Ambient Monitoring from an Elderly-Centred Design Perspective: What, Who and How

Marije Kanis, Sean Alizadeh, Jesse Groen, Milad Khalili, Saskia Robben, Sander Bakkes and Ben Kröse

Amsterdam University of Applied Sciences, Duivendrechtsekade 36-38, 1096 AH, Amsterdam, The Netherlands
{M.Kanis, Sean.Alizadeh, S.M.B.Robben, B.J.A.Krose}@hva.nl

Abstract. This paper describes a participatory design-oriented study of an ambient assisted living system for monitoring the daily activities of elderly residents. The work presented addresses these questions 1) What daily activities the elderly participants like to be monitored, 2) With whom they would want to share this monitored data and 3) How a monitoring system for the elderly should be designed. For this purpose, this paper discusses the study results and participatory design techniques used to exemplify and understand desired ambient-assisted living scenarios and information sharing needs. Particularly, an interactive dollhouse is presented as a method for including the elderly in the design and requirements gathering process for residential monitoring. The study results indicate the importance of exemplifying ambient-assisted living scenarios to involve the elderly and so to increase acceptance and utility of such systems. The preliminary studies presented show that the participants were willing to have most of their daily activities monitored. However, they mostly wanted to keep control over their own data and share this information with medical specialists and particularly not with their fellow elderly neighbours.

Keywords: Ambient Assisted Living, ambient interaction, information sharing, elderly-centred design, data visualization, participatory design

1 Introduction

The growth of the elderly population and the exponential increase of medical expenditure have stimulated interest in Ambient Assisted Living (AAL), an emerging field that promotes independency in the old age with the support of advanced technologies. Residential monitoring is particularly being explored for this purpose. Typically, it is focused on monitoring elderly Activities of Daily Living (ADL); a set of activities used by physicians to benchmark physical and cognitive decline. Although the governmental and clinical perspective is dominant in the design of monitoring technology, designing such systems should indeed be accompanied with the elderly acceptance and understanding. A recent study amongst elderly care specialists [1] supports the foremost importance of including elderly input in the telemonitoring process. However, the exact workings of novel, ambient intelligent systems in the home might not be entirely clear to the user. This makes it difficult to

gather honest and true opinions and attitudes that can rightly inform the design of a monitoring system. The work described in this paper, is therefore focused on gathering insights and means to include elderly in this process of designing a system for monitoring their daily activities. The following sections introduce the what, who and how issues of designing a system for monitoring ADL's.

What: Ambient Monitoring. Ambient monitoring systems [2] (also referred as tele- or residential monitoring) are particularly under investigation as to gather and analyze information about elderly's activities of daily living in the home. Ambient monitoring involves placing sensors in the environment to be monitored, rather than on the user themselves. In our current investigated home aged care scenario, this involves placing 15 simple sensors such as motion detectors and switches on doors throughout elderly homes that track the user's activities of daily living. Deviations in ADL (e.g. bathing, toileting and eating) may reveal information that leads to preventive measures. Researchers have progressed on the rather techno-centric issue of activity recognition [3] and clinical-centric issues such as the importance of the various ADL from the medical specialists view [1]. Though important for acceptance, an underexplored issue is elderly's perceptions on what kind of activities to monitor.

Who: Sharing Information. The elderly in the context of this study reside within assisted living environments and are considered independent in terms of performing their activities of daily living. Given the personal nature of behavioural information that may be monitored and transmitted, the general belief is that such data needs to be carefully dealt with. A study on user acceptance issues from the elderly perspective [2] specifically suggests control as an important factor for elderly acceptance of sensor technology. One may argue that to be in control, the elder needs to be aware and able to make sense out of the incoming data. Yet, the difficulty of ambient technology and the almost invisible interaction and data streams it facilitates, is that it becomes difficult to know what information is being collected, and with which party or person such data is being shared. In this context, it is unclear whether the elder want to share ambient data with medical specialists, friends, family or neighbours and leaving the interpretation of ambient data to expert others. As the desired level of sharing of information has obvious design and ethical implications, this needs to be clarified first, particularly as this has not been studied to a large extent.

How: An elderly-centred design approach. Researchers [4-6] argue that when designing care systems for the elderly, end users should be very much involved in the process. They suggest that human-centred design methods such as participatory design and value sensitive design, which emphasize the values and opinions of direct and indirect stakeholders, are key to upholding the ethical and democratic standards of the design process. Participatory design also plays a valuable role in creating more useful and better technology for end users [4] and hence acceptance of technology. However, some argue [5, 7] that strategies and methods on how to involve seniors in technology design are still unclear. Furthermore, the near invisibility and novelty of ambient technology makes it difficult to imagine residential monitoring systems and the (sensor) data streams it can produce. This has obvious consequences for engaging users in the design of the system. Providing users with example scenarios (e.g., via

theatrical techniques [8], dollhouses [9] or smart home environments (such as Ambient kitchen [10]) are imaginative ways for requirements gathering. The challenge is to develop novel methods for AAL requirements gathering, particularly ones that fit within the daily life [4] of the citizen, and cater for the diverse ideas and agendas of multiple stakeholders and users involved [8]. Furthermore, enabling users to experience technology in the home and present appropriate feedback on monitored data would help to improve understanding of the system, and so help its acceptance.

