1st Workshop on Situational Awareness in Semi-Automated Vehicles

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ABSTRACT

This workshop will focus on the problem of occupant and vehicle situational awareness with respect to automated vehicles when the driver must take over control. It will explore the future of fully automated and mixed traffic situations where vehicles are assumed to be operating at level 3 or above. In this case, all critical driving functions will be handled by the vehicle with the possibility of transitions between manual and automated driving modes at any time. This creates a driver environment where, unlike manual driving, there is no direct intrinsic motivation for the driver to be aware of the traffic situation at all times. Therefore, it is highly likely that when such a transition occurs, the driver will not be able to transition either safely or within an appropriate period of time. This workshop will address this challenge by inviting experts and practitioners from the automotive and related domains to explore concepts and solutions to increase, maintain and transfer situational awareness in semi-automated vehicles.

Author Keywords

Context Awareness, Situational Awareness, Automated Driving, Cognitive Load.

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ACM Classification Keywords

H5.m Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

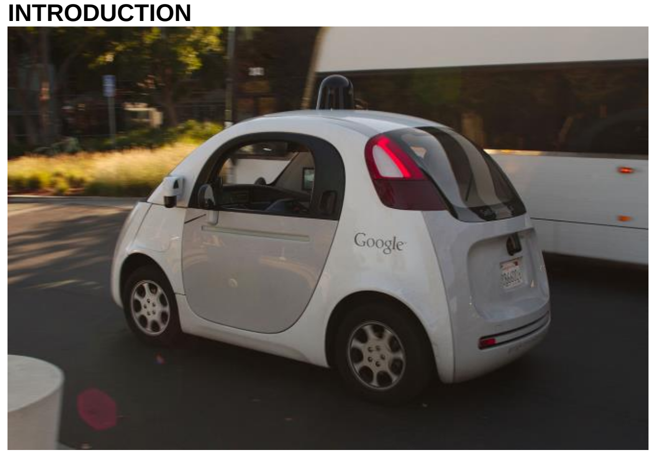

Figure 1 The Google Self Driving Car[1].

The rise of (semi)-automated vehicles coupled with their relative success (see the Google Car [1] and Figure 1) brings with it a set of opportunities and challenges. One major challenge is that the driver will no longer be as engaged in the driving task and may engage in other activities, from conversing with other occupants, through to playing games or sleeping. As a result, drivers are effectively out of the loop. Nevertheless, as these vehicles

[1] By Michael Shick - Eigenes Werk, CC-BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=44405988

will be available for the foreseeable future and encounter events they are not able to handle safely, drivers will be required to resume control. This requires that the drivers possess enough situational awareness to respond effectively to a takeover need. As a consequence the vehicle must be able to share its interpretation of the situation with the driver effectively and establish and maintain a shared situation representation [2] or a "common frame of reference (COFOR) [3] with the driver, so as to communicate relevant and critical information for the resumption of vehicle control.

This workshop will focus on SAE Level 3 (L3) and Level 4 (L4) automated vehicles [4], namely those which either automate all critical functions within certain contexts or are fully automated at all times. This emphasis means that the vehicle must possess situational knowledge about and be able to respond to environmental cues in order to safely navigate. However, even at L4 the assumption is that the driver may have to take back control under certain situations. Assuming that the driver will not spend all of their time focusing on the road and their surroundings during automated driving, there is a high likelihood that they will be unprepared to respond to control transition requests in time and/or with the appropriate reaction. Therefore, the driver requires awareness of the traffic situation during automated as well as manual driving, in order to be able to respond to changes in the traffic situation – which includes transitions between driving modes. This workshop will address these complex set of challenges.

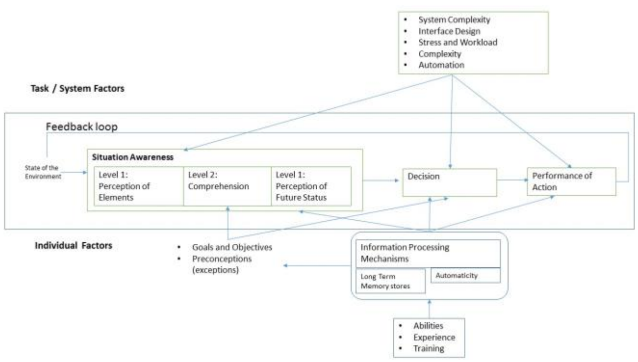

Figure 2 Model of Situation Awareness in Dynamic Decision Making based on Endsley (1995) [6]

Level 1 SA: Perception of the elements in the environment

Level 1 SA focuses on the car or driver correctly perceiving the environment [6], examples include a child running across a road or a serious road defect. In L3/L4 automation this requires that a potentially large of elements need to be monitored for example vehicle status, terrain, neighboring traffic elements, other people and other drivers. Challenges include perceptual failures by the vehicle e.g. due to sensor malfunction, lack of awareness of the limitations of the systems by the driver and problems adapting to the limitations of the system.

