Emotion GaRage Vol. IV: Creating Empathic In-Vehicle Interfaces with Generative AIs for Automated Vehicle Contexts

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ABSTRACT

This workshop aims to design advanced empathic user interfaces for in-vehicle displays, particularly for high-level automated vehicles (SAE level 3 or higher). Incorporating model-based approaches for understanding human emotion regulation, it seeks to enhance the user-vehicle interaction. A unique aspect of this workshop is the integration of generative artificial intelligence (AI) tools in the design process. The workshop will explore generative AI's potential in crafting contextual responses and its impact on user experience and interface design. The agenda includes brainstorming on various driving scenarios, developing emotion-oriented intervention methods, and rapid prototyping with AI tools. The anticipated outcome includes practical prototypes of affective user interfaces and insights on the role of AI in designing human-machine interactions. Through this workshop, we hope to contribute to making automated driving more accessible and enjoyable.

CCS CONCEPTS

• **Human-centered computing → HCI theory, concepts and models**.

KEYWORDS

empathic vehicles; emotions; affective computing; interaction design; ChatGPT

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1 INTRODUCTION

The advent of automated vehicles (AVs) promises a future where road safety is significantly improved, and passengers can spend their travel time more leisurely and productively. Considering not only their navigational capabilities but also the nuances of interaction between occupants and vehicles is critical. An emotionally intelligent in-vehicle system can provide a more personalized [2] and reassuring user experience [1], contributing significantly to building trust [7, 12], a crucial factor in the widespread acceptance of automated vehicles. Therefore, the emotion-aware design of in-vehicle agents in AVs is not a luxury, but a necessity, because it is an important aspect that can substantially enhance user experience, safety, and trust in this new technology. Given the importance of empathic displays in automated vehicles, we organized three previous workshop iterations on this topic.

In the first iteration of the workshop, we studied emotion detection methods, gauged the difficulty of detecting emotions across different channels, identified key emotions and theorized on emotion changes during driving, and prototyped solutions for emotionally challenging road situations [3]. During the second iteration, we discussed the benefits of empathic vehicle displays with automotive experts. As vehicle automation advances and drivers become passengers, mobility becomes accessible to a broader audience. Hence, experts suggested that empathic display designers should go beyond just catering to the average user, but also consider age-specific

user needs, as younger and older users would encounter unique challenges. Furthermore, empathic displays could also benefit vulnerable users [9]. In the third iteration of the workshop, researchers and practitioners brainstormed empathic interface designs for vehicles with different levels of automation, created prototypes of empathic displays that can intervene with drivers' emotions, and discussed the design flow for their empathic displays considering different emotions, driving scenarios, and the potential impact on drivers' emotions [6, 8].

The rapid development of Artificial Intelligence (AI) has precipitated a paradigm shift across multiple sectors, catalyzing transformative changes in the ways people interact with technology. One such promising avenue is generative AI for in-vehicle agent interaction design. Our proposed workshop will investigate the possibilities and implications of large language model incorporation within human-vehicle interaction. The workshop will facilitate an in-depth discourse on AI's contextual responses, the distinction between AI-generated and human-crafted responses, and the consequent impact on user experience and interface design. By shedding light on this significant yet underexplored aspect of user-vehicle interaction design, we hope to contribute to the ongoing efforts toward making automated driving more enjoyable and widely accepted.

2 GOAL

The overarching goal of this workshop is to facilitate the design and development of an advanced affective in-vehicle user interface. By bringing together experts from academia and industry, we intend to collaborate and generate ideas on intervention methods to achieve this goal. Central to this initiative is incorporating of emotion dimensions and model-based approaches such as sensory [11] and cognitive level emotion regulation methods [5]. These approaches are pivotal in fostering a nuanced understanding of human emotions and promoting more effective interaction between the user and the automotive displays. Moreover, our workshop will delve into the situation where the vehicle is primary responsible for driving; we will specifically focus on automated vehicles of SAE level 3 or higher [4]. This focus will allow us to explore and develop interfaces compatible with highly automated vehicles, which provide a different driving experience than traditional manual driving. Therefore, research on interaction design that reflects the characteristics of automated driving is considered crucial. Finally, we aim to add a unique dimension to this workshop by incorporating generative artificial intelligence (AI) tools, such as ChatGPT [10], into our rapid prototyping process. By integrating AI as one of the participants, we will see the potential of utilizing AI in designing interactions between user and system. Our goal is to facilitate an innovative, collaborative space wherein we can make meaningful strides in affective user interface design for the automotive industry, ultimately enhancing human-machine interaction.

3 TOPICS

This workshop aims to create affective user interfaces designed for high-level automated vehicles. By merging the expertise of academia and industry, we will engage in a collaborative session to brainstorm driving scenarios that may arise in highly automated driving environments and discuss the emotions drivers may experience in those situations. Based on this discussion, we will develop intervention methods using model-based approaches and AI tools. Participants will have the opportunity to craft storyboards and engage in rapid prototyping of practical user interfaces, aligning this workshop with the scope of the conference.

4 OUTCOME

The anticipated outcomes of this workshop will be as follows:

- Generate ideas for in-vehicle situations and respective emotional responses of drivers or passengers in highly automated vehicles.
- Develop empathic intervention methods using model-based (e.g., sensory or cognitive) approaches to enhance drivers' driving experience.
- Create practical prototypes of empathic user interfaces to provide participants with a tangible understanding of the design process and potential solutions.
- Facilitate discussions and foster hands-on experience with potential usefulness of the integration of generative AI tools for designing human-machine interaction.