2 Study

Through conducting participatory design activities, as well as in-depth interviews with additional questionnaires, the study's aim was to better understand the needs of the elderly within the context of residential monitoring and consequently address acceptance issues. Specifically, the study aimed to address the following issues: (1) What: Activities from the elderly point of view, (2) Who: Investigate seniors' attitudes on the sharing of data with different parties, and (3) How: Employ participatory design techniques to aid the elderly in having a better understanding of residential monitoring. The scope of the study was restricted to the anticipated users of the system and directly related to monitoring seniors living independently in their own homes in a residential care environment. The participants included six senior citizens residing in an assisted living environment in Naarderheem, The Netherlands. Though some participants had partial physical or cognitive impairments, the elderly in question were able to live and perform their daily activities independently. The participants had no prior experience with a monitoring system in their home. However, prior to the present study they had expressed an interest in having such system installed. The study involved: (1) Frequent (in)formal discussions between the researchers and different stakeholders (such as the technical specialists and care staff), (2) Participatory design activities (i.e. co-creation sessions and iterative prototyping) to critique, build and evaluate the monitoring system being designed and installed, (3) Semi-structured interviews with the senior participants in their home, (4) A questionnaire investigating what kind of activities the interviewees wanted to be monitored (similar to the one used in previous study [2]) and with which party (just themselves, medical specialists, friends, family and/or neighbours) they wanted to share this information. The participants rated the importance of monitoring each ADL and preferred sharing party using a 7-point Likert scale.

2.1 Results

This study uncovered several what, who and how issues with regards to designing a monitoring system for the elderly. General issues involving the design of telemonitoring have been explored as well as developing participatory design techniques to aid the elderly in understanding monitoring technology.

What: Monitoring activities from the elderly point of view. The results from the interviews indicate that the majority of the participants are currently familiar with

some form of telemonitoring system, such as wearable panic buttons. However, the elderly were not very keen on such wearable devices. Furthermore, the majority of the interviewees (5/6) discarded the idea of using video and audio recordings for monitoring as being too invasive. As one participant explained "*Imagine if I have guests over, will you be monitoring them as well?*" On the other hand, the elderly felt that such system could be useful in acute situations, such as heart failure or fall accidents. When regarding the importance of activities as rated by the elderly in the questionnaire and expressed in the interviews, the participants found telemonitoring useful for a number of activities, such as taking medication, movement and continence. Still, the elderly all found that being able to have their own say when regarding their personal state was most important.

Sharing information with others. From the interviews and questionnaires it was found that the participants were generally not very willing to share one's daily living routine with others, except when it concerns sharing with a medical specialist. Results reveal less willingness to share information with friends and family members. Particularly so, willingness to share information with neighbours was rated lowest in the questionnaire, but also in the interviews the participants made it clear that they were particularly not interested in sharing information with their neighbours. As a participant expressed "*I do regularly greet the lady next door, but I don't want her to know anything about my personal life*."

Participatory design for ambient assisted living: An interactive dollhouse. The participatory design process resulted in an interactive dollhouse as a new tool to aid users' understanding of telemonitoring and engage users in the desired workings of such system. This dollhouse (a scale model copy of the participants' home) has been equipped with simple sensors that are able to track movement and so simulate the actual monitoring environment. The dollhouse communicates with a graphical user interface that displays simple feedback on what is being monitored in the dollhouse. Representations of sensor data derived from monitoring technology are often designed and visualized in a way that only allows a trained professional to interpret and act, but the interface of the dollhouse was designed with the elder user in mind. The dollhouse (Fig. 1.) has already been used in five participatory design sessions and was found to be a helpful tool in giving the elderly and other stakeholders a better understanding of the desired workings of the system and its output. The dollhouse has also been found effective in helping discussion and reaching more common understanding between the elderly, researchers and other parties involved.
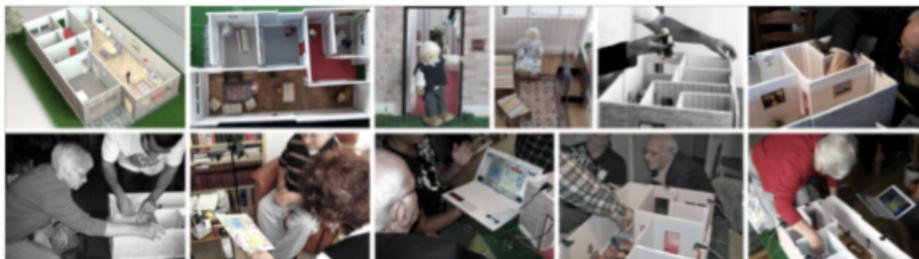
Fig. 1. Dollhouse prototype and participatory design with the elderly.

3 Conclusion

Senior citizens represent a growing base of users that can benefit from an engagement with monitoring technology. Considering the pilot study results, it can be concluded that the elderly find ambient monitoring useful for a number of activities. According to the study, their considerations and input is most important, and thus key in creating a monitoring system that is accepted by the end users. However, traditional user-centred design methods provide little guidance in how to involve the elderly in accepting ambient assisted living scenarios. To address this, an elderly-centred approach was taken to discuss challenges for designing monitoring technology. The interactive dollhouse was found a useful technique to engage the elderly and appeared to be an effective tool to familiarize the end user with monitoring technology currently being installed, and so to engage them in accepting and influencing the proposed monitoring solution. The study was also fruitful in terms of increasing awareness of the workings of the system and long-lasting partnerships formed with the elderly and other stakeholders involved. This is valuable and essential to progress further study. As to draw more reliable and insightful conclusions, a larger group of participants is required and recommended for future work. Furthermore, issues such as data visualization, activity recognition, information sharing and acceptance need to be further considered and explored in-situ to bring real value to the users. In doing so, it is recommended to be sensitive to the attitudes of the elderly and exemplify ambient scenarios to aid democratic engagement in ambient technology design.

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