Level 2 SA: Comprehension of the current situation

Level 2 SA is how the car and/or driver correctly understands the environment they find themselves within. For example, in a lane-changing task, drivers are expected to continuously estimate their lane position and the traffic in the neighboring lane in order to transition from one lane to another smoothly. Within this context, how do humans currently piece together disjointed Level 1 elements in order to effectively apply them to the pursuit of their goals? How do existing algorithms fuse sensed data in order to perform tactical maneuvers and how are drivers expected to takeover control when such algorithms fail?

Errors at this level are commonly attributed to a lack of or incorrect mental model, and over-reliance on default parameter values.

Level 3 SA: Projection of future status

An experienced driver is able to anticipate the consequences of the choices that are made during vehicle control. For example, the effect of swerving to avoid a small child that has run onto the road while continuing to be aware of the other obstacles and taking appropriate action. A key aspect here is how autonomous vehicles can project their future status relative to the surrounding traffic in order to effectively support tactical and strategic planning.

Errors at this level are commonly attributed to a failure or to a lack of or an incorrect mental model, over-projection of observed trends, a failure to maintain multiple goals, and a reliance on a habitual schema.

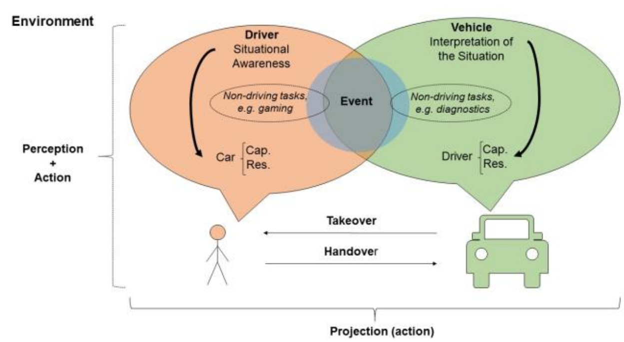

Figure 3 Situational Awareness between the Driver and the Car.

FUTURE CHALLENGES

As automated vehicles become more able to act as an autonomous agent the relationship (see Figure 3) between car and driver will change to be more symbiotic (see the middle part of the diagram). Such a relationship requires that the automated vehicle and driver must possess a shared situation representation, that both include a shared environmental model and information about intentions, goals, states and actions ([2][3]). The vehicle must also possess knowledge of the current non-driving activities relating to both the driver and other occupants in order to evaluate situation awareness transition strategies.

OBJECTIVES

In order to explore the challenges related to SA, the workshop will specifically explore the topics outlined below, although submissions relating to other aspects of SA will also be considered:

- Multimodal cues for supporting situational awareness and handovers/take overs
- Shared situational awareness between the car and its occupants; what information has to be shared and how to share it
- Engagement in non-driving tasks; how to measure levels of immersion, flow, engagement and involvement in secondary tasks
- The tradeoff between driving and non-driving tasks
- Optional vs compulsory hand-overs
- The bi-directionality of handovers and takeovers; the relationship between car and driver during the handover situation and information exchanged
- Resumption of control of non-driving tasks
- Tactical, operational and strategic knowledge
- Mental models of handover situations and the transfer of situational awareness
- The impact of different automation levels on situational awareness, handovers and takeovers
- Metrics for assessing situational awareness
- Deskilling; the impact of a possible drop in driving skills relating to the less frequent experience of the driving task

PROPOSAL FOR WORKSHOP SCHEDULE

The workshop will last for a total of four hours (or half of one day). The emphasis will be on collaboration rather than presentations. The workshop will be limited to approximately 20 participants.

Before the Workshop

All participants will be asked to provide a short one slide introduction to themselves, which highlights their key research interests and affiliation etc. The organizers of the workshop will then use this to generate an overview of the interests of the workshop participants. The organizers will then assemble a number of groups. Prior to the workshop, a document will be circulated to all participants outlining who is attending and areas of interest.

