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Workshop on User-Centered Design for Automated Driving Systems

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Abstract
Automated driving systems (ADS) are mainly regarded from an innovation and technology-centered perspective. In academia, as well as in industry, there is a concentration on technical issues to maintain competitiveness while aspects like acceptance, trust and user experience are widely under-researched. However, the "human factor" is critical for a comprehensive establishment of ADS technology on the market. We believe that there is a need to focus on a user-centered design (UCD) perspective to bring ADS innovation to a next level and to achieve a wide acceptance in society. In this workshop we want to discuss special requirements of UCD applied to ADS, to address challenges and opportunities and to reveal new research fields for future work.

Author Keywords
Automotive user interfaces; Automated driving systems; User-centered design.

CCS Concepts
•Human-centered computing → HCI design and evaluation methods; User centered design;

Motivation

All global players of the automotive industry (e.g. BMW, VW, JLR, Ford, Tesla etc.) are focusing on the development of automated driving systems (SAE J3016: ADS). Beside car manufacturers also technology companies like Google, Apple, Nvidia and Intel are working intensively to bring the technology to the market. The automated driving race to commercialization is funded on the premises that this technological breakthrough will bring universal mobility access, reduced traffic flow, lower emissions, and especially of increased safety. Tesla declared in July 2016 in their master plan the goal to build an autopilot system ten times safer than a human driver. This was publicized on their website only a few days after the first fatal accident of a partly automated Tesla car [4].

Accidents like the first fatal Tesla accident show that automated systems are not error-free and remind us of the volatility of users' individual acceptance and in general the impact that public acceptance has on technology-based products. Even though the accident happened due to sensor failures, it is not enough to regard the topic only from an innovation- and technology-centered perspective. By designing a better collaboration between the users and systems and making system actions visible for and understandable by the user, e.g., in take-over situations, such accidents should be prevented. Since the human is one of the most critical factors which can affect a comprehensive establishment of ADS, there is a need to focus more on the users.

ADS are a radical innovation, inspired by advances in new technology (e.g., advanced algorithms, cameras, sensors, etc.). To further increase the product quality, incremental innovation is necessary. This can be achieved by applying the User-Centered-Design (UCD) process. This established

Figure 1: How can the UCD adapted for automated driving system?

design process centers on the user by utilizing a problem-solving iterative framework: analysis, design, evaluation and implementation. Users are observed in the context to be able to create ideas and requirements, to develop prototypes, and especially to evaluate and test concepts with real users [5]. Norman and Verganti [6] compare this process with the way of hill climbing of a blindfolded person, scanning the environment till sensing the next higher position. The mountain peak is a metaphor for the ideal quality of a product.

As researchers, we face several challenges to the application of UCD to ADS. User assessment is hindered by restricted access to latest technology, by the cost of fully functional prototypes, and by the potential risk of real world evaluations. On the other side, low-fidelity environments such as driving simulators that can provide controlled set-

tings for testing ADS experiences might lack the required realism to break through existing misconceptions or mental models that users have. In addition, users cannot draw from existing experiences, since ADS technology is not yet available on the market. As interactions and responsibilities are transferred from users to systems, a wide-spread acceptance of the technology and optimal user experience can only be reached by fulfilling users' needs and values in their real life situations. Thus, user research, (instant) feedback and continuous evaluation are imperative. The application of special methods are essential to understand users and the context of automated vehicles.

There are several examples in the Human Computer Interaction (HCI) community in which automated driving is regarded from a user-centered perspective, especially focusing on factors, such as acceptance and user experience. Users' acceptance and affect while driving with an automated vehicle was analyzed by Wintersberger et al. [13] and Häuslschmid et al. [2] investigated how auto pilot visualizations can help to support trust in automation. Roedel et al. [9] investigated the effect of different levels of automation on user acceptance and experience, which are decreasing with higher automation. Kuderer et al. [3] mention the acceptance of the driving style of an automated vehicle as highly relevant for the overall user experience. Pfleging et al. [8] investigated the users' needs for non-driving-related tasks in automated cars. Furthermore, there exist several studies in which a user-centered approach is applied. Especially takeover systems for semi-automated vehicles are investigated and evaluated by conducting user studies [10, 11]. Petterson and Karlsson [7] explored expectations for future automotive technology. Furthermore there are already first approaches in which the UCD as possible way to create ethical decisions in moral dilemma situations is used, analyzed and discussed [1, 12]. However, a systematic contemplation of the UCD approaches for ADS in general is not yet existing. To inspire future work and to emphasize the need for a user-centered perspective on ADS we want to discuss this topic within a workshop with researchers and professionals of the HCI community.