A catalog of these points and the results of the rapid prototyping activity will be compiled. Based on a qualitative analysis of insights gained from the workshop session, a report will be prepared and presented at the upcoming AutoUI conference.

5 SCHEDULE

This half-day workshop will bring together experts from academia and industry in the fields of automotive user interfaces, interactive design, artificial intelligence, and human factors. The workshop will consist of the following sessions:

- Introduction (20 min): We will briefly introduce the organizers of this workshop and provide a summary of what has been done during the previous three iterations. Then, the participants will be introduced to what they will do in this workshop and the distinctions from the previous iterations.
- Icebreaking (15 min): Participants will be asked to form small groups of 4 - 5 people. They will then engage in an "Emotion Charades" activity to break the ice and get to know each other.
- Decision for Scenario (1 hour): Participants in each group will discuss and decide on which level of automated vehicle, ranging from AV levels 3 to 5, they want to focus on. They will also discuss the potential use cases that can arise from the chosen level of automated driving and, based on this, decide emotions that are relevant to the situation.
- Coffee break (15 min)
- Tutorial (10 min): Organizers will give a short tutorial for using generative AI tools such as ChatGPT before starting the rapid prototyping. They will also give an introduction to emotion models and model-based common emotion regulation and intervention methods.
- Prototyping (1 hour): Based on the selected level of AV and the derived use cases and emotions, participants will rapid prototype empathic user interfaces. During this activity, participants will be welcomed to use any other type of AI tools

such as ChatGPT, DALL·E 2, and BERT as one of their group members or prototyping tools.
- Presentation and discussion (50 min): Each group will present their prototyping results to the other participants. We will share our experiences using generative AI tools and discuss insights and implications.
- Closing (10 min): We will close the workshop by discussing the lessons and the possible collaboration opportunities, including future workshops or journal special issues.

6 PRESENTER BIOGRAPHIES

Mungyeong Choe is a Ph.D. student majoring in the Grado Department of Industrial and Systems Engineering with a concentration in human factors at Virginia Tech. She is studying in the Mind Music Machine Lab (tri-M lab). Her research focuses on the effects of empathic in-vehicle agents in driving contexts.

Esther Bosch is a Human Factors researcher at the German Aerospace Center (DLR) with a background in Neuroscience. She is especially interested in modeling traveler experience by using multimodal data including context data and has worked in several projects regarding this topic.

Jiayuan Dong participated as a Ph.D. student majoring in Industrial and Systems Engineering with a concentration in human factors at Virginia Tech. Her research projects focus on emotions and trust in human-robot interaction (HRI) and human-computer interaction (HCI). She has various experiences with different types of social robots, especially using them as intelligent agents in automated driving and other dynamic environments.

Ignacio Alvarez is Principal Engineer at Intel Labs, USA. He obtained his PhD in Computer Science at University of the Basque Country, Spain, and Clemson University, USA. in the application of Human Computer Interaction to Automotive Engineering. His research interest is on automated driving systems, intelligent transportation and the practical application of cognitive sciences to affective computing and ADAS. He has been serving in several roles as a steering committee member of the AutoUI community.

Michael Oehl is head of the research group Human-Machine Interaction (HMI) at the German Aerospace Center (DLR), Institute of Transportation Systems in Braunschweig and Berlin, Germany. The research group is devoted to user-centered human-machine interaction and interface design in future transportation systems. Additionally, Michael is adjunct senior lecturer for Traffic Psychology at the German Police University. Michael has a strong background in Human Factors as well as Engineering and Traffic Psychology.

Christophe Jallais is a Research Director at Universite Gustave Eiffel (former IFSTTAR) in Lyon (France) at LESCOT (Laboratory of Ergonomics and Cognitive Sciences for Transport). His research interests concern principally with the role of degraded attentional states (emotions, cognitive distraction) on decision-making processes, driving performance, risk-taking and the use of automation. With a neuro-ergonomics approach, he also develops research on degraded attentional state identification and monitoring.

Areen Alsaid is an Assistant Professor in the Industrial and Manufacturing Systems Engineering Department, and the Director of the Safe, Empathetic & Trustworthy technology (SET) Lab at the University of Michigan-Dearborn. Her research program focuses on drivers' cognitive and affective state estimation through physical manifestations and contextual information, to smooth the interaction between humans and automation.

Chihab Nadri is a Ph.D. candidate in Industrial and Systems Engineering with a specialization in human factors and auditory display design. His research interests focus on the design of novel interfaces and displays using user-centered design, empathic interfaces, and sonification in surface transportation, automated systems, and human-machine interaction settings.

Myounghoon "Philart" Jeon is an Associate Professor in the Grado Department of Industrial and Systems Engineering and the Department of Computer Science (by courtesy) at Virginia Tech. His Mind Music Machine Lab focuses on emotion and sound research in the context of automotive user experiences, assistive robotics, and arts in extended reality. He edited books, "Emotions and Affect in Human Factors and Human-Computer Interaction" and "User experience design in the era of automated driving". He hosted AutoUI 2022 as a General co-Chair and has been serving as a steering committee member of the AutoUI community.

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