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User-centered priority setting for accessible devices and applications

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Abstract
Currently, ICT applications and devices like 'smart glasses', are hitting the consumer market. These devices offer great potential for people with disabilities, such as the visually impaired, but only when they are accessible for all users. This study comprehends a user-centered design process thoroughly analysing the needs and priorities of the prospective users. In order to assess the possibilities and limitations of smart devices for people with visual impairments, we created a priority list for to-be-developed functions and apps based on different empirical studies, including an interview and a survey. We propose that both designers and developers use this list as a starting point for generating or assessing the feasibility of new ideas for apps for the visually impaired.

1. Introduction

At the moment, wearable ICT applications and devices, such as 'smart' glasses and watches, are hitting the consumer market. Such smart devices provide the features of a smartphone in new, wearable forms, such as a head-mounted frame or a wristband. Current prototypes and products contain features like wireless internet connectivity, embedded camera, speech input-output commands, GPS, tilt sensor, accelerometer, activity tracker, and bodily function sensors. Such features offer opportunities for functionalities such as navigation, object detection, and text scanning and reading it out aloud. We are interested in exploring the possibilities and limitations of multimodal interfaces in new wearable devices and their applications for visually impaired persons (VIPs), using Google Glass and similar smart glasses as our showcase.

Smart wearable devices and their apps form a new means of access to all kinds of publicly available information and services (content), which are essential or even critical for daily life activities (DLA) and participating in society. These new devices, applications and content offer new possibilities to people with disabilities, but these possibilities can only be realized when they are accessible “for all”, regardless of the age and (dis)abilities of the users. It is a fundamental right to have access to publicly available communication, information, services, transactions and/or entertainment, and that right is not dependent on the specific technology, device or application that is used for providing them (UN Declaration of Rights of Persons with Disabilities, article 9, 2006; Peters & Bradbard, 2010).

Hence, from a designer’s point of view, it is logical to design for acceptance, accessibility and ease of use for *all* prospective users from the beginning of the design process, rather than retrofitting devices, applications and content for specific segments of the consumer market. Incorporating accessibility and universal design principles in the design process (often called “mainstreaming accessibility”) is not just an acknowledgement of the rights, needs and interests of people with disabilities, but also makes sense from a business perspective. If devices, applications and content are developed in line with the principles of universal design, they do not need to be retrofitted, or VIPs are not forced to use costly assistive add-ons (Van der Geest et al , 2011; Goggin & Newell 2007; Hurtienne, Horn, et al, 2014).

At this stage of development of smart glasses, it is hard to say what would make prospective users willing to start using this new technology and its applications. However, technology acceptance and adoption studies of other innovations have demonstrated over and again that two factors are very important predictors of acceptance and use: perceived ease of use and perceived usefulness (Venkatesh & Bala, 2008). In the cases where designers have made an effort to involve users in the design process, they often have limited the user involvement to user-centered *evaluation* studies (Van Velsen et al, 2008). At best, a prototype is presented to a limited number of representative users who are asked to judge the expected or perceived ease-of-use. Such evaluation studies do not reveal much about the perceived usefulness of the innovation. We think that a proper user-centered design process should *start* with a thorough analysis of the needs and priorities of the prospective users, to increase the chance that what is going to be developed will be eventually accepted and used.

Therefore, in our project on the assessment of the possibilities and limitations of smart glasses for VIPs, we have started by creating a priority list for to-be-developed functions and apps, defining priority in a user- centered way. The priorities are defined and set by asking VIPs about the most pressing problems they experienced in their daily life activities (DLA), rather than presenting them with a wish list of possible functions and applications based on the possibilities offered by the technology. To develop our priority list, we made use of three different studies, including a study by Broerse et al. (2015) which was conducted in 2014-2015 among VIPs in The Netherlands.

2. Three studies

We aim at developing a priority list for app development for smart devices, based on what according to persons with visual impairments are the most urgent problems and the most useful solutions. We have combined three different studies to support the development of the priority list.

1.1. Research agenda-setting survey

In 2014, two Dutch organizations for people with visual impairments, the Oogvereniging (*Eye Association*) and the MDVereniging (*Macular Degeneration Association*), commissioned the Athena Institute of the Free University of Amsterdam to develop a research and development agenda for people with visual impairments and eye diseases, explicitly involving visually impaired participants (Schölvinck, Pittens et al, 2015). In a series of workshops, focus groups and interviews with patients, their representatives and experts, a list of themes and topics was formulated for the research and development agenda. That list was then in the form of a survey presented to a broad group of people with visual disabilities and diseases. A grand total of 674 persons responded to the 48 themes and topics on the list that concerned daily life and social activities. The respondents indicated their top R&D priorities from the list of 48 topics. A detailed report on the development of the research agenda and the findings is available at the Athena Institute (Broerse, Schölvinck,et al 2015, in Dutch).

The list below shows the themes and topics in the daily life/social activities realm that were ranked highest by the visually impaired respondents.