During the Workshop

The organizers will present an overview of the attendees and their research interests. This will be assembled from the provided slides. Each participant will also be invited to stand and introduce themselves in one sentence, along with their accompanying slide (times will be strictly enforced). After this they will present an overview of the topics of interest and suggest groups of 4-6 people to work on the first group of selected topics. Two such break-out sessions will take place and the participants must not always work with the same group of people. The break-out groups will be provided with materials to enable prototyping of ideas. After each session they will be asked to present a summary of their work to the other participants. At the end of the workshop a summary poster will be created that will be presented to the other Automotive UI participants. Videos will be made of the results from the breakout group.

Time plan

20 minutes: introduction to workshop and overview of participants and topics of interest.

70 minutes: first break-out groups on identified topics

25 Minutes: presentation of results from each group

70 minutes: second breakout group session

25 minutes: presentation of results from each group

15 minutes debrief and development final poster to present at Automotive UI

A break of 15 minutes will also be provided.

After the Workshop

The results will be presented during the Automotive UI poster session. The videos of the work developed during the workshop will be made available to the participants.

OUTCOMES

The outcome will be a set of new concepts to tackle the problem of situational awareness within autonomous vehicles. Related to this will be the formation of an early community of people working in this area.

The workshop will propose key areas which need to be addressed and explore the idea of a special issue of a journal based around these concepts.

BIOGRAPHIES OF THE ORGANISERS

Rod McCall is a Lead Researcher at the Luxembourg Institute of Science and Technology. His research focusses on human-factors within the fields of (semi)-autonomous vehicles and mixed realities. He is an associate editor of Interacting with Computers (Oxford University Press), is the vice-chair of the IFIP Working Group on Social and Ethical Issues in Entertainment Computing. He has co-organized workshops at CHI, MobileHCI and Automotive UI.

Ioannis Politis is a Postdoctoral Researcher at the University of Cambridge, Department of Engineering. He is working on the HI:DAVe part (Human Interaction: Designing Autonomy in Vehicles) of the TASCC project (Towards Autonomy, Smart and Connected Control), funded by EPSRC and Jaguar – Land Rover. He is close to completion of his PhD at University of Glasgow, Multimodal Interaction Group, looking into the use of multimodal displays to alert drivers of manual and automated cars.

Ignacio Alvarez is Research Scientist at Intel Labs, USA. He obtained his PhD in Computer Science at University of the Basque Country, Spain. His background is in Human Computer Interaction. His research interest is on future intelligent transportation systems and the practical application of cognitive sciences to affective computing and ADAS.

Martin Baumann leads the Department Human Factors at Ulm University, Germany. His research interests focus on the psychological processes, such as situation comprehension, anticipation, trust, underlying human behavior in the context of human-machine interaction and driver-vehicle interaction specifically.

Shadan Sadeghian is a researcher at the Interactive Systems group at OFFIS -- Institute for Information Technology in Oldenburg, Germany. Her research investigate ways to support task switching and take-over situations in highly automated driving using multi-modal cues evaluated in driving simulator experiments.

Jacques Terken is an associate professor at the User-centred Engineering group of the department for industrial design of Technische Universiteit Eindhoven. His research focuses on automotive human factors, with a special interest in different aspects of the experience of autonomous driving as well as the relation between the occupant/vehicle and the surrounding road users. He has been the general chair for Automotive UI 2013, and a co-organizer for several Automotive UI workshops.

Alexander Mirnig is a Research Fellow at the Center for HCI at the Computer Sciences Department of the University of Salzburg, Austria. He holds a Master's Degree in Analytic Philosophy and his research interests include driver space design patterns, handovers in semi-automated vehicles, and ethical issues in automated driving.

Alexander Meschtscherjakov is an Assistant Professor at the Center for HCI at the Computer Sciences Department of the University of Salzburg, Austria. In his research he deals with automotive user interface design as well as user experience with autonomous vehicles and "deskilling" issues.

Manfred Tscheligi is professor for HCI & Usability at the University of Salzburg and is heading the Business Unit Technology Experience at AIT. He is very much involved in driving experience activities (e.g. as a national initiative on Car Interaction Safety) and has been shaping the discussion on autonomous driving and human robot-interaction over the last years.

Lewis Chuang leads research on "Cognition and Control for Man-Machine Systems" at the Max Planck Institute for Biological Cybernetics (Tuebingen). His research investigates information-seeking and -processing behavior, especially in the context of man-machine systems, by relying on gaze-tracking and EEG/ERP methods.

ACKNOWLEDGEMENTS

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