Workshop for designing biofeedback of driver's state and emotion in automated vehicles

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ABSTRACT

Different drivers' states and emotions can affect negatively the driving performance. Recent advances in affective computing now give the opportunity to measure the users' state or emotions using various sources of data such as physiological signals or voice samples. Conveying biofeedback in the car could help to make roads safer and improve users' health and mental state during a ride in an autonomous car. This workshop aims at selecting the drivers' hazardous states and emotions that are crucial to be assessed, as well as how to convey the appropriate biofeedback to the driver, using multimodal interaction in the car.

CCS CONCEPTS

• **Human-centered computing → HCI theory, concepts and models**; *Visualization design and evaluation methods.*

KEYWORDS

Automated Vehicle; Intelligent System; Bio-feedback; Human-Vehicle Interaction; Multimodality; Emotional and Affective State; Empathy

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1 INTRODUCTION

For many people, daily commuting takes up a substantial part of their day. In addition, a large number of accidents are due to drivers' errors. Even though the level of automation is increasing in cars to support them, the conditional automation (Level 3 of SAE classification) still needs the driver to take over control in case of automation fallback. Therefore, it is crucial to evaluate continuously the drivers' state and emotions to ensure that they are ready to take over control. Various drivers' hazardous states such as fatigue, distraction, cognitive load or stress can affect negatively driving performance [7]. For instance, fatigue due to sleep deprivation [16] or induced by a task [14] were shown to deteriorate driver's performance. The latter could be related to a high level of mental workload. Since an operator perform badly under level of under or overload with automation [19], the driver's level of mental workload should also be measured continuously. Also, driving often tends to be associated with negative emotions such as anger [18] or anxiety [10] and is considered by many people as one of the most unpleasant experiences of the day [12]. Potential triggers for negative emotions include lack of control, travel delays, potential accidents, and the high cognitive load induced by driving [21]. Although certain negative emotions such as stress help people achieve goals, such as arriving safely at their destination while driving, too many or too few can negatively impact driving performance and overall well-being [8]. For example, drivers that are in an extreme happy and arousal states are worse drivers [11]. Therefore, detecting a drivers' emotions and responding to their state should provide the opportunity to improve road safety, but also potentially promote mental health. Previous studies showed that drivers' psychophysiological states and emotions can be automatically detected using techniques of machine learning. In the context of driving, drivers' hazardous states such as distraction [7], stress induced by the driving environment [4], or task-induced cognitive workload in conditionally automated driving [15] can be detected with high accuracy. Also, the drivers' emotions and affective state can be measured using voice segments as inputs of machine learning algorithms [1].

The information on the driver's state or emotions could be used to generate a biofeedback in the car, since it has been shown that visualizing its own state is beneficial for a user interacting with a machine [17]. Also, the time spent in the autonomous car could be used to improve the driver's condition and/or emotions. This biofeedback could be conveyed in different ways, modalities and locations in the car, such as an icon or a message displayed on the vehicle's dashboard or user's personal device [3], vibrations in the seat [2], multimodal agent [5, 9], ambient lights to reduce driver's stress [6, 20], or even psychological-based interventions [13].

2 OBJECTIVES

We seek to gather experts in the field of human-vehicle interactions and affective computing in order to communicate the affective and emotional state of the driver. As mentioned above, it is important for the driver to be aware of his or her emotional and/or affective state because it can influence his or her driving. In the context of autonomous driving, the communication of the driver state could increase the sense of companionship, as the vehicle shows that it "knows" the driver and can remedy or adapt to her/his needs. In the case of promoting mental health, the context of autonomous driving could then make sense by freeing the driver from the main task of driving and being able to work on his condition. The objective of this workshop will be to discuss and propose a concept on how the vehicle can provide bio-feedback to the driver? There could be two approaches to thinking about the response of the intelligent system based on the driver's condition:

- through classical visualization of the driver's state using in-vehicle interfaces such as ambient light, driver seat, text on console or dashboard, auditory or visual feedback...
- by interacting with /through the emotion of the vehicle (intelligent system) itself. For example, the vehicle could react as follows: "What did I do wrong?", "Are you sure you're okay?", etc.

3 WORKSHOP PLAN

3.1 Workshop preparation and outreach

Because the workshop will be held totally online, a large part of the preparation will consist of the implementation of collaborative interactive tools (Miro board, Wooclap questionnaire, Zoom channel...).

We are not planning to do a call for paper for this workshop. However, we will ask registered participants to provide a slide to introduce themselves and their current projects related to the topic. This slide will be part of the presentation. Two sessions of flash presentation are planned during the workshop.

