

Augmented Hearing for elderly people – User Requirements and Use Cases

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Abstract

In this short contribution, we present the first results of our research about a novel augmented hearing system extended with assistive services. Primary goal of this system is the support of elderly people in their everyday life. The key feature is the voice-user-interface embraced with a microphone and communication components enabling a speech-based system interaction. Additional ear-in sensors for vital-sign measurement can be used for health self-management. Throughout the project use-cases have been developed and a user requirements analysis was performed. The results indicate a positive attitude towards the proposed system by primary users and a high potential of adding additional value to the life of elderly people.

1 Introduction

With increasing age, eye sight, hearing, memory and coordination skills decrease. The use of assistive technology systems can help maintaining or even improving the quality of life of elderly people despite physical and cognitive changes. To meet the requirements of physical changes in older age as well as to ensure an easy handling of assistive technology new operating and interaction concepts are needed.

With this paper, we present our first results of our research project AHEAD - Hearing Experience and Assistance for Daily Life, funded by the EU. The aim of AHEAD is the development of a speech-controlled assistive system that supports elderly people in their everyday life. This system is both, a communication tool and a healthcare manager, e.g. initiating phone calls, recording vital parameters, providing environmental information, etc. It will be integrated into hearing glasses as a combination of a novel hearing aid (without the need for a plug in the ear) and a vital sensor system, plugged in the ear. By this, the system allows ubiquitous and non-obstructive monitoring services such as triggering emergency calls.

Our work will extend the current state-of-the-art by developing hearing glasses with assistive services assessable through a voice- or graphical-user-interface. The development process follows a user-centered approach involving as a first research step a user requirement analysis as basis for further design and implementation considerations.

In the following, we describe the results of the user requirements analysis. We address the research question: Which use cases are suitable for the application of an Augmented Hearing system?

2 Related Work

To our knowledge there are no studies that have evaluated the elderly people's use of hearing glasses. Only a few studies have evaluated voice-controlled systems with elderly users, mainly as part of multimodal user-interfaces such as smart home environments (Callejas & Lopez-Cozar, 2009; Ferreira et al., 2013; Lines & Hone, 2013) or Living Home Centers (Pires et al., 2012). The studies revealed two relevant insights: On the one hand the results showed that elderly people appreciated the idea of "speaking to a home" and that multimodal voice- and touch-enabled interfaces allow an easier use of technologically complex devices and services as well as improve electronic and social inclusion of elderly users (Pires et al., 2012). On the other hand, in the study of Portet et al. (2013) some elderly people stated that they do not plan to use such systems at present. They indicated that such a system would be more devoted to people with disabilities. Ferreira et al. (2013) performed a user evaluation of a multimodal medication assistant for elderly users based on a smartphone. Their study showed that interaction through spoken language and recommendations given by a medication assistant evoked a positive impact on elderly users. The above-mentioned studies, involving elderly people, investigated multimodal user interfaces mostly applied on a smart phone or tablet.

3 Prototype

The technological approach of AHEAD combines eyeglasses and hearing aids, and the integration of microphones, sensor-data and several applications. Therefore, we apply an ontology-based context management with the OpenAAL middleware (based on UniversAAL reference architecture). The middleware enables a simple implementation, configuration and situation-dependent provision of flexible, context-sensitive and customized assistive services. Figure 1 describes the basic architecture (openAAL collects all sensor data, a mobile app controls the hearing assistant, and the hearing assistant (temples of glasses) consists of a microphone (for noise speech recognition), vital sensor (for vital sensor data) and earphones (for speech assistance).



Figure 1: Architecture (left) and prototype (right) of the technological approach

4 User Requirements

To ensure the acceptance of elderly users for the AHEAD system we first conducted a user requirements analysis involving primary (seniors) and secondary users (informal caregivers: family members, formal caregivers: health professionals, hearing aid acousticians) to explore the preference and suitability of different features and the developed use cases. A mix of qualitative and quantitative methods has been applied to cover a broad variety of information from the different target user groups:

- Interviews to gather demographic, technology experience and acceptance data as well as requirements towards services and future scenarios.
- Focus Groups were conducted for collecting qualitative data.

4.1 Results of the interviews

Individual interviews with primary users have been performed in Austria and Germany. In Austria 20 participants (13 female, 7 male) aged between 51 and 87 years old (Mn= 67, Sd= 10) have been interviewed. In Germany 18 participants (12 female, 6 male), 9 with hearing impairments and 9 without hearing impairments, between 53 and 85 years old (Mn= 73, SD=11) were interviewed. The interview questions targeted besides the demographic data (age, gender, technology experience, size of household, independence level and sharing privacy data) at the perceived usefulness of 10 use cases (see Table 1) for elderly users. Ratings were given on a 10-point-likert scale (1= very useless – 10= very useful).