Objectives for the Workshop

Potential topics to be discussed at the workshop include, but are not limited, to:

- What are special requirements for Automated Driving Systems (ADS) regarding UCD?
- What does User-Centered Design mean for ADS?
- Which aspects of ADS need to be evaluated (i.e., pragmatic & hedonic quality, user needs, emotions, others)?
- What are specific challenges of the different levels of ADS (according to SAE, NHTSA, BASt classification) on UCD? Are the existing definitions suited for actual users?
- Which existing evaluation approaches and methods are feasible?
- Is there a need to adapt exiting approaches and methods for ADS?
- How can existing approaches and methods be adapted for ADS?

Submission Process and Selection of Participants

Participants were invited to submit position papers of up to 4 pages in the CHI extended abstracts (EA) format. Beyond the authors of the accepted papers, we will, depending on capacity, allow additional participants with registration for the main conference to participate in the workshop.

Workshop Summary

The half-day workshop will feature short ignite talks of a few minutes each. Authors of position papers will present a brief summary of their paper/research while the rest of participants will get a chance to introduce themselves and their vision/approach on the topic of the workshop (potentially organized as Pecha Kucha). After that, attendees will create a brainstorming wall for the workshop topic. This 30-minute brainstorming will collect obstacles, ideas, challenges, etc. in the form of post-its aiming to present an overview of the state of knowledge regarding user-centered design and automated driving systems.

After the coffee break, participants will be split into groups and assigned a specific topic each (based on the result of the brainstorming wall). Each group will nominate a moderator and note-taker. The group will perform a dive into the current problems and is tasked with producing a solution (proposal). Groups will get a chance to present the result of the discussions to the rest of the attendees. Presentation and discussion of group work results will further foster the exchange between participants. In the closing panel, we will explore the chance of future collaborations & publications within this group of researchers in plenum.

Expected Outcome and Publication Plans

The aim of this workshop is to bring together automotive researchers with particular interest in the workshop topic. The expected outcome is a list of obstacles as well as potential solutions related to the problem of user-centered design in automated driving with focus on user interfaces and interaction. The organizers commit to provide a platform for future exchange of problems, ideas and results related to UCD in automated driving. This way, we should be able to create shared understanding of goals, challenges and potential ways to overcome them.

9:00 - 9:15	Opening and introduction
9:15 - 10:00	Paper summaries and participant intro (short ignite talks)
10:00 - 10:30	Brainstorming wall (exercise to loosen up everybody for the next session)
10:30 - 11:00	Coffee break
11:00 - 12:15	Group discussion (4 groups) - Topics to be defined based on results of brainstorming wall
12:15 - 12:45	Group result presentations
12:45 - 13:00	Recap and next steps

Table 1: Preliminary workshop schedule (half day, AM)

The workshop website will feature all accepted papers as well as outcomes of the workshop (posters of group sessions, summary of the discussions, etc.). In addition, it is planned to write a summary article. Depending on the number of submissions, we might propose a special issue at the Springer PUC, Elsevier PMC or Emerald IJPCC journal.

Organizers

Anna-Katharina Frison is an assistant researcher at Technische Hochschule Ingolstadt (THI) and doctoral candidate at Johannes Kepler University (JKU) Linz, Austria. She is researching user experience factors for automated driving systems (ADS) from a user-centered design perspective. She received her Master degree at the chair for Human-Machine Interaction at LMU Munich.

Bastian Pfleging is a postdoctoral researcher at the chair for Human-Machine Interaction at LMU Munich. His general research interests are multimodal and natural user interfaces. In particular, he explores novel human-computer interaction techniques in the automotive context, especially related to automated driving.

Andreas Riener is a professor for HMI and VR at Technische Hochschule Ingolstadt (THI), Germany with co-appointment at CARISSMA (Center of Automotive Research on Integrated Safety Systems and Measurement Area). His research interests include driving ergonomics, driver state estimation from physiological measures, human factors in driver-vehicle interfaces and trust/acceptance/ethics in automated driving.

Myounghoon "Philart" Jeon is Associate Professor of Cognitive Science and Computer Science at Michigan Tech. He directs the Center for Human-Centered Computing at Tech. His research on ADS includes auditory interaction, affect, and accessibility.

Ignacio Alvarez is Research Scientist at Intel Labs, USA. He obtained his PhD in Computer Science at University of the Basque Country, Spain. His background is in Human Computer Interaction. His research interest is on automated driving systems, intelligent transportation and the practical application of cognitive sciences to affective computing and ADAS.

Wendy Ju is the Executive Director of Interaction Design Research at the Center for Design Research at Stanford University, and Associate Professor at California College of the Arts in San Francisco. Her research focuses on the design of interactive devices, particularly human-robot interactions and autonomous vehicle interfaces.

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