments?
How do people learn in the context of the home?

4 Ethical Issues Regarding the Elderly

Bringing technology with monitoring functions into a person's home also raises important ethical questions with regard to possible conflicts with principles of dignity, independence and privacy. The appropriate choice of technology can help to migrate some of these concerns. For example, monitoring a patient's wellbeing or activity at home might not require video-cameras, but can be done less intrusively through tactile or infrared sensors, as practiced in the above mentioned pilot projects. Technology implementation and careful application of social norms can also reduce a sense of intrusion and loss of privacy.

Another ethical challenge is to avoid the perception that the installation of technologies for "ambient assisted living" means that decision making power is left to a heuristic machine or that it replaces human care and prepares the erosion of social interactions. This perception is a major barrier to the uptake of new technologies. It leads to the important ethical, as well as operational, principle that these services should not aim to substitute existing care networks, but that they should be promoted and implemented as complementary solutions. Smart home devices for example, should be seen as a means to enhancing social care rather than as a substitute for it. Consequently, assistive technologies (especially information and communication technologies) as applied in smart home solutions should not increase isolation; instead they should be tools for maintaining and, ideally, even strengthening social networks and keeping the independence of their users [1].

Other adverse psychological effects of AAL solutions can also be imagined. Having to rely on unattractive technological devices in day-to-day life can do considerable harm to the self-image and confidence of the user. Efforts for better design, discreet ambient integration and the upgrading of conventional home devices with AAL-capabilities can ameliorate this problem. Most importantly, if the personal autonomy of a potential user of supportive technologies is to be fully respected, the

user must have the right, to overrule or switch off the technology. These rights must be built into the services. User should also have the right to opt out completely from using the services, if they wish so.

5 Conclusion

Active ageing with the help of assistive technologies, like “smart homes” or “ambient assisted living”, presents a major opportunity to utilize technological progress for individual autonomy and dignity as well as for social inclusion. In order to make the best of this opportunity, it is essential to place users and their needs in the centre of our considerations when designing and implementing novel technical solutions within an elderly persons’ living environment. Consequently, it is decisive to strengthen user involvement and to take better account of user contexts.

References

1. Comyn, G., Olsson, S., Guenzler, R.: DG INFSO/H/1, ICT for Health Unit: User Needs in ICT Research for Independent Living, with a Focus on Health Aspects. Seville, Spain, pp. 34–35 (June 2006)
2. Ehrenstrasser, L., Prazak, B.: Assistive Technology and Design for All: Inclusive design versus "Universal design"? A critical approach from a product designer. In: Proceedings of the CVHI 2006, July 19-21, 2006, Kufstein, Austria (2006)
3. Fugger, E., Morandell, M., Prazak, B.: People with Cognitive Problems and the Aging Population - Introduction to the Special Thematic Session. In: Miesenberger, K., Klaus, J., Zagler, W., Karshmer, A.I. (eds.) ICCHP 2006. LNCS, vol. 4061, pp. 415–420. Springer, Heidelberg (2006)
4. Fugger, E., Ehrenstrasser, L., Hochgatterer, A., Russ, G.: Proactive Assistant for Intelligent Homecare Environments – A Development Pilot. In: Proceedings of the (ICOST 2006), 4th International Conference On Smart Homes and Health Telematics, (June 26-28, 2006), Belfast, Northern Ireland, pp. 347–350 (2006)
5. Lee, K.: Shaping the future of global health cooperation: where can we go from here? Health Policy Unit, London School of Hygiene and Tropical Medicine, *Lancet* 351, 899–902 (1998)
6. Pollack, M.E.: Intelligent Technology for an Ageing Population: The use of AI to Assist Elders with Cognitive Impairment. *AI Magazine*, pp. 6–7 (2005)
7. Schaie, K.W., Wahl, H.W., Mollenkopf, H.: Aging Independently, Living Arrangements and Mobility, pp. 55–56. Springer, New York (2003)
8. How demographic decline and its financial consequences will sink The European Dream (February 1, 2007), <http://www.new-frontiers.org/mediacentre/EuropesDemographicDecline.pdf>