Designing Tablet Computers for the Elderly
A User-Centered Design Approach

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Abstract. The fast aging of many western and eastern societies and their increasing reliance on information technology create a compelling need to reconsider older users' interactions with computers. Changes in perceptual and motor skill capabilities that often accompany the aging process bring important implications for the design of information and communication technologies. This paper summarizes different methods integrated into a user-centred design approach to develop design concepts for a tablet computer, focussing on the needs and wishes of the elderly. Therefore, current tablet computers were compared respective their applicability und usability. Furthermore, based on the results of a questionnaire, elevating the needs of the user group two design concepts were developed and evaluated.

Keywords: Demographic change · Aging computer users · Tablet computers · User centered design

1 Introduction

Our society is currently characterized by two major trends: The demographic change and the mechanization and automation of processes in the working environment as well as in the private sector. The usage of computers often represents a barrier for older users due to changes of the perceptual, cognitive and psychomotor system (Czaja 1997; Hawthorn 2000) as well as their attitude towards new interaction technologies (Brickfiled 1984). This leads to a digital divide between older and younger users (Selwyn 2002). However, the rapid development in the mobile sector could lead to significant improvements in the usage for older users and reduce the digital divide. The users require less implicit knowledge of computers and direct input with a touch sensitive screen simplifies the interaction with the system (Luczak et al. 2011; Jochems et al. 2010; Caprani et al. 2012; Stößel et al. 2010). Nevertheless, there is a conflict for producers in the mobile sector between the intuitiveness of usage and exploiting technical possibilities. The features of the terminals increase with the rapid growth of the mobile market at the expenses of easy usage especially for elderly users. Is it necessary to develop mobile systems especially for elderly users because of these age-related changes and, if so, how should they look like?

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1.1 State of the Art

The first tablet computers, coming into market in the 1990s, were developed to support tasks like managing contacts or appointments as well as administrative tasks. After the rollout of the first tablet from Apple, the so called iPad, a rapid distribution of tablet computer started. Especially the touch-sensitive display and the corresponding interaction with gestures were ground-breaking technological innovations. By now there are a multitude of tablet computers of diverse providers, based on different software like Android, iOS or Microsoft Phone.

Considering the frequency of use of the elderly (65 plus), effective 10 % of this group use up-to-date tablet computers (BITKOM 2015). Looking at products designed specific for this user group, currently no tablet exits on the European market. There are just a few possibilities to adapt current systems, regarding luminance or font size. Therefore, the users have to know about these possibilities and also need the ability to execute the adaptation. First applications (for example Big Buttons, Keyboard Deluxe, BigDialer and mElderly) for mobile systems could be found considering elderly users. However, these applications are not integrated into an overall concept and the main focus is as well just the adaption of the font size.

In a time when the aging population have become global trends, we cannot afford to exclude an increasing number of people by design, for ethical *and* financial reasons.

2 Method

For the development of a tablet computer especially focussing on the elderly a user-centered design (UCD) approach was chosen (DIN EN ISO 9241-210:2010 2011). Therefore, different methods and analysing steps were combined. In Fig. 1 the different aspects and methods as part of the UCD process are visualized.

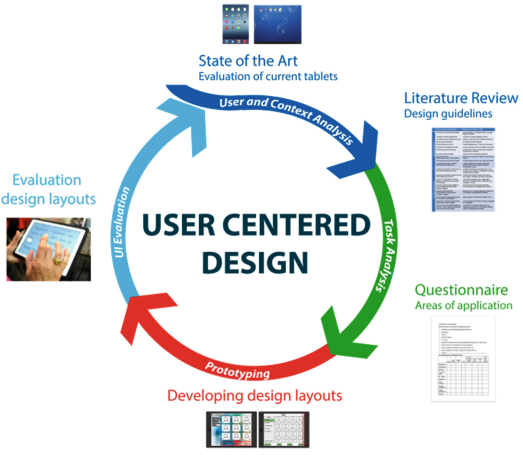


Fig. 1. User-centered design process

The approach consists of the following parts (1) evaluation of current tablet computers, (2) literature review regarding design aspects focusing the elderly, (3) questionnaire to identify suitable areas of application, (4) developing design concepts and (5) evaluating the developed concepts.

