Cyborgs on the Road: Workshop on Augmenting Road Users to Quantify their Behaviour

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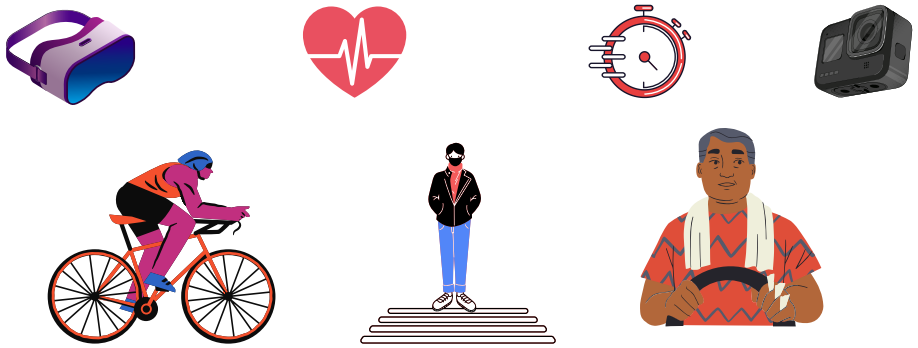

Figure 1: Examples of augmentation techniques and road users.

ABSTRACT

There is an increasing number of studies evaluating road user (e.g. cyclists or drivers) behaviour in traffic. These are important for informing traffic safety, road infrastructure design and the impact of automated vehicles on traffic. Road user evaluations often involve collecting data such as perceived safety and motion sickness. However, collecting objective, quantified forms of these behaviours is challenging. Experimenters commonly measure these with questionnaires after the study. Finding solutions to collect these data in real-time without relying on participants' subjective input could result in more rigorous study designs and a better understanding of user behaviour. This workshop aims to gain insights on how road users may be augmented with devices, such as heart rate monitors, in evaluation studies to quantify behaviour on-the-go. The workshop will result in study designs that augment road users to quantify their behaviour, which would inform future research with novel techniques for data collection.

CCS CONCEPTS

• **Human-centered computing** → Empirical studies in HCI; *Empirical studies in HCI*.

KEYWORDS

Road Users, Traffic, Augmentation, User Study

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1 BACKGROUND

There is an increasing number of user studies exploring road user behaviour [2, 11, 13–16, 21–23, 28], primarily due to the technological advancements paving the way for connected and automated vehicles (AVs) [1, 19]. These studies are crucial to ensuring a safe future traffic environment and understanding road user perceptions of novel technologies. They vary in their study design, from simulator studies [7, 29] to controlled user studies in outdoor settings and in-the-wild explorations of road user behaviour [23]. A typical example is a photo-based study where cyclists express their perception of an approaching AV [4] or an outdoor study with a pedestrian indicating whether they would cross the road given a particular condition [12].

Quantifying road user behaviour remains a common challenge among these studies [17]. Researchers often collect data representing perceived risk, motion sickness, and physical and mental effort [6, 12, 20]. However, these are usually collected using subjective measures, such as questionnaires applied after the study. More recently, researchers have explored behaviour by augmenting road users with devices such as speed sensors, eye trackers, and heart rate monitors. This proved valuable, as it allowed for collecting objective physiological data based on road users' reflexive behaviours in real-time [3, 24, 27]. Another approach is augmenting road users with devices such as smartwatches or bike computers, allowing researchers to collect continuous subjective data. Pedestrians could, for example, be asked about their current state and use a smart device to rate their willingness to cross the road when a vehicle approaches [2].

This workshop conducts a series of sessions exploring the potential of augmenting road users to quantify their behaviour in user studies. This would involve exchanging ideas to identify the variables researchers should measure and how augmenting road users would facilitate this. We will also demonstrate augmentation techniques to participants, including eye tracking and heart rate monitoring, and discuss these methods. Participants are expected to collaborate and develop potential study designs involving augmented road users. The workshop will result in innovative ideas that could inspire future research to take new ways to measure and quantify road user behaviour.

2 WORKSHOP GOALS

The workshop's overall goal is to provide attendees with a platform to discuss how participant behaviour can be quantified and exchange ideas on augmentation techniques that will enhance their future work. This will be achieved through the following five aims.

