Workshop on Evaluating Augmented Reality in Transportation (EvalAR): A Dialogue Between Researchers and Practitioners

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ABSTRACT

The Workshop on Evaluating Augmented Reality in Transportation (EvalAR) brings together researchers and practitioners to address the challenges of evaluating augmented reality head-up displays (AR HUDs) with safety as a priority. With a collaborative approach, this workshop endeavors to shine a spotlight on the unique features of augmented reality, critically examine existing evaluation practices, and collectively identify future hurdles and actionable solutions. Our overarching goal is to collaboratively establish a strategic roadmap that addresses these challenges over the next 3-5 years and beyond. A key highlight of EvalAR is the introduction of the United Nations Economic Commission for Europe (UNECE) and its Working Party on General Safety Provisions to the AutoUI community. This introduction fosters invaluable collaboration and knowledge exchange, enabling researchers and practitioners to leverage each other's expertise. By facilitating discussions on knowledge and evidence provision, our workshop aims to bolster the academic community's contributions to regulatory improvements transportation safety. Furthermore, EvalAR actively explores avenues for alignment with global regulations and industry standards, creating a fertile ground for potential collaborations, funding opportunities, and transformative advancements in augmented reality research for enhanced transportation safety.

CCS CONCEPTS

• **Human-centered computing**; • **Human computer interaction (HCI)**; • **HCI design and evaluation methods**;

KEYWORDS

Head-up Display, Augmented Reality, Safety

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1 INTRODUCTION

In the very near future, we expect increasingly large Augmented Reality Head-up Display (AR HUD) field-of-views, affording placement of information in many locations; from windshield-fixed positions to conformal graphics that seem to be attached to real-world referents. In the same timeframe, we will see early-generation automated driving systems where drivers must still attend to both the road scene and system information (likely provided via AR HUDs), that might create the perfect storm for potentially dangerous and distracting AR interfaces.

While next-generation AR HUDs hold the promise to provide a fundamentally new driving experience**, we currently do not know how to effectively evaluate user interfaces in this space.** Extant methods for evaluating the effectiveness of computer-based user interfaces are arguably not rich enough to capture the total effects of AR HUD interfaces on human performance, in part because they presume a visual field where there is visual separation between the primary (driving) and secondary (AR HUD) task demands. Without new methods, researchers and practitioners are left to base user interface design and assessment on current understanding of traditional in-vehicle information systems. Thus, as we start fielding, and designing for new AR HUD displays, we must also develop our understanding of AR HUD effects on driver distraction. In a design space that affords fundamentally different user experiences, we must pose the question: *"When AR HUD user interfaces are visually integrated into the primary task space, what are the most effective methods to evaluate their impact on driver performance, ensuring the safety of this technology?"*

The conversation surrounding the development of new AR HUD evaluation guidelines, standards and requirements is both timely and crucial, given the current trends in the automobile industry. Manufacturers are progressively deploying AR HUD technologies, spurred by marketing teams advocating for increasingly advanced AR HUD user interfaces.

Fortunately, we are presented with a unique opportunity to positively influence the manner in which AR HUDs are evaluated during their early design development phase. With swift and decisive

action, we can create and circulate modern assessment methods tailored specifically for AR HUD interfaces, with the primary objective of minimizing distraction. If we neglect to expedite this process, it could lead to the emergence of distracting AR HUD designs, which might result in property damage, loss of life, and the introduction of reactionary transportation policies (as was seen with cell phone use in automobiles). Therefore, it is imperative that we proactively address these issues to ensure that the evolution of AR HUD designs is both safe and efficient.

2 WORKSHOP GOALS

Both in the realms of research and application, numerous challenges persist in the application of appropriate methodologies to assess the comprehensive impact of AR HUDs on distraction, and thus safety. Academic researchers acknowledge the inherent attributes and characteristics of AR that could potentially affect its safe incorporation in vehicles. However, translating these academic findings into practical applications is a nuanced and complex task. Simultaneously, industry practitioners, despite actively developing and deploying AR HMI in vehicles, continue to grapple with the same design and evaluation hurdles to ensure safe AR interfaces. Consequently, there is a compelling need for researchers and practitioners to collaborate, fostering a deeper understanding of the best practices and challenges involved in designing and assessing AR HUD interfaces with safety as the priority.