In a first step current tablet computers were compared and evaluated regarding their usability, especially focusing on the needs of elderly computer users. In a next step general age specific design guidelines as well as results of own user studies (see Schlick et al. 2013) were analysed regarding their fitting for the age-specific design of mobile systems, especially tablet computers. In order to understand the needs and wishes of the elderly computer users a questionnaire with 35 items was developed. Afterwards based on the results of the literature review as well as the questionnaire two different concepts were designed and evaluated.

2.1 Evaluation of Current Tablet Computers

Primarily two of the most commonly used tablet computers (Samsung Galaxy Tab with Android software and Apple iPad with iOS) were compared respective their usability for elderly computer users. Therefore, the subjects have to work with the two systems, executing typical tasks like editing or sending emails. Thereby suggestions, ideas and problems while working with the systems were collected with the thinking aloud method (Boren and Ramey 2000). Afterwards the subjects rated the overall performance of both systems on a scale from 1 = excellent to 6 = insufficient.

Test Subjects. The sample consisted of nine subjects between 61 and 75 years (M = 69.8, SD = 5.2). Their previous technical knowledge was rated by the subjects on a scale from 1 to 6 with 3 (SD = 1.1).

2.2 Literature Review – Design Guidelines

Fortunately, there is already a large body of tried and tested knowledge and design principles available. Table 1 describes a small extract of age-related changes of performance and corresponding design guidelines which where considered. For the overall results (see Jochems et al. 2010).

2.3 Development of the Questionnaire

The questionnaire consists of 35 questions focussing on (a) demographic data, (b) technical affinity (Karrer et al. 2009), (c) prior technical knowledge, (d) frequency of use and (e) application scenarios for tablet computers.

Test Subjects. The sample consisted of n = 54 participants. 59 % were female and 41 % were male. The participants were between 61 and 86 years of age (M = 71.2, SD = 5.5). For the statistical analysis the participants were divided into two age groups. Age group I (AGI) consisted of 22 participants between 61 and 68 years

Table 1. Age-related changes and corresponding HCI guideline

Age-related changes	Corresponding HCI guidelines
Decrease accommodation ability	Increase duration of presenting objects
Degradation depth perception	Simple two-dimensional consistent visualization
Reduction visual acuity	Adaption of font size
Limitation color perception	High-contract colors
Reduction contrast sensitivity	Maximize contrast between font and background
Problem to record information in memory	Highlighting of important information, for example arrangements in groups
Reduction of memory span to 5,5 items	Elimination of nonrelevant information, highlighting important information
Loss of information (working memory) especially complex information	Reduce complex visualizations, improve recognition by uniform design
Reduction of spatial sense	Assistance for spatial orientation like directory of available information, adaption of the menu, assistance to navigate for example overview map
Problems learning new skills regarding attended time, number of mistakes, number of repetition and so on	Reduce complexity of required skills and present suitable training material
Reduction of fine motor skills	Alternative input devices, large buttons, adaption of the menu structure

(M = 65.6, SD = 1.9). Age group II (AGII) consisted of 31 participants between 71 and 86 years (M = 75.1, SD = 3.3).

In terms of educational level 27.5 % of the subjects had certificate of secondary education, 35 % general certificate of secondary education, 7.5 % advanced technical college entrance qualification and 30 % final secondary-school examinations. Regarding their current working situation 85.2 % were pensioners while 14.8 % are still employed.

2.4 Development of Different Design Concepts

Based on the findings thus obtained, two different interface layouts were designed and mock-ups were implemented. Both mock-ups contain the essential features based on the results of the questionnaire. The main differences are the visual illustration of the structure (categories or applications with corresponding icons) and the implementation of individual functions as well as interaction concepts. Concept 1 is based on an interaction concept similar to tablet computers while concept 2 is based on interaction concepts of personal computers.

2.5 Evaluation of the Design Concepts

The evaluation was conducted in two steps. In a first step the systems were introduced to a possible user group during a senior event for analysing advantages and disadvantages of the two concepts. Afterwards the subjects rated the overall impression of the two concepts on a scale from 1 = excellent to 6 = insufficient.

In the second step a task-based evaluation inside a usability lab was executed. The subjects have to work with the application photo gallery (see Fig. 4). Therefore, typically tasks like searching and editing of photos have to be performed.

