Senior Drivers: Using the Benefits of Automated Driving for the Elderly

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Abstract

Since the commercial launch of vehicles, life expectancy in Western countries almost doubled, and this trend is expected to continue. By 2060, some 30% of the society will be elderly people (aged 65+). It is obvious that the elderly will become an important target group for manufacturers of automated driving systems and that vehicle designers will have to deal with their special needs and requirements. This is further underpinned by the fact that most purchaser of (premium) vehicles are over 50. In this work, we discuss relevant aspects of the target group 65+ in the context of (highly) automated driving and propose a research method to identify how future interfaces for automated vehicles should look like. By performing a user-centered design process composed of different methods (user studies in driving simulators, think-aloud, and UX-curves), we hypothesize that the requirements of elderly people can be assessed adequately. The final result of this project should be a better understanding of critical issues for senior driver-passengers in terms of UX, user acceptance, and trust in technology.

1 Introduction

Mobility is a valuable asset for the entire society. Two out of three German retirees use their car daily (Automobilwoche, 2016). However, with increasing age also discomfort and health restrictions come along. Impaired vision and hearing, together with reduced concentration ability, are main reasons why the elderly are at high risk for road safety. The broad availability of automated driving is thus highly relevant and useful for this age group. Due to the demographic change, the share of elderly people is increasing and the age distribution in society will be shifted. It is expected that in 2060, 33% of the German population will be aged 65+ (DESTATIS, 2015). This is the same time automated vehicles are predicted to be capable and comprehensively established on the market (Litman, 2017), even though vehicles with lower levels of automation (SAE level 3) may come to market earlier (SAE, 2014). Furthermore,

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elderly people often have more purchasing power and are already an important target group for vehicle manufacturers. Only 6.8% of todays over 65 years old people cannot afford an own vehicle (DESTATIS, 2015) and the average age of purchaser of new vehicles is above 52 years (Markenartikel Magazin, 2017). Based on the estimations of the demographic change, the importance of this market will be even higher than previously. Therefore, the special needs and requirements of the elderly have to be specifically considered when designing driving systems and interfaces for the future. In particular, issues like health-related problems, trust in the technology, user experience/usability, and general acceptance need to be investigated in detail. The problem is, that the current generation of seniors will not be the driver-passengers of the future, and the users of the future do not yet have empathic insights into requirements of elderly people. So how to design for a target group which is not yet available? With this work we want to assess how we can create user experiences for the elderly by applying a user-centered design process. As the development of automated vehicles already started, this topic is highly relevant for further investigation. We present existing studies to examine the acceptance of automated driving in general and critically review their capability for the aim of this research project. We further propose a method for investigating acceptance and special requirements of elderly people in the context of automated driving systems.

2 Related Work

The relevance of automated vehicles for elderly people was already addressed by several studies. (Fluhr, 2013) investigated their acceptance and trust in automated vehicles and concluded, that about half of the participants liked the concept. Looking on the acceptance of automated driving systems (ADS) from a driver or passenger perspective, (Wintersberger et al., 2016) could show with a driving simulator study that there are no differences concerning subjects affect and emotion. The study was, however, conducted with younger subjects (age range 20+) and therefore, results potentially not applicable for the senior generation. Another study from 2016 about automated vehicles in general shows that many people are concerned about security issues. (Schiller, 2016) reports that 90% of the subjects do not trust the technology and would like to still be able to intervene in ADS. In the same study, participants were asked about preferred side activities during automated driving. Answers show that 50% of the subjects would like to talk to other passengers in the car, or use Email, mobile phones and social media for communication. Back in 2014, already 57% of people over 65 years used a computer and 45% were using the Internet – an increase of about 8% since the 2010 numbers (DESTATIS, 2015). An up-to-date study of (Wendel, 2017) shows, that for 88% of today's elderly people it is already common to use digital technologies. Only 9% are afraid of the technology due to privacy problems. So if acceptance of digital technology arrived already for the older people,

the same can be expected for automated systems like ADS – especially when we consider that the younger generation of today will be the older generation of tomorrow. Applying a user-centered design process for developing automated driving systems which meet users' expectations and needs is challenging anyway. It is still hardly possible to evaluate concepts in a real settings as highly automated vehicles do not yet exist. Driving simulators and low-fidelity prototypes can help to get initial results. (Petterson & Karlsson, 2015) investigated subjects' interactions with imagined vehicles using chairs and the outline of a car painted on a parking space. Preferred activities were collected with interviews and probes. Subjects had the possibility to draw on the floor or re-arrange the chairs to generate a new interior design (lying on the floor was also possible). Such a methodology can help to get insights in early stages of the development process, but to do this in the same way with elderly people seems to be unrealistic. Decreased mobility and health problems would reduce the methodical abilities and so also the expressiveness of such a study. Contrary, doing the same with younger subjects while considering them as the elderly of tomorrow is hardly an option, as they do not know about the requirements, challenges, and needs of elderly people. (One approach could be use of age suits, such as the "age simulation suit GERT"[1].)