Therefore, this workshop represents a crucial step where researchers and practitioners can openly share their insights, experiences, best practices, and obstacles encountered during the design & evaluation process of AR HUD interfaces. We are excited to introduce to the AutoUI community and engage in this workshop's discourse, a group of practitioners from the United Nations Working Party on General Safety Provisions (GRSG), on the topic Field of Vision Assistant. This group is part of the UNECE World Forum for Harmonization of Vehicle Regulations (WP.29) which is dedicated to technical regulations applied to the broad automotive sector, addressing the safety and environmental performance of wheeled vehicles, their subsystems, and parts.

This group's objectives align closely with ours, focusing on tackling issues that ensure safe vehicle operation when utilizing diverse technologies, including AR HUDs. By fostering an open dialogue between practitioners and researchers on how we should evaluate HUDs to ensure safety, **we aim to create a strategic roadmap to navigate these challenges effectively**. This inclusive and collaborative approach is our strategy to promote safer and more effective AR HUD designs in the future.

In short, this workshop strives to achieve three primary objectives: **(1)** Highlight the distinctive features of augmented reality, emphasize the significance of human factors in assessing AR safety from a research standpoint, and advocate for innovative evaluation metrics; **(2)** Examine current practices in evaluating AR effectiveness, and identify challenges from a practitioner standpoint; and; **(3)** Engage researchers and practitioners invested in this domain to collaboratively identify a series of evaluation challenges for the next 3-5 years and beyond, and establish a strategic roadmap to address these challenges.

2.1 Expected Outcomes

In addition to the workshop objectives, the following outcomes are also expected:

- **Enhancing Academia's Contribution to Regulatory Improvements**: The workshop will facilitate discussions on how academia can effectively provide knowledge and evidence to the UNECE, thereby contributing to the improvement of regulations.
- **Alignment with Global Regulations and Industry**: The workshop will explore opportunities for aligning academia with global regulations in order to better understand the key goals and directions of research. This alignment may lead to new collaborations and funding opportunities, fostering advancements in the field of augmented reality and its compliance with regulatory frameworks.
- **Identification of Additional Areas for Alignment**: The workshop will investigate other areas in which a community like AutoUI can align with global regulations and industry within the UNECE. By identifying these areas, the workshop aims to broaden its scope and facilitate collaboration on diverse topics related to augmented reality and human-computer interaction.

3 ORGANIZATION

3.1 Pre-Workshop

- **Formation of Program Committee:** We will create a committee of five distinguished experts in AR to enhance the workshop's effectiveness and quality. The committee members will be chosen from the organizers' extensive network, ensuring diverse representation from academia, industry, and government sectors. They will play a vital role in expanding the workshop's reach, reviewing reflection statements, and attending the workshop when possible. We aim to establish a geographically diverse committee and promote inclusivity by considering factors like gender and age in selecting members.
- **Workshop Publicity and Outreach:** To maximize the visibility and reach of our workshop, we will establish a dedicated website developed and maintained by the workshop organizers. We will leverage the CHI/UBICOMP mailing lists, the Driving Assessment mailing list, the AutomotiveUI social media channels, among others, to distribute our call for participation.
- **Submission and Review of Reflection Statements:** We will invite individuals keen on participating in the workshop to submit succinct reflection statements that align with one or more of our proposed workshop objectives. Researchers are particularly encouraged to provide statements pertaining to the first workshop objective, while practitioners are urged to focus on the second. This approach will foster early engagement with the workshop and help us curate a diverse mix of participants, enriched by varied backgrounds, affiliations, and perspectives on the topic. The organizing team, along with the program committee, will review these statements, culminating in a fair and informed selection process.

Table 1: Proposed tentative workshop schedule.

