[Poster] Towards Mobile Augmented Reality for the Elderly

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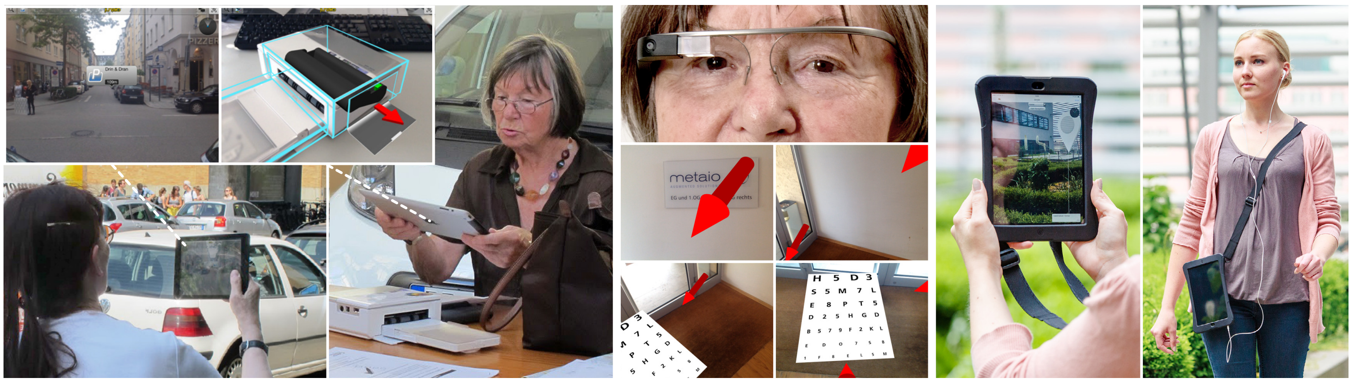

(a) (b) (c) (d)

Figure 1: We conducted a user study to evaluate the usability of handheld AR applications for the elderly (a,b). Since the results show that elderly users have difficulties holding up a tablet computer over a long period of time, we tested whether using head-mounted displays is an alternative for them (c). We also propose improved AR user interfaces for tablet PCs that do not require continuously holding up the device (d).

Abstract

Mobility and independence are key aspects for self-determined living in today's world and demographic change presents the challenge to retain these aspects for the aging population. Augmented Reality (AR) user interfaces might support the elderly, for example, when navigating as pedestrians or by explaining how devices and mobility aids work and how they are maintained. This poster reports on the results of practical field tests with elderly subjects testing handheld AR applications. The main finding is that common handheld AR user interfaces are not suited for the elderly because they require the user to hold up the device so the back-facing camera captures the object or environment related to which digital information shall be presented. Tablet computers are too heavy and they do not provide sufficient grip to hold them over a long period of time. One possible alternative is using head-mounted displays (HMD). We present the promising results of a user test evaluating whether elderly people can deal with AR interfaces on a lightweight HMD. We conclude with an outlook to improved handheld AR user interfaces that do not require continuously holding up the device, which we hope are better suited for the elderly.

1 Introduction and Related Work

With the demographic change, the meaning of mobility and independence for the elderly is more important than ever before. Besides outdoor and in-house mobility, modern mobility also includes all kinds of physical and digital interfaces such as transfer points in public transport or ticket vending machines. It is important to adapt the variety of available technical solutions and products to the elderly's needs. The aim of the research project *PASSAge* [2] is the implementation of seamless mobility chains, which include and combine different kinds of supporting technologies, services, and solutions, including Augmented Reality.

There is relatively little work on AR applications to support elderly people. Avilés-López *et al.* [1] propose using an augmented view onto a pillbox through the camera of a mobile phone to help elderlies when to take medication. Schall *et al.* [6] developed a prototype system to support elderlies in hazard detection while driving a vehicle. A robot with an AR screen to support drug dose control has been proposed and tested by Lera *et al.* [4].

Our field tests aim at evaluating the suitability of existing AR technologies running on tablet PCs for the elderly and whether AR can support their mobility and independence. The insights of the tests shall provide valuable input for improvements and further development. As theoretical background for describing users' acceptance we use a model by Meyer and Mollenkopf [5]. It describes requirements of technological devices according to the needs of elderly people. Based on these, semi-standardized interview guidelines have been developed for the tested technologies [3].

2 Field Tests With Tablet Computers

We tested an AR pedestrian navigation and an AR user manual application both running on a tablet PC, see figure 1 (a,b). The applications were implemented as channels in the junaio AR browser. The live video feed of the back-facing camera is superimposed with virtual 3D instructions on the display in real-time.