- **Identify the behaviours that could be measured by augmenting road users:** This would provide attendees with a foundational knowledge of the behaviours that should be quantified and the challenges in achieving this. It will spark open discussions that will lead attendees to overcome these challenges with augmentation techniques.
- **Explore the feasibility of various augmentation solutions:** We will explore the range of possible augmentation solutions and discuss their suitability to measure different types of road user behaviour and whether utilising them could offer better results or contribute to already established techniques such as questionnaires (e.g. NASA-TLX [5]). We will also discuss other factors, including cost and accessibility. Achieving this aim will shed light on the challenges researchers may experience when opting for participant augmentation.
- **Familiarise workshop participants with simulators and augmentation hardware:** Simulators, e.g. driving or cycling simulators, have become a critical component of user studies. They can be used to display currently inaccessible solutions (e.g. fully autonomous vehicles) [10] or put participants in potentially dangerous situations that are difficult to explore in real traffic [6]. We aim to introduce participants to such simulators and how they are used in research. This will be a starting point for discussing the relationship between augmentation and simulator studies. Attendees with experience in building simulators will benefit from exchanging ideas with other experts, which could inspire them to enhance their simulators. Attendees without simulator experience will be introduced to the benefits of these solutions first-hand. It will also be helpful to familiarise participants with augmentation hardware, e.g. eye trackers. This will provide attendees with a more immersive experience and could inspire innovative ideas about how this hardware may be used in future work.
- **Understand how augmenting road users fits into user studies:** While augmenting road users might seem achievable to workshop attendees, it is critical to explore how our solutions can be used in the scope of a user study. Some augmentation solutions may only be appropriate for a certain road user, or researchers may want to avoid over-augmenting participants. This will prompt interesting discussions on which behaviours and augmentation solutions should be prioritised in certain studies.
- **Foster collaborations between attendees:** Attendees are encouraged to discuss and collaborate in the workshop, but we also aim for these collaborations to extend beyond the workshop by allowing participants to socialise and exchange contact information.

3 WORKSHOP ORGANISATION

3.1 Pre-workshop

- **Publicity:** The workshop will be advertised on a dedicated webpage on the University of Glasgow's Multimodal Interaction Group's (MIG) website and at popular mailing lists (e.g., CHI-ANNOUNCEMENTS), calendars, and social media (e.g., Twitter, Facebook). Furthermore, we will directly contact researchers working in the fields of interaction with vulnerable road users, (micro-)mobility, and related areas. We will continuously promote the workshop during the period leading up to the workshop deadline.
- **Abstract submission and review:** Attendees can submit abstracts related to the topic using the dedicated webpage. The workshop organisers will review these; if accepted, participants will present their work during the workshop. This allows us to recruit attendees with diverse backgrounds and

Activity	Time	Content
Workshop Introduction	10:00-10:15	Workshop organisers introduce the workshop schedule and goals.
Attendee Presentations	10:15-10:45	Attendees who have submitted abstracts present their submissions.
Opening Keynote	10:45-11:15	A researcher with experience augmenting road users for data collection presents their work.
Short Break	11:15-11:30	A short break to allow attendees to socialise and exchange contact information for future collaborations.
Demonstration Session 1	11:30-12:00	Workshop organisers demonstrate driving and cycling simulators to inspire attendees in later discussions.
Open Discussion	12:00-12:30	Workshop organisers and attendees openly discuss the challenges of measuring road user behaviours and the types of data that could be measured through augmentation techniques.
Lunch Break	12:30-13:30	-
Demonstration Session 2	13:30-14:00	Workshop organisers demonstrate various devices that can be used to augment road users, including an eye tracker and heart rate monitor.
Participant Group Discussion	14:00-14:30	Participants will be split into groups, each representing a road user. Groups are expected to design a user study which involves augmenting the road user they were assigned.
Short Break	14:30-14:45	A short break to allow attendees to socialise and exchange contact information for future collaborations.
Participant Group Presentations	14:45-15:00	Each group must present their user study. Other participants will have the opportunity to provide feedback.
Closing Keynote	15:00-15:30	Professor Stephen Brewster presents work involving cyclists augmented with eye trackers and bike computers in real-world traffic.
Workshop Conclusion	15:30-15:45	Workshop organisers summarise the outcomes and collect feedback from attendees.