The results of the demographic data showed that in Austria the averagely household size is 1.25 persons. 4 out of 20 persons would use a hearing glasses assistant. Only 2 participants indicated that they don't have a mobile device (cell phone or smart phone). The majority (14/20) are not using a headphone regularly. Almost all participants (19/20) wear eye glasses and only 4 participants were using hearing aids (in ear bud style). Only 1 person mentioned

to feel restricted because diminishing hearing abilities. Concerning the independence level only one person received professional care at home. Most of the participants (16/20) would share their privacy health data with the medical professional, 13 persons with their family members and 12 persons with their care takers.

In Germany the average household size is 1.77 persons. 3 out of 18 participants would use a hearing glasses assistant. All participants (18/18) are using a mobile phone, but none a smart phone. More than half of the participants (10/18) are not using a headphone regularly. All participants were wearing eyeglasses but none were using an in ear bud hearing aid. A few participants (5/18) mentioned to feel restricted because of their increasing hearing loss. No participant was in need of professional care support. The majority (15/18) would share their privacy health data with the medical professional, 12 persons with their family members and 15 participants with their care taker.

The results of the primary user-group in both countries are presented in Table 1.

Use cases	Austria <i>Mean (SD)</i>	Germany <i>Mean (SD)</i>
Weather information	6.9 (3.3)	5.44 (2,17)
Phone calls	7.6 (3.3)	7.39 (2,34)
Emergency calls	8.4 (2.6)	9.44 (1,26)
Health care monitoring	7.05 (3.4)	9.28 (1,09)
Reminder	7 (3.3)	7.17 (2,95)
Oven/window warning system	7.1 (3.5)	8.00 (1,53)
Drinking reminder	7.4 (3.2)	7.44 (1,83)
Medication reminder	7 (4.0)	7.17 (2,24)
Finding Assistant	6.3 (3.5)	6.56 (2,09)
Camera	4.25 (3.6)	4.67 (2,47)
Public Transport assistant	6.75 (3.5)	7.44 (2,99)

Table 1: Rating of the perceived usefulness of the use cases

4.2 Results of focus groups

Focus Groups were also performed in Austria and Germany. In Austria 4 nurses and one managing director of mobile home care attended as formal caregivers at the focus groups. In Germany informal caregivers, family members (n=12) and formal caregivers, hearing aid acousticians (n=4) participated at the focus groups. Both focus groups started with the pre-

sentation of the project and a demonstration of hearing glasses (by Bruckhoff Hannover¹). In a next step the ten use cases were presented and discussed along the questions: What do elderly people need? What meets their practice? Which functions are seen as helpful by health care professionals?

The results of the care staff focus group show a rather negative attitude towards the proposed hearing glasses system. Mentioned reasons were that elderly people would admit through this their disability in seeing and hearing and therefore might feel ashamed. Moreover elderly people would mostly own more than one pair of glasses so that this would lead to problems in compatibility with different models of eyeglasses. In addition the participants stated that handling such a system might be too complicated for the elderly users, for example the On/Off-button on the presented hearing glasses might be too small and doesn't meet the needs of persons with reduced fine motor skills.

Also a high beep as signal was rated as irritating and uncomfortable. In the case of dysfunction or disturbance professional help is needed. In the opinion of the health care staff, the necessity of controlling the hearing aid and conducting regular adjustments could lead to more work for health care professionals. Furthermore the participants reacted critically to the feature of measuring the vital parameters. Generally they don't trust in the reliability of this feature. The question arose who should provide service for the hearing glasses. They noted that there must be a health care professional or physician who intervenes if necessary.

The reminder for medication intake was criticized. The participants stated that the hearing aid would not know if the client already took medicaments or not. In both cases the hearing aid would remind the client and could possibly lead him/ her to a double intake. The focus group agreed that the hearing glasses are too unsecure for medical functions. The benefit of the assistance system was seen in the features concerning the household and all-day life. Thus, the "reminder function when the person leaves" (e.g. the stove is still switched on; a window is opened) was positively valued.

The voice-dial-function was also seen very critically because the voice-recognition must be switched on and off. This wouldn't meet the fine motor skills and cognitively overstrain the elderly. The participants proposed that maximum 3 functions would meet the practice of elderly people best, which should be chosen individually by the owner. Additionally, the system should be adjustable to the arising needs and therefore be able to "grow" with the user. The complexity of the hearing glasses would target the ability of younger people but should be tailored in future to the needs of elderly people.