The AR user manual was tested by 17 subjects at the age of 66 to 93 years. It explains how to change the cartridge of a photo printer by superimposition of instructions on the live video feed, cf. figure 1 (b). A 10-inch tablet PC (iPad) was used by 10 subjects, while 7 subjects did the test with a lighter and smaller 7-inch tablet (iPad mini). The second application was outdoor pedestrian navigation, where the direction of and the distance to the destination were

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superimposed on the camera image as shown in figure 1 (a). This application was tested with 8 subjects at the age of 68 to 93 years with a 10-inch tablet PC. All subjects were initially briefed about the objective of the experiment. Then, they used the AR applications hands-on to solve the task of changing the printer cartridge or reaching the destination for the navigation application respectively. Finally, all subjects were interviewed about their experiences and potential areas of improvement using the interview guidelines.

The majority of subjects were convinced that visual presentation of instructions is more intuitive to understand than written instructions. The fact that the navigation application determines the user's position automatically via GPS was considered as very helpful, since it renders the inconvenient process of searching for the own position on a printed map unnecessary. However, in comparison with classical media, such as printed maps or printed manuals, we did not find a clear preference for the AR applications in terms of intuitiveness and usability. This was mainly due to the following problems which were observed in the field test. The visual instructions were partially too small for the subjects with visual impairments, and, in some cases, the meaning of the animated instructions (e.g., moving arrows) could not be correctly interpreted.

The most critical issue, however, is that the tested applications require the user to continuously hold the device up. This is necessary since the back-facing camera needs to capture the scene that should be augmented. This is not appropriate for the elderly because handheld devices are heavy and their slick surfaces make it difficult to hold them up over a longer period. The vast majority of the subjects (88 %) in the AR user manual experiment prefer the lighter and smaller 7-inch tablet to the 10-inch tablet. However, using a 7-inch tablet PC does not solve the fundamental problem, which needs to be resolved in the continuation of our research.

3 Field Tests With Head-Mounted Displays

One approach to avoid fatigue as a result of holding up a tablet computer is to use a head-mounted display instead. Recently different such devices with little weight and an integrated wearable computer became available. In our test, we used Google Glass to evaluate general applicability of AR applications running on such devices for the elderly. Figure 1 (c) shows screenshots of the application we used. The orientation of the HMD is determined from attached inertial sensors and is used to render a set of 3D arrows located around the user such that they appear to be static in the world. All arrows point towards a virtual eyesight test, which is located on the floor next to the user. We had 10 female subjects aged between 69 and 78 years test the application. The subjects were standing in a room with free space around them. After putting on the device, all subjects were asked to look at where the arrows point and to tell once they found the virtual eyesight test. This first step took on average 1:43 minutes ($\sigma = 54$ seconds). The subjects were then asked to read out loud the characters and numbers on the test. These were compared with the actual characters by the experimenter. This test has two objectives. The goal of the first part is to find out whether elderly people understand directions from virtual 3D arrows, which may be used in future pedestrian navigation applications. The second part provides a reliable way to assess how well elderly people can read from such a relatively small head-mounted display.

One subject discontinued the test; for the remaining 9 subjects we found that on average they correctly recognized 90 % of the biggest characters in the first two rows, 78 % of the medium-sized characters in the next two rows, and 62 % in the last two rows with the smallest characters. When excluding two subjects that did not want to read the lower 4 rows, the recognition rates for the remaining 7 subjects are 95 %, 95 % and 79 %. Afterwards all subjects were asked whether they could imagine using a head-mounted display in their everyday life. Only 3 subjects affirmed this question, 4 subjects denied, 2 were unsure, and 1 subject did not answer.

4 Handheld AR User Interfaces for the Elderly

Another way to tackle the problems found in the first field experiments, is to improve AR user interfaces for tablet computers. We propose an adaptive approach to enable non-interrupted user experiences. Once AR-based presentation cannot be used anymore because the tablet has been put down or stowed away, our approach automatically switches to a different way to present the same digital information to the user. For example in an AR user manual application when the user puts the tablet computer on a table, we propose to switch to a Virtual Reality (VR) presentation of the same real object and digital instructions associated to it. For pedestrian navigation, we use a silicone case that provides better grip to hold the device up for an Augmented Reality view, see figure 1 (d). The case further includes a shoulder strap enabling to wear the tablet computer like a purse. This situation can be detected using inertial sensors and we then switch to an audio mode which guides the user by means of spoken instructions via headphones, until the user decides to hold up the device again to experience the AR view. This adaptive contextual switching approach facilitates digital information delivery in a suitable way for the user: visually superimposed on the live video feed, visually without live video, or acoustically.

5 Conclusions and Future Work

Our field tests have shown that the tested handheld AR applications are not suited for the elderly, mainly because they require holding up the device, which is exhausting. Using lightweight head-mounted displays could be an alternative to using tablet computers, and our first test provides promising results that such devices might be suitable. An alternative approach to using different hardware is to design AR user interfaces tailored to the needs of the elderly. While this poster presents some first ideas in this direction, we will continue developing improved Augmented Reality user interfaces for the elderly and evaluate them with subjects in future work.

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