Table 1: Workshop Schedule

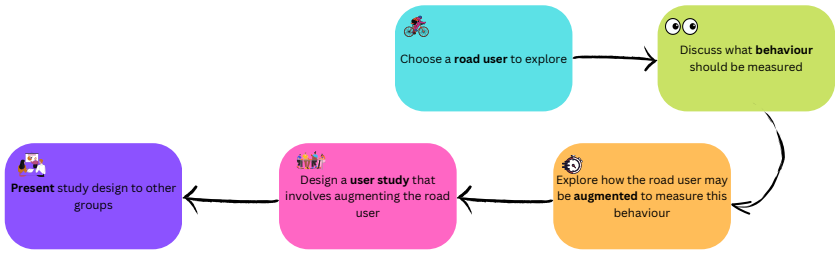

Figure 2: Visualisation of the group task: Group members start working together to develop a study design involving collecting data by augmenting a road user of their choice, followed by possible solutions to augment road users and a study design. Group members will then present their study design to other attendees.

expertise and have them engage with the topic prior to the workshop.

- **Workshop preparation:** This includes several activities, such as testing any hardware to be demonstrated, arranging appropriate times and topics for keynote speakers to present and providing appropriate stationery for group activities in the workshop.

3.2 Workshop Schedule

The workshop schedule, shown in Table 1, was designed to achieve all our goals and encourage fruitful discussions and collaborations between attendees. It includes two keynotes from established researchers in the field. Attendees will take part in open discussions and a group task (shown in Figure 2).

4 WORKSHOP OUTCOMES

After the workshop, we plan to collect and combine participants' ideas and study designs to include them in an overview paper that will be submitted to a relevant conference or journal. Workshop participants are welcome to collaborate with the organisers on this process. The resulting paper would benefit future research by presenting solutions to quantifying road user behaviour and showing how these solutions can be used in user studies. This will be in the form of guidelines researchers can follow to augment study participants.

5 ORGANISERS

- **Ammar Al-Taie** is a PhD student in the School of Computing Science at the University of Glasgow. His area of research is Autonomous Vehicle-Cyclist interaction. This often involves utilising unconventional technologies, such as new displays on the car's exterior. Ammar is a "hands-on" researcher; most of his work is conducted in real-world settings using new technologies such as eye-tracking.

- **Katharina Margareta Theresa Pöhlmann** is a Post-doctoral Researcher in the School of Computing Science at the University of Glasgow working on the ViAjeRo project (https://viajero-project.org/). She earned her PhD in Psychology at the University of Lincoln. Her research focuses on using VR as a tool for motion sickness mitigation in AVs, focusing on multisensory cue integration to mitigate motion sickness.
- **Thomas Goodge** is a PhD student in the Schools of Computing Science and Psychology at the University of Glasgow. His research focuses on Human-Car interactions in the context of driver awareness during takeover requests in autonomous vehicles. Thomas' research attempts to apply cognitive methods used for measuring attention and awareness to evaluate driver states in autonomous vehicles.
- **Andrii Matviienko** is an assistant professor at KTH Royal Institute of Technology in Stockholm, Sweden. His research focuses on the assisting technology in urban environments, in particular on designing, constructing, and evaluating multimodal and mixed reality interfaces for vulnerable road users. He is also a co-organizer of the SIGCHI-sponsored International HCI Summer School on Cycling and a series of workshops about vulnerable road users [8, 9, 18, 25, 26].
- **Frank Pollick** is a Professor of Psychology in the School of Psychology and Neuroscience at the University of Glasgow. He serves as the Director of Innovation, Engagement and Enterprise for the School and is co-author of the textbook Cognitive Psychology published by McGraw Hill Education. He has a diverse set of research interests that include how people interact with technology; neuroergonomics and the use of real-time fMRI neurofeedback to understand cognition; how the perception of human movement varies with expertise, disease and brain development. He contributes editorial service to the International Journal of Humanoid Robots and Technology, Mind, and Behavior.
- **Stephen Brewster** is a professor of Human-Computer Interaction in the School of Computing Science at the University of Glasgow. His research focuses on multimodal HCI or using multiple sensory modalities and control mechanisms (particularly audio, haptics and gesture) to create a rich, natural interaction between humans and computers. His work has a strong experimental focus, applying perceptual research to practical situations. A long-term focus has been on mobile interaction and how we can design better user interfaces for users who are on the move. Other areas of interest include haptics, wearable devices and in-car interaction. He pioneered the study of non-speech audio and haptic interaction for mobile devices with work starting in the 1990s.

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