High priority for research & development:

- Adapt widely used and new technology (such as smartphones, tablets, indoor GPS, Google Glass etc.) and make it accessible for VIPs, to avoid or replace (costly) assistive technology.

- Develop a simple method to increase the accessibility of product packaging. This concerns information such as the product, expiration date, or the ingredients in a mixed package.

- Improve the technique to communicate printed and written texts (including study materials) in other ways, to make them more accessible for VIPs.

- Raise awareness about widely used technologies that are available, usable, and accessible for VIPs.

- Improve the accessibility of (household) appliances using an app which can interact with a range of appliances. By doing so, there is no need to adapt every single appliance for VIPs.

- Develop auditory/tactile information and interaction functions of everyday appliances such as coffee makers, the washing machines or microwaves.

- Improve navigation systems in such a way that they can detect obstacles like poles and trees in public space. Navigation systems should also be suitable for indoor use and indoor way-finding.

- Increase the usability of the OV-chip (public transport) card for VIPs.

The R&D priorities as reported by the respondents of the survey will be presented at the workshop, side by side with the priorities that we distinguished in the next two user studies.

1.2. Interviews at an assistive technology fair

During an assistive technology exhibition for VIPs in The Netherlands (ZieZo beurs, Houten, april 2015), we conducted a short interview with 26 exhibition visitors with impairments (age range 19-87 years). We asked them to describe the biggest problem they faced in their daily life activities (DLAs) due to their visual impairment, and how they coped with the identified problem. We also asked some questions about the nature of their impairment and their use of assistive technology and other ICT applications.

The 'biggest' problems mentioned most often concerned navigating in public environments and reading written information. Specific DLAs that were reportedly very difficult were *wayfinding, including detecting objects in a person's path such as wrongly placed bikes* and *identifying specific products in a supermarket.* An overview of the themes discussed at the ZieZo fair can be found in Table 1.

Topic	**#**
Wayfinding	21
Reading written information	17
Object detection/recognition	16
Technology usage	10
Person recognition	7
Other activities	6
Low light situations	2

Table 1: Biggest daily life activity problems, reported in interviews at Ziezo fair

For coping with their most pressing problem, the 26 respondents used a variety of devices, many of which were not specifically designed for people with visual disabilities. Sixteen of them frequently used their smartphone as a support in their DLAs. As one of the respondents said: “The iPhone, that is my most important aid” [r27]. With their GPS and internet connection, smartphones are often used for navigation with apps such as iCane Mobilo, BlindSquare, ViaOpta Nav, and Google Maps. Some respondents also used their smartphone to process written information, using it as a text-to- speech device (mentioned 6 times), or as a magnifier (mentioned 4 times). The final list of user-centered priorities as reported by our 26 interviewees will be presented at the workshop.

1.3. Telephone interviews with DLA questionnaire

The third study is in its initial phase at the moment of writing this paper. In this study we are starting from a comprehensive list of DLAs. We used existing DLA surveys and scales that are used to assess visual functioning, such as the Glaucoma Quality of Life questionnaire (Gothwal et al. 2012; Khadka et al. 2011), Impact of Vision Impairment scale (Lamoureux et al. 2008), NEI-RQL 42 questionnaire (McAlinden et al. 2012), Catquest-9SF (Lundström & Pesudovs 2009), NEI-VFQ (Pesudovs et al. 2010a; Pesudovs et al. 2010b), DLTV (Schmier & Halpern 2006), and the VA LV VFQ (Stelmack & Massof 2007).

We combined the various DLA scales to come to a comprehensive overview and have added a category of media/technology-related activities, such as finding information on the internet using a computer, internet banking, and using a public transport swipe card. This type of activities are not represented in the existing DLA scales, however the respondents in the research agenda survey of study 1 rated them as very important research topics (study 1). Our final list contained 59 DLAs; which are presented to VIPs during a telephone interview. For each activity, respondents are asked to what extent this DLA is difficult for them, using a five point Likert-scale, ranging from 1 (no difficulty) to 5 (impossible). Then, the respondents are asked how important that particular DLA is for them, on a four point Likert-scale ranging from 1 (not important) to 4 (extremely important). At the end of the interview, respondents can add DLAs to the list that they consider important.

We aim to contact at a minimum of 30 respondents of various ages and visual impairments. A full list of the user-centered DLA priorities as reported by the interviewees will be presented at the workshop, side-by-side with the priorities distinguished in the national survey (study 1) and our short interviews (study 2).

3. Conclusion

The results from the three studies will form an empirically validated user-centered priority list of problems experienced in DLA for people with various visual impairments. It also gives detailed insight in how important a specific DLA is for the individual respondent. In our projects, this list will be used to formulate requirements for applications and content to be developed for multimodal interfaces for wearables, such as smart glasses. But we hope (and expect) that other designers and developers of applications will also use the list, either as a starting point for idea generation or as a reality check for design ideas. We feel safe to state that our priority list validly reflects the needs and interests of users with visual impairments, who should be at the center of the design process of accessible interaction with devices, applications and content.

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