Test Subjects. In the first evaluation step 12 subjects (60 plus) filled in the questionnaire and rated the two layouts. In the second step nine subjects between 61 and 75 years of age (M = 69.8, SD = 4.83) took part in the usability study.

3 Results

3.1 Evaluation of Current Tablet Computers

Based on the thinking aloud method many usability problems (for this specific user group) appeared. Neither of the subjects had the ability to solve the tasks unassisted. Major functions were not found, buttons und functions misinterpreted and problems with the touch-sensitive screen appeared. In Fig. 2 (right) the main aspects are summarized. Overall four of the subjects preferred the android tablet because of its simple symbols and its layout, four subjects preferred the iOS systems because of its similarity to well-known systems and one subject preferred either of them.

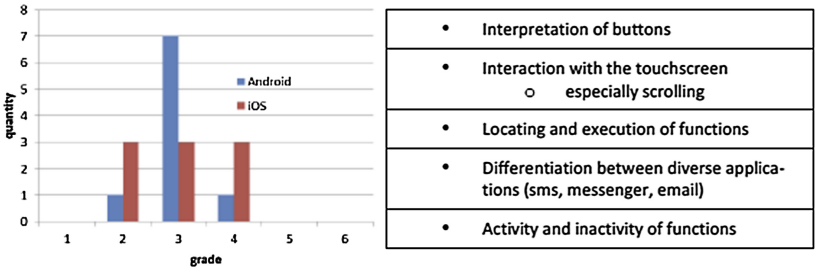


Fig. 2. Results of the evaluation, total score of the two system (left), usability problems (right) (Color figure online)

3.2 Questionnaire

Overall 54 subjects filled in the questionnaire. Focussing on the use of information and communication technologies especially the use of mobile technologies, 17 subjects use a smartphone while nine persons are daily users and seven subjects didn't even know it. Regarding tablet computers 11 subjects use it, six subjects are daily users and seven didn't know this technology.

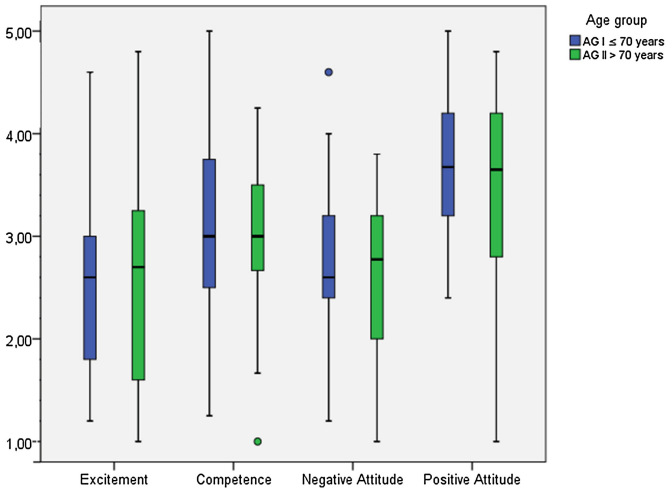


Fig. 3. TA subscales regarding age group (Color figure online)

Considering the technical affinity (TA, see Karrer et al. 2009) among the elderly, no significant correlation between age and TA could be found. Figure 3 visualised trends between age group and the TA subscales (excitement, competence, negative attitude and positive attitude).

Concerning the correlation between ICT use and technical affinity, significant positive correlations could be found between the use of smartphones and TA (r = .48). Interestingly there are no significant correlations between the use of a tablet computer and technical affinity.

Another important goal of the questionnaire was the investigation of suitable application areas for the development of an age-specific tablet computer. Therefore, on

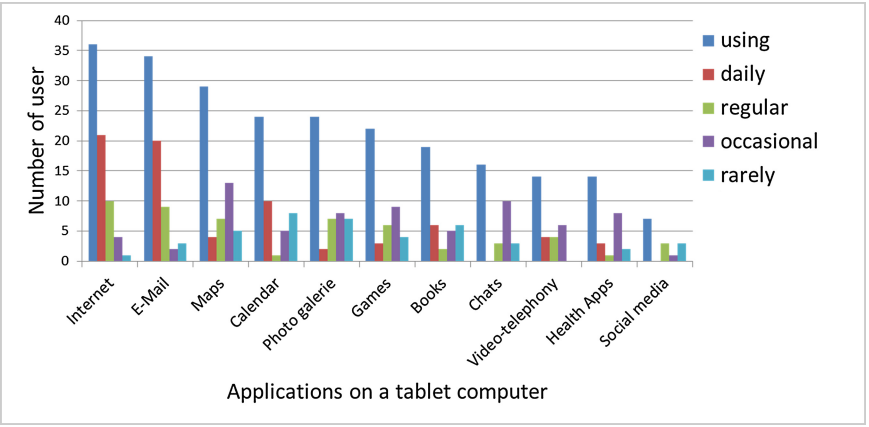


Fig. 4. Using frequency of common applications (Color figure online)