3 Research Questions

Existing studies that address elderly people's acceptance in automated driving systems show several challenges for applying user-centered design methods. Therefore, we postulate the following research questions:

- RQ 1 How is acceptance and trust in automated driving influenced by the age of potential users?
- RQ 2 How can user needs be investigated and requirements of elderly people be derived by applying a user-centered design approach?
- RQ 3 What are needs and requirements of tomorrow's elderly people?
- RQ 4 How can the resulting insights be utilized to create valuable vehicle interfaces for elderly people?

4 Methodology

To answers these research questions, we want to evaluate differences in elderly people's acceptance of and trust in ADS using a between-subjects design:

[1] http://www.age-simulation-suit.com/, Retrieved July 12 2017.

- Group 1: elderly people of today
- Group 2: elderly people of tomorrow
- Group 3: elderly people of tomorrow wearing an age simulation suit (GERT or similar) to experience the requirements of elderly people

4.1 Preliminary Considerations

Before actually executing this study, the following questions need to be answered:

- For which level(s) of automation do we want to design for?
- What means to be "old" in the context of investigation?

To identify needs and requirements of elderly people, we first have to decide which level of automation, described by the SAE, should be targeted by future vehicles interfaces (SAE, 2014). Each level of automation might have certain requirements – in semi-automated driving (level 3 and 4) requires users' attention as they are required to drive by themselves in some situations. Moreover monitoring tasks need concentration ability and proper vison. Based on the selected level of automation, a target group needs to be defined. Lower levels (level 2 and 3) are already, or will be, available in nearer future than higher levels (level 4 and 5) (Litman, 2017). Further, to decide which subjects (age range) should be invited for the study, it has to be defined what "old" means in this context. In 1975 in Britain the Friendly Societies Act defined old age as 50+, now there is no clear definition but the UN agrees with the general understanding from being old at any age after 60 (World Health Organization, 2017). So society is changing as well as people's mindsets and physical conditions due to potential improvements in health care. Golden agers of today are different to the generation 10 or 20 years before. Looking into the future, this development will keep going on, and the sample needs to be selected carefully.

4.2 User Study

After selecting the subjects for the test groups, the following user study will be conducted (discussed in the following in the context of semi-automated driving): as this level of automation is expected to be on the market in the next 10 to 20 years we will invite subjects in the age range 70-80 years for the group "elderly people of today (group 1)" and subjects in the age range of 50-60 years for the groups "tomorrows elderly people (group 2)" and "tomorrows elderly people, wearing an age simulation suite (group 3)". Subjects have to experience a drive with a driving simulator (moveable platform). The trip includes different stages: manual driving (1), handover (2), automated driving, handback (3), manual driving (4). While driving, think aloud is used in combination with semi-structured interviews to get insights into thoughts, problems and internal desires of subjects. By using psychophysiological measures, mental and physical effort will be investigated. After the experiment subjects will

mark their experiences on paper using a UX curve to identify critical points during the trip. We do not suggest further scales to keep subjects' effort minimal.

4.3 Analysis and Deviation of Design Opportunities

Analyzing the collected data from the user study might reveal important issues of elderly people. By comparing the groups we can see which challenges and opportunities elderly people have due to a general acceptance, as well as physical and cognitive limitations (caused by subjects' age). By creating an insight matrix (Table 1), observed challenges, opportunities, and insights can be derived for the different groups. Afterwards, established methods of design thinking and user-centered design can be used to develop such an interface.

		Group 1	**Group 2**	**Group 3**
Challenges	Acceptance			
	Physical Limitations			
Opportunities	Acceptance			
	Physical Limitations			

Table 1: Insight matrix to derive design opportunities

5 Conclusions & Future Work

As the presented methodology is not yet validated, we would like to discuss the concept with other researchers during the workshop. Furthermore, we want to learn from the experience of others, who are already familiar in working with, and designing for elderly people. In this position paper, we have discussed several arguments why elderly people are an important user group to be targeted by vehicle manufacturers in the context of (highly) automated driving. We have further proposed a research methodology allowing to evaluate the emerging requirements. By using a user-centered design approach, best practices and guidelines for designing in-vehicle interfaces for the respective target group can be derived.

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