Guest Editorial Preface

Special Issue on Recent Advances in Automotive User Interfaces and Interactive Vehicular Applications Research:
Part 1 - Novel Interaction Approaches

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In today's automobiles, digital interfaces and interactive services have become a decisive factor for safety, attractiveness and market penetration. Upcoming trends of shared mobility, personalization and autonomous driving are increasing the complexity of interface design even further. In order to sustainably shape the future of automotive user interfaces, substantial research efforts are needed that put the experience, performance and behavior of human drivers, passengers and other road users into the center of investigation.

Recent research has achieved considerable progress, and we are happy to present some of the most significant examples of this research in our special issue "Automotive User Interfaces and Interactive Vehicular Applications Research" of the International Journal on Mobile Human-Computer Interaction (IJMHCI). The nine papers selected for this purpose are separated in two parts: the present first part of the special issue features advances and reflections related to how automated vehicles can interact with drivers, passengers, and with other traffic participants directly, reaching from more expressive forms of visualization to novel modalities of multimodal feedback and social communication channels. The second part of this special issue, which will be appearing shortly, continues with contributions on more implicit interactions and attentive interfaces. This encompasses the management of pre-driving expectations as well as the provisioning of attentive system features that predict take-over requests, touch gestures, or recognize driver distraction.

The articles included in this special issue are derived from the best rated papers of the 10th Automotive User Interfaces and Interactive Vehicular Applications (AutomotiveUI '18), which took place in Toronto, Canada. Each year, this conference serves as the premier forum for academics and practitioners to present and discuss novel vehicle technologies through models and concepts for enhancing the driver experience, performance, and behavior. The topics covered in this conference include, but are not limited to, automated vehicles, driver information processing, display and control design, in-vehicle information systems, and vehicle-pedestrian interactions. From a total of 94 papers received for the main conference papers track, 35 submissions were accepted, which corresponds to an acceptance rate of 37%. The assessment of submissions was conducted by a committee of 44

experts who performed detailed reviews themselves and invited further external reviewers. The author teams with the highest-ranked AutomotiveUI '18 contributions, having received a committee rating score of 4 or higher (on a scale of 1 to 5), were invited to provide extended versions with additional original contributions. The papers were then shepherded by the special issue guest editors, with the help of further external reviewers.

The first two papers deal with the improvement of augmented reality (AR) technologies in the car – an area that is facing high interest from drivers and can ease the driving task. Lisle, Tanous, Kim, Gabbard and Bowman present an experiment that assessed the potential benefits of depth-perception cues in AR head-up displays in a driving simulator experiment. They found that using volumetric displays increased the accuracy and speed of depth perception, as compared to standard fixed focal-plane AR head-up displays. These results are encouraging, as volumetric displays may support drivers in correctly matching virtual and real objects and therefore facilitate a safe use of AR displays in cars.

Showing lead cars on AR head-up displays is presented as a promising way of providing navigational aid by Topliss, Pampel, Burnett, Skrypchuk and Hare. In two consecutive studies, they provide insights into how drivers use lead vehicles in navigational tasks, and examine how an AR implementation of a lead vehicle as a navigational aid performs. Their overall finding is that a real lead vehicle supports good navigational performance in complex situations, such as a roundabout, but that it is not sufficient alone and should be used in combination with other navigational aids to support driver orientation and knowledge of upcoming maneuvers. Furthermore, they found that a dynamic AR acting similarly to a real lead vehicle leads to good navigational performance but also has advantages in terms of confidence level and subjective workload, as compared to a static lead vehicle waiting for the driver.

While the above contributions are good examples for using visual aids to assist drivers, it is just as important to explore novel, non-visual interaction modalities which are less likely to be distracting and obtrusive. Di Campli, Brewster, Pollick, White, Skrypchuk and Mouzakitis investigated the suitability of thermal feedback during driving in a set of simulation studies. Participants received thermal feedback through temperature changes, indicating the direction of upcoming lane changes. The study results suggest that thermal feedback may be a promising notification method in non-urgent situations when vibration may be unnecessarily attention grabbing. An example for appropriate application would be when fuel is running low, or for foreseeable events, such as turning points in navigation scenarios. The authors propose several directions for further research aiming at improved recognizability of stimuli.

In-car interaction also involves communication with other traffic participants, and this can go as far as collaboration between cars, e.g. when driving together to an event or through an unknown area. Perterer, Meerwald, Stadler, Meschtscherjakov and Tscheligi present an in-situ study with co-driver pairs in two different vehicles and a set of collaboration tasks. Drawing on the rich qualitative results of their study, the authors provide suggestions for a user-centered augmentation of vehicle-to-vehicle (V2V) communication and locative mobile social network systems, in order to enable co-drivers to keep track of each other and to anticipate their upcoming decisions and activities. The results also inspire recommendations for dynamic car exterior design solutions such as a stronger differentiation through shape-changing technologies for better recognition among co-driving peers.

We conclude this first part of our special issue with an experimental investigation on how to visually communicate situation- and function-specific uncertainty of an automated vehicle as a way to maintain situation awareness of drivers and improve trust in the system. Kunze, Summerskill, Marshall and Filtness show that especially less experienced drivers can be supported by functionally detailed indications of uncertainty. Out of 11 investigated visual properties, hue- and animation-based variables appear to impose the lowest workload on drivers when monitoring such uncertainty displays. These findings should be of interest for automotive user interface designers as they are applicable to a wide array of driving functions. Nevertheless, future research on this question should also include

further modalities, as especially in phases with where the car is driving autonomously, and drivers cannot be expected to continuously monitor visual displays.

The papers in this special issue document the persistent strive of the automotive user interface research community towards exploring and critically reflecting on new opportunities for in-car interaction. The collection also shows the variety of empirical research methods that have been employed, ranging from experimental research in the driving simulator to novel machine learning approaches to road studies with qualitative contextual analysis. We can also see a clear trend towards investigations beyond pure safety and performance issues, towards more fine-grained analyses of acceptance, trust, attitudes and motivations. For future research, it is critical to leverage these advanced approaches even further in order to optimally support the development and improvement of the plethora of upcoming intelligent and automated technology in the driving context.

We would like to thank the Automotive UI 2018 conference committee members and reviewers for attracting, selecting and guiding the contributions that were the basis for this collection. Furthermore, we are grateful for the advice and support provided by the IGI Global team and chief editor Joanna Lumsden. We hope that the presented papers can provide inspirations for both further research and practice, and we encourage readers to also explore the second part of the special issue which focuses on attentive interfaces.

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