Workshop on Prosocial Behavior in Future Mixed Traffic

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ABSTRACT

"Prosocial Behavior" means cooperating and acting in a way to benefit others. Since more and more diverse road users (such as electronic bicycles, scooters, etc.) but also vehicles at different levels of automation are sharing the safety-critical road environment, acting prosocial will become increasingly important in the future for both human and automated traffic participants. A few papers so far have already begun to address this issue, but currently, there exist no systematic methodological approaches to research this area. In the proposed workshop, we plan to define more specifically what characterizes prosocial behavior in future traffic scenarios where automated and manual vehicles meet and interact with all kinds of vulnerable road users. We further want to identify important scenarios and discuss potential evaluation methods for researching prosocial behavior. Ultimately, these findings will be integrated into a research agenda actively pursued by cooperation initiated during this event.

CCS CONCEPTS

• **Human-centered computing** → **Social engineering (social sciences)**; **Participatory design**.

KEYWORDS

prosocial behavior, vulnerable road users, automated vehicles

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1 INTRODUCTION

Even though traffic is a highly regulated environment, many situations require informal coordination in order to resolve conflicts where formal rules are insufficient. This, for example, can include non-compulsory means (signals, horns, etc.) but also anticipatory action, facial expressions, eye contact, or body movements [12]. Acting prosocial in such situations benefits all the traffic participants and may help in resolving the possible conflicts in a good time and manner.

In a broad sense, prosocial behavior is defined as *"actions that benefit others"* [29] and, consequently, it comes into play in everyday traffic situations. Prosocial behavior in traffic scenarios requires acting by taking the well-being of other traffic participants into account and promoting effective cooperation with others such as drivers, passengers, pedestrians, and cyclists [14]. Acting prosocially in traffic benefits all traffic participants in positive ways, and it helps to resolve traffic conflicts easily and effectively (especially in non-rule-based traffic situations). This happens, for example, when searching for parking lots or letting pedestrians etc. cross the road, when merging lanes effectively, and in many other situations.

In the future, prosocial behavior will become even more relevant as both the types (i.e., new forms of micro-mobility like e-scooters, e-bikes, hoverboards, etc.) but also the numbers of traffic participants (especially so-called "vulnerable road users", see below) steadily increase. Consequently, there is a need to support prosocial behavior both at the individual and societal level, with the goal to foster cooperation but also safety. Still, fostering prosocial behavior is not necessarily straightforward. First, it must be made clearer what defines prosocial behavior in traffic and what the key features are (i.e., which maneuvers, behaviors can be considered as prosocial?). Second, methodological approaches (for example, scenarios and

assessment methods operationalizing the concept) need to be developed. Third, the behavioral expectations of automated vehicles (AVs), especially in the context of prosocial behavior, are yet to be discovered.

In the proposed workshop, we want to address these issues. Our goal is the formulation of a research agenda to guide future directions at this important intersection of mobility, social sustainability, prosocial behavior, and automated driving.

1.1 Vulnerable Road Users

Vulnerable road users (VRUs) are often described as pedestrians, cyclists, and motorcyclists, for example by the World Health Organization [28]. Other definitions highlight their vulnerability as they do not have a protective outside shield [34]. Recently, Holländer et al. [15] defined this target group with regards to the needs in Human-Computer Interaction more granularly. They first distinguish between motorized (motorcyclist, personal conveyance) and non-motorized (pedestrian, personal conveyance, cyclist) VRUs. Every class can contain the attribute "especially vulnerable". This can be due to age or disability [15]. Alternatively, previous work tried to assist vulnerable road users by augmenting bicycles [22], helmets [24, 32], and surrounding environments [23, 25] or by measuring their perceived safety using head movements [26]. However, the communication between AVs and VRUs remains unexplored, and is important to explore this design space even further.

1.2 Automated Vehicles

The On-Road Automated Driving Committee of SAE and the ISO workgroup on Intelligent transportation Systems define an automated vehicle as a (motor) vehicle system that is capable of executing a part or all of the dynamic driving task on a sustained basis [27]. With the provision of advanced automation systems converging to full automation (SAE Level 5), the role of the human driver becomes increasingly irrelevant. In a highly- or fully-automated vehicle, the vehicle's occupant can no longer assume responsibility for the driving behavior or the intention of the vehicle. As a result, common human-centric interaction protocols such as attempting to look inside the vehicle for confirmation of the driver's situational awareness are moot [13, 17]. This leads to a communication gap, especially in situations where the vehicle's driving behavior in the traffic context is not enough to disambiguate the intention of the vehicle.

Research on the interaction between AVs and other road users have proposed external Human-Machine Interfaces (eHMIs) as a viable solution in addressing this communication gap, and evaluations of eHMIs have shown promise in mitigating ambiguity [7, 10], increasing trust [16], enhancing perceived safety [11], and improving the user experience [9]. Anticipating surrounding traffic behavior, adapting to environmental factors, and operating in a social context is critical. Therefore, beyond just the functional eHMI, it is important the aspect of pro-social behavior is considered in the design of eHMIs from the earliest stage.

2 GOAL AND TOPICS OF THE WORKSHOP

Given the considerations above, it becomes clear that most research on interactions between AVs and VRUs has focused on pragmatic aspects like safety, trust, or UX, in limited settings (mostly from the perspective of pedestrians). As so far, only a few works (such as [30, 33]) have been focusing on prosocial behavior, and we want to address this emerging issue in the proposed workshop. In particular, we aim at:

- providing an interdisciplinary forum for designers, practitioners, and researchers in HCI to discuss interaction concepts to enhance prosocial traffic behavior.
- discussing state-of-the-art research on prosocial traffic behavior [14, 30, 33], and how this can influence everyday life and interactions in future vehicles.
- discussing individual (positive) experiences of prosocial behavior and how these examples can be integrated in the design of automated vehicles.
- exploring new interaction paradigms that support prosocial traffic behavior.
- formulating a research agenda to develop initiatives in research and practice to exchange ideas in overlapping areas of automated driving, mobility, prosocial behavior, and social sustainability.