3.2 Workshop schedule

The workshop will last approximately 2h. A first attempt at a timetable is proposed in Table 1. The workshop starts with an introductory session given by the organizers to welcome the attendees and to detail the organization. It also explains the objectives and expected outcomes of this workshop. This introduction will be followed by a first round of discussions: half of the attendees are invited to introduce themselves during a flash presentation pitch session. Participants have between 1 and 2 minutes each to make a pitch about their background and research interests using only one slide. Another round of discussion session will take place before the second coffee break.

The organizers will then provide a small overview of the context, including insights and relevant definitions about automated driving as well as multimodal, driver's state detection and affective interaction. During this part, attendees will also participate in an interactive way. For this, we will use an interactive questionnaire platform allowing participants to reflect on very general ideas related to the different concepts presented. For example, which driver states and emotions they think would be critical in the case of driving, etc... After the brainstorming session, the second flash presentation will occur followed by a short break.

For the second activity, participants will be divided into groups of 3 or 4. Based on the first ideas and tracks of reflection generated previously, each group will have to propose a concept for conveying bio-feedback to the driver. Cards with interaction modalities and driver's state and emotions will be proposed by the organizer in order to facilitate the creativity process. It is expected that the proposed concept gives insights about which bio-feedback is sent to the driver. The way of conveying that information using empathy and different modalities should also be tackled. To support this session, online tools for sketching and rapid prototyping such as Miro will be proposed to support attendees' creativity. Finally, each group will have few minutes to present their concept to the other attendees. All the participants have the opportunity to discuss and ask questions about the prototype designed by each group.

3.3 Virtual conference

The workshop will be held online during the virtual conference. As the majority of the organizers are from Europe, it would be ideal for the workshop to start at 3pm CEST. Indeed, we would also like participants from other continents to attend the workshop.

In order to engage with participants, we propose to use Zoom which will also allow us to create breakout rooms for group activities. In order to keep them engaged, we plan varied activities (passive listening, active participation, creative activity, discussion..). We also plan to use different virtual interactive tools: a platform of interactive questionnaires for the interactive context presentation (Wooclap) and Miro board for the creativity session. We have also planned a break halfway through the workshop.

Session	Duration
Introductory session	10 min
Flash presentation I (1st half of the participants)	10 min
Interactive context presentation	25 min
Flash presentation II (2nd half of the participants)	10 min
Coffee Break	10 min
Creativity session	30 min
Presentation and discussion & Report	20 min
Closing session	5 min

Table 1: Proposed schedule - around 2h

3.4 Expected outcomes

The expected outcome for the interactive introduction session is a non-exhaustive list of driver's state that can be conveyed to the driver, what kind of emotion and states should be measured, what kind of empathetic response/reaction from the vehicle might be. The expected outcome for the creativity session are some practical ideas on how to communicate the representation of one's bio-feedback to the driver. In the long run, we hope that this interdisciplinary topic can connect communities interested in the study of the driver's state, emotions and their role in (autonomous) driving, but also in human-machine centered techniques to communicate them. We hope that in the future, the appropriate design of human-vehicle interaction will improve the user experience and confidence in the car while increasing safety on the roads.

4 SHORT BIOGRAPHY OF THE ORGANIZERS

Marine Capallera is a PhD student at University of Fribourg and the HES-SO University of Applied Sciences and Arts Western Switzerland. She is working on conditionally automated driving and she is focusing more specifically on multimodal Human-Vehicle Interaction model for supervision.

Quentin Meteier is a PhD student at University of Fribourg and the HES-SO University of Applied Sciences and Arts Western Switzerland. He is working on conditionally automated driving and focuses his research on evaluating the physiological state of the driver using machine learning techniques.

Kevin Koch is a PhD student at the Bosch IoT Lab at the University of St. Gallen. His research focuses on algorithms to detect (critical) driver states and the design & development of in-vehicle well-being interventions.

Markus Funk is a Senior UX Researcher at Cerence GmbH in Ulm, Germany. His research interests encompass Voice-User Interfaces and affective computing for automotive scenarios.

Mira El Kamali is a PhD student at the University of Fribourg in collaboration with the Humantech institute at the University of Applied Sciences and Arts Western Switzerland. Her research interest is human-computer interaction and focuses on conversational agents to improve well-being.

Karl Daher is a PhD candidate at the University of Fribourg in collaboration with the HumanTech institute from the University of Applied Sciences and Arts Western Switzerland. Co-creator of Empathic Labs group. Karl's main interest is empathy in human-computer interaction and the application of empathy in real-world scenarios to improve humans mental and physical well-being.

Omar Abou Khaled is a Professor at the University of Applied Sciences and Arts Western Switzerland. His research fields are Human-Computer Interaction and Wearable and Ubiquitous computing.

Elena Mugellini is a Professor at the University of Applied Sciences and Arts Western Switzerland and head of the HumanTech Institute. Her research fields are Human-Computer Interaction and Data Analytics.

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