Augmented Reality For AV-VRU Interactions

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AUGMENTED REALITY FOR AV-VRU INTERACTIONS

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This project aims to explore whether augmented reality (AR) technology is suitable for communication between automated/autonomous vehicles (AVs) and vulnerable road users (VRUs). The issues of preferred design, interpretability, comparison to current communication strategies, and trust are or will be explored.

INTERVIEW STUDY

An interview study with 16 Human Factors researchers was conducted to better understand the future of AVs, AV-VRU interaction, and the potential of using AR for communication.

The researchers agreed or stated that:

- Fully autonomous vehicles will not be introduced in the near future.
- Implicit communication will remain dominant.
- Commended AR for its potential in assisting VRUs, but given the technological challenges, its use, for the time being, seems limited to scientific experiments.
- Highlighted various challenges which AR faces, such as privacy, invasiveness, user-friendliness, technological feasibility (eg., brightness, image stability) and inclusiveness (access to the technology).
- Most agreed that: AR could prove useful for resolving the one-to-many problem that occurs in eHMIs, or for resolving language barriers by providing person-specific feedback.
- Some of the researchers believe that AR should be a secondary cue to implicit communication and other communication methodologies (eg. eHMIs) in the real layer because not everyone can be expected to wear an AR device.

Following this study, the next stage was to analyze the outcomes of the paper, including various interface ideas proposed by the researchers, and develop AR prototypes.

DESIGN STUDY

In this study, 9 AR concepts for pedestrian-AV interaction were designed, implemented, and demonstrated in a real crossing environment. Despite certain limitations of the current technology, the study offers an indication of how future AR systems may support future pedestrian-AV interactions.

Process:

- Extracted 7 quotes from *Tabone et al., 2021*, in which experts proposed pedestrian-AV interaction concepts using AR.
- Literature was collected to serve as a theoretical foundation for the subsequent design phase. Supporting theories and related concepts were identified.
- Brainstorming design sessions were conducted between the authors using MIRO. Scenario with vehicle approaching from the right was envisaged for all concepts. Two states created for each concept (ie. ‘vehicle is yielding’, ‘vehicle is not yielding’). Followed by low-fidelity paper sketch and heuristic evaluation.
- Implemented on an iPad Pro 2020 with LiDAR using Unity MARS. Concepts were demoed on an unmarked crossing in Malta with the additional use of a Toyota Yaris Hybrid vehicle.

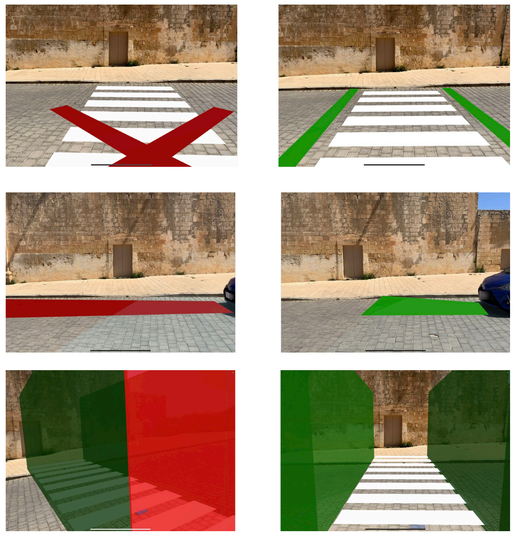

Fig.1: Examples of various pedestrian-AV interaction AR concepts. The non-yielding state is shown on the left, whilst the corresponding yielding state is demonstrated on the right. Click on the figure for demo video.

Despite various workarounds due to the nascent status of the technology, future improvements could be accomplished through computer vision methods and IoT communication. In the future, automated vehicles could transmit their yielding intent, position, and speed wirelessly to the VRU.

FUTURE OUTLOOK

The next phase of my research will involve filtering out designs through user testing, and exploring trust through simulations, and real-world scenarios.

LATEST RESEARCH OUTPUT

Wilbert Tabone, Joost De Winter, Claudia Ackermann, Jonas Bärgman, Martin Baumann, Shuchisnigdha Deb, Colleen Emmenegger, Azra Habibovic, Marjan Hagenzieker, Peter A. Hancock, Riender Happee, Josef Krems, John D. Lee, Marieke Martens, Natasha Merat, Don Norman, Thomas B. Sheridan, and Neville A. Stanton. (2021). Vulnerable road users and the coming wave of automated vehicles: Expert perspectives. Transportation Research Interdisciplinary Perspectives, 9, (Mar. 2021), 100293. DOI: https://doi.org/10.1016/j.trip.2020.100293

Wilbert Tabone, Yee Mun Lee, Natasha Merat, Riender Happee, and Joost de Winter. 2021. Towards future pedestrian-vehicle interactions: Introducing theoretically-supported AR prototypes. In 13th International Conference on Automotive User Interfaces and Interactive Vehicular Applications (AutomotiveUI ’21), September 09–14, 2021, Leeds, United Kingdom. ACM, New York, NY, USA, 10 pages. DOI: https://doi.org/10.1145/3409118.3475149

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