To initiate and guide the discussion, we propose a (non-exhaustive) list of potentially interesting research questions (to be extended during the workshop):

- What are the key features of prosocial behavior in traffic?
- Which scenarios and measurements can be applied for operationalizing prosocial behavior in traffic?
- What assumptions, beliefs, and values do people hold about Automated Vehicles?
- What type of prosocial behavior is expected from Automated Vehicles?

3 EXPECTED OUTCOMES

By bringing together researchers and designers who intend to work at the intersection of prosocial behavior and automated vehicle technologies, we aim at getting a detailed overview of recent challenges important in interactions between vulnerable road users, automated vehicles, and/or manually driven cars, and potential ways to overcome them. Based on such insights, we want to extend the problem space of cooperating in dynamic traffic environments and embed prosocial behavior as a key issue. Participants are expected to discuss, share, and take away beneficial insights/strategies, as well as novel research ideas and a network of potential collaborators. We further aim to touch upon the effect of individual and cultural differences on prosocial behavior.

We will set up a workshop website at https://www.prosocialws.uni-oldenburg.de, which will feature videos and overviews of the discussions. Further, depending on the success of the workshop, it is planned to compile a survey paper about the "Grand Challenges", issues, approaches, etc. discussed at the workshop to communicate the state-of-the-art in prosocial interaction between VRUs and automated vehicles to the community (ACM Computing Surveys).

4 WORKSHOP ORGANISATION AND SCHEDULE

Our main target group are researchers and practitioners working on automated vehicles, e.g., with a focus on external human-machine interfaces. We will promote this workshop using a dedicated website and reach out to the community via social media channels (e.g., Twitter, Facebook, or LinkedIn), mailing lists (e.g., GI, or ACM SIGCHI), and at the AutomotiveUI'21 conference. We plan to organize the sessions in the morning or afternoon time in Central Europe. This will allow participants from other parts of the world to join our workshop at reasonable times.

Following suggestions for virtual workshops [1], we plan to keep our participants engaged in the workshop by limiting the time of exhausting synchronous video-meetings below 90 minutes while preferring interactive formats, such as discussions in break-out groups. In addition to Zoom, we will make participants actively use Miro boards during the workshop activities to give ideas, feedback or answers. The schedule is presented below:

Day 1

- Opening and participants introduction (30 min)
- Interactive session 1 (50 min)
- Discussion (10 min)

Day 2

- Recap (10 min)
- Interactive session 2 (60 min)
- General discussion on future directions (20 min)

In the first session, we introduce the topic and use break-out groups to explore expectations with regard to prosocial behavior in current traffic situations. Between the two sessions, workshop participants will be asked to continue thinking about the topic add some some answers on questions like "What does automated driving mean to you?" asynchronously. The second session focuses on the expected prosocial behavior of automated vehicles. We will discuss this topic in break-out groups that focus on different traffic participants.

5 BIOGRAPHIES

Hatice Şahin (corresponding author) is a doctoral candidate at Carl von Ossietzky University of Oldenburg, in the Media Informatics and Multimedia Systems Group. Her research focuses on the interaction between VRUs and AVs and prosocial behaviour in traffic.

Heiko Müller is a postdoctoral researcher at Carl von Ossietzky University of Oldenburg, in the Media Informatics and Multimedia Systems Group. His research interest lies in the future of transportation.

Shadan Sadeghian is a postdoctoral researcher at the University of Siegen in Germany. Her research focuses on designing multimodal user interfaces in automated vehicles and socially and environmentally sustainable mobility [30, 31].

Mark Colley is a PhD candidate at the University of Ulm, Germany. His research looks into communication possibilities between AVs and VRUs such as pedestrians and cyclists [4–6] and human factors of automated driving [2, 3].

Debargha Dey is a postdoctoral researcher at Eindhoven University of Technology, Netherlands. He has a background in Human-Computer Interaction and his research interest lies in automotive human factors. His research focuses on human behavior in traffic and Human-Machine Interfaces for automated driving.

Andrii Matviienko is a postdoctoral researcher in Telecooperation Lab at Technical University of Darmstadt, Germany. His research focuses on the assisting technology in urban environments using mixed reality and multimodal interfaces.

Andreas Löcken is a postdoctoral researcher in the HCI group at the Technische Hochschule Ingolstadt (THI). His research focuses on Ambient Displays for Human-Computer Interaction in general, and specifically the interaction between AVs and VRUs (e.g., [8, 19, 21]) or passengers (e.g., [18, 20, 36]).

Azra Habibovic is senior researcher at the independent and nonprofit organization RISE Research Institutes of Sweden and research area director for road-user behavior at the research center SAFER. Her research focuses on improving traffic safety and user experience by means of automation and connectivity. A special interest is design and evaluation of interactions in and around automated vehicles, including interactions with vulnerable road users.

Philipp Wintersberger is a researcher at TU Wien. His publications focus on trust in automation [35], attentive user interfaces [37], transparency of driving algorithms, as well as UX/acceptance of automated vehicles. Currently, he serves as Technical Program Chair for AutomotiveUI'21.

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