the one hand typical application areas for tablets as well as their frequency of use were analysed and on the other hand possible further application areas were determined. Figure 4 illustrated the number of subjects using the different applications (overall, daily, regular, occasional and rarely).

These results confirm general statistical data regarding application areas of elderly tablet users. In this regard 84 % of elderly users surf the web, 77 % watch videos or photos and 77 % write or read emails on a tablet computer (see BitKom 2015).

Looking for further possible applications the subjects are interested in music (57 %), gardening (44 %) as well as news (70 %).

3.3 Design Concepts

Based on the results of (1) the evaluation of current tablet computers and the corresponding usability problems, (2) the design guidelines (literature review) as well as (3) the results of the questionnaire two design concepts were developed. Therefore, the main areas of application (internet, communication and photo gallery) desired by the subjects, were implemented. In the following some main aspects of the two concepts are described. One aspect that is implemented similarly for both concepts is the possibility of adaption respective luminance and font size. The possibility of adaption of these dimensions is the first step when working with the tablet.

One aspect that differentiated between the two concepts is the interaction with the touch-sensitive display. In the first concept the user could thump though the data while in the second one they have to scroll (see Fig. 5).

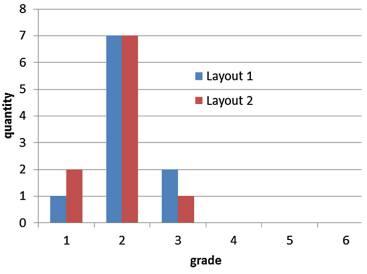
Fig. 5. Two different interaction concepts for navigation within the application "photo gallery", left: concept 1 (thumb through the photos) right: concept 2 (scroll through the photos)

One further problem mentioned by the subjects regarding current systems was the differentiation between diverse communication applications (see Fig. 2). Therefore, in concept 1 all communication approaches are combined in one application (see Fig. 6).

Fig. 6. Two different concepts for communication. Left: concept 1 integrated different communication applications, right: concept 2 based on a classical separated design

3.4 Evaluation of the Design Concepts

First the two concepts were evaluated by 12 subjects during a senior event. The overall evaluation of both concepts is described in Fig. 7. To this effect the two concepts were valuated approximately equal with a tendency for concept 2. If the subjects have to select one of the two concepts 50 % preferred concept 2 because of its clearly arranged design, whereas only 17 % preferred concept 1. Some positive and negative aspects as well as improvements mentioned by the subjects are summarized in Fig. 7.



negative		positive		improvements	
1	2	1	2	1	2
too many information	divergent to known concepts	simple interaction	more functionality than 1	function to print emails	function to take a photo should be renamed
less functionality	less functionality	appealing background	clearly arranged		
		browsing page by page	less useless information than 1		

Fig. 7. First evaluation results for both concepts (Color figure online).

The next evaluation step was a task-based usability study. Following first impressions of the subjects based on the differences between the both concepts are summarized:

- Scrolling is preferred compared to browsing page by page
- Stepwise presentation and zooming of photos is favoured
- Pop-up windows are desired instead of inconspicuous windows
- Navigation in full screen is preferred

4 Discussion

The distribution and the common use of mobile systems in the working environment as well as in the private sector, make safe handling of the systems necessary for users of every age in order to participate in nowadays social life. Within the scope of this study, design approaches for tablet computers are developed to facilitate the interaction for elderly users. Thereby the presented approach described just a starting point combining different methods as part of a user centered design process. In a next step the two concepts have to be overworked regarding the first impression and references of the subjects and have to be tested in an extensive usability study recording objective as well as subjective data. The overall goal should be the transformation of the results into general design guidelines for information and communication systems designed for elderly users.

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