The results of the family members indicated that the hearing glasses system has to be easy to use, have a high wearing comfort and offer feedback to the user. Moreover they appreciated the idea of being connected to the grandparents via AHEAD in terms of getting easily in contact, being able to monitor vital signs and if needed also the daily activities. Concerns were related to the issue that the primary users first have to admit that they would need such an assistive system and that technology often discourages elderlies because of its complexity.

¹ www.bruckhoff.com/

The focus group also emphasized that it is important that the primary users could control the communication flow by themselves. Moreover the majority of the family members indicated that the system has to provide a well-known voice to the user to avoid difficulties in understanding. Referring to the household size, the participants mentioned that the real value lies within the single person households when there is no other person to remind about tasks, activities and safety aspects like running stove/open window, etc. Among the focus group there were no concerns about privacy data and sharing it between family, professionals, care givers and friends. Concerning the financial aspect the participants preferred that costs for the device and the services should be expressed by an initial selling price and not by a monthly fee or charges per requested service. If the hearing glasses system would work as described, 11 of the 12 participants would advise their relatives to use the system; most of them indicated to use the system also, if others in their age-group would use it too.

The hearing aid acoustician focus groups mentioned that new technologies aren't connected to the hearing aid market yet although specific technological aspects of hearing aids have advanced such as battery lifetime, size and sound quality. They also explicitly mentioned that the customers would welcome new technologies that add additional value to life. The most appreciated aspects in this focus group were "help in emergency situations" and "the measuring of vital signs". The least popular aspect was the constant monitoring. The participants agreed with the family members that the future users would accept the idea of a hearing glasses system if it is easy to use, the purchase price is reasonable and if the elderly people recognize their need for new technologies.

5 Services and Use Cases

Based on the results of the user requirement analysis the initial developed use cases were refined which will represent future services available on the AHEAD system (Table 2).

Services	Use Cases	Description
<i>Emergency call</i>	Triggered by vital signs	Vital parameters of the user are monitored and evaluated. Depending on the measured health state of the person, actions are triggered
	Triggered by voice command	An emergency call or alarm is triggered by a voice command generated by the user. Functionalities are similar to current social alarm (push button) devices but triggered by voice.
	Triggered by push button	An emergency call or alarm is triggered by the user pushing a button/icon on the screen of the smartphone. Functionalities are similar to current social alarm (push button) devices.

	Phone call	The user has the possibility to initiate phone calls with the hearing glasses system. He/she retrieves per voice command the contact number or dials the telephone number on the display of the Smartphone. The communication is performed through the infrastructure of the hearing glasses.
<i>Health care monitoring functions</i>	Medication reminder	Reminds the user for taking his/her medicine just in time.
	Health and Fitness assistant	health and fitness recommendations will be provided
	Affective Assistant	To support the current daily activity or propose a new action (e.g. meet a friend, go for a walk, take medications, and perform an aerobic activity)
	Sensor Data History (Context)	All gauged values of sensors are stored. Every application, running on the AHEAD has the possibility to retrieve this data.
<i>Warning systems</i>	Key Reminder	Key reminder alerts the user to remind him to take the keys. Or if the user is searching his keys, he can trigger the alarm of the key to locate it
	House Status	The House Status and the status of the devices (lamps, doors, windows, fridge, oven, etc.) in every room is shown on a graphical-user-interface. The user has also the possibility to switch some devices on or off.
<i>Daily Life Services</i>	Infotainment	The user can access “standard” smartphone features like obtaining weather information, news podcasts or start an audio book
	Timetable and Navigation	The user asks for timetable of public transport or is searching a place or address from his current position.

Table 2: Services and Use cases

6 Summary

The results of the user requirements analysis revealed a positive attitude towards the proposed AHEAD system by primary and secondary users. The most preferred feature was the emergency call function, followed by phone call, health care monitoring functions and the warning system (open window/running stove). The majority of the primary users indicated to possibly use such a system in future. For the focus groups the results were more heterogeneous. The attitude of the secondary users group (health care staff) was less positive compared to the primary user group. The focus groups with family members showed a more positive attitude towards the hearing glasses system. They especially appreciated the integrated communication service that enables direct contact to the primary users as well as the vital sign measurement. The focus group with hearing aid acousticians underlined the beneficial effect of such a system for the life of elderly people in particular when it comes to emergency situations and health care support.

In summary we can conclude that the proposed voice-controlled hearing glasses extended with assistive service is a very promising system that has the potential to add additional value to the lives of elderly people taking advantage of ICT use. The results of the user requirement analysis will directly be integrated into further developing and optimization processes of the hearing glasses prototype. Future work will target at user-studies evaluating first low-fi prototypes by elderly participants to guarantee user-tailored system which meets with the needs of elderly users. Following this user-centered approach will enhance the overall acceptability of the hearing glasses system by the future user.

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