Time	Phase	Description
09:00 – 9:20	Welcome, introduction to workshop goals, and round of introductions.	We will facilitate a round of introductions where each participant will have the opportunity to succinctly present themselves and articulate their primary interest within the realms of in-vehicle AR.
9:20 – 10:00	Keynote Speaker: Human Factors Aspects on Evaluating AR	Highlight the distinctive features of augmented reality, emphasize the significance of human factors in assessing AR safety from a research standpoint, and advocate for innovative evaluation metrics.
10:00 -10:30	Session 1: Reflection Statements from researchers	Researchers present reflection statements on topic (4 presenters, 5 minutes each). This will be followed by an interactive 10 minute brainstorming session, inviting participants to further expand their ideas and identify potential challenges.
10:30 – 11:00	Coffee Break	
11:00 – 11:20	United Nations Field of Vision Assistant Informal Working Group	What is the group about? What have they done? A special focus will be given on examining current practices in evaluating AR effectiveness, and identify design & evaluation challenges from a practitioner standpoint;
11:30 – 12:00	Session 2: Reflection Statements from practitioners	Practitioners present reflection statements on topic (4 presenters, 5 minutes each). This will be followed by an interactive 10 minute brainstorming session, inviting participants to further expand their ideas and identify potential challenges.
12:00 – 13:00	Group Discussions	Participants will be separated in 4 groups and each group will discuss the goal under consideration using the presentations, the results from the brainstorming session and the initial questions (from preworkshop activity) as starting points.
13:00 – 13:45	Session 3: Presentation of group discussions and overall discussions in the auditorium.	After the discussion, each group will give an overview of their suggestions to solve the problems in the field and how the given goal can be accomplished. Finally, these suggestions/ solutions will be discussed among the entire group.
13:45 – 14:00	Wrap-up and closing	

- **Structuring of Sessions:** The workshop organizers will categorize the accepted reflection statements into distinct clusters, each of which corresponds to a specific workshop goal. Using these curated reflection statements, the organizers will devise a set of initial questions that will act as catalysts for in-depth, small-group discussions during the workshop.

3.2 At the Workshop

In this proposal, we seek approval for a half-day workshop designed to accommodate approximately 25-30 attendees, including the organizers. We will need support with a projector with a laptop connected to the internet, tables that can be moved to form small group discussions. The tentative schedule is outlined on table 1.

3.3 Post Workshop

Post-workshop, the organizers will amalgamate the suggestions and ideas generated from the group discussions and brainstorming sessions. Our objective is to compile these into a comprehensive document suitable for publication in a pertinent journal or for presentation at a relevant conference. We will extend an invitation to all engaged workshop participants who can allocate the necessary time and effort, to collaborate on this consequential publication.

4 ORGANIZERS

- **Gary Burnett** is a Professor in Transport Human Factors at the University of Nottingham, UK. Professor Burnett's primary research concerns human-machine interface design for future vehicles and he is an internationally-recognised expert on this topic, especially related to the assessment of driver distraction. He has conducted a number of studies concerning AR within vehicles, including several presented at previous Auto-UI conferences. More broadly, he innovates considerably in teaching using Metaverse platforms and has considerable expertise regarding the user-experience implications of AR, VR, MR in numerous contexts.
- **Joe Gabbard** is an associate professor at Virginia Tech. He has been a pioneer in usability engineering with respect to

applying and creating methods for new interactive systems for more than 20 years. He has conducted numerous user-studies in AR examining human performance and safety in applied (usability engineering) and basic science domains (color perception, occlusion, depth perception). More recently, he has explored human performance, natural user interaction, situational awareness and safety associated with AR displays in transportation, military, manufacturing, building & construction.

- **Valerian Meijering** is Senior XR Researcher at the National Automotive Innovation Centre University of Warwick, Jaguar Land Rover. With over a decade of experience in Human Machine Interface Research, Valerian specializes in pioneering future Head Up Display technology and Human Factors. His primary focus is on investigating innovative concepts that revolve around the seamless interaction between humans and vehicles.
- **Nayara Faria** Ph.D. candidate specializing in Cognitive Engineering at Virginia Tech. With a strong background in human factors and UX research, Nayara has dedicated her expertise to investigating the profound effects of augmented reality head-up displays on perception, performance, and user preferences. Her primary interests lie at the intersection of Human-Computer Interaction (HCI), UX Research, Perception & Cognition, and the application of AR/VR in transportation for enhanced safety.