Workshop on Human Machine Interaction in Autonomous Vehicles: the Perspective of the Two Current HORIZON 2020 Projects ADAS&ME and AUTOMATE

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Abstract

The challenges related to the development of automated vehicles are not only of a technical nature, but also affect the quality of on-board interaction. The role of the HMI is crucial to manage unexpected events and ensure a safe and smooth transition of control. The workshop will promote and discuss the approach used in the HMI design for autonomous vehicles realized from the European projects ADAS&ME and AutoMate. ADAS&ME is dedicated to the creation of new driver state adaptive ADAS that incorporate driver/rider state, the situational and environmental context, as well as the adaptive interaction to automatically transfer control. AutoMate will enhance safety by using the strength of both the automation and driver in a dynamic situation dependent way. In the workshop the main challenges emerged in the projects will be discussed with the audience, to obtain feedbacks and enhancements, and to highlight themes and strategies not yet emerged.

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CCS Concepts

H.5.2. Graphical user interfaces (GUI); HCI, Ergonomics, H.5.m. Miscellaneous;

Introduction

The theme of the autonomous vehicle is currently involving different aspects of automotive research. Among these, the Human Machine Interface (HMI) is regarded as being of increasing importance. The underlying question concerns the HMI of self-driving cars with an automation level between L3 and L5 (SAE) [7] and the overall interaction strategy in highly automated vehicles. Studies of human factors have already shown how this issue is essential as vehicles that provide driver supervision and guidance, such as Level 3 vehicles, or full delegation of the driving task, as in L4 and L5 cases, will lead to new scenarios not fully known in the automotive industry. In some cases there are new issues, such as the takeover request [1] or voluntary control transitions, and in general the need to rethink the on-board information structure [5]. The problem is so significant that more than one scholar stated that the real theme of the interaction between the present and future autonomous vehicles does not concern either control or technological solutions, but rather aspects related to interaction and Human Factors [3].

On the other hand, issues such as deskilling, putting the user out of the control loop, overconfidence or even

unforeseen workload management or sickness in the driver are new themes to which research is beginning to look [4]. The topic is very important and this is the reason why projects within the new HORIZON 2020 Framework Program are also explicitly pointing to the theme of interaction with the automated driving vehicles. Two of these projects, AutoMate and ADAS&ME, have a strong focus in this direction. Two different approaches will be discussed, to establish meeting points and to merge the most relevant evidences, sharing them with the research community.

AutoMate and ADAS&ME: concepts, findings and challenges in two Horizon 2020 projects

AutoMate intends to develop and implement the concept of the team-mate in the vehicle, that is, the idea that the totally or partially autonomous driving system can establish a relationship of cooperation with the driver. The system learns from the driver what it did not know to deal with ever-new situations, it is able to ask for specific interventions by the driver it cannot handle a situation alone, and the driver receives adequate information about its state from the situation about its state, environment perception and planning when the system is driving autonomously. At the same time, the system can detect the driver state, contextualize vehicle and environmental aspects and adapt the transition of control, from the vehicle to the driver and vice versa, in terms of time needed to take over and communication strategies, including multimodal interaction concepts. The main challenge is the definition of the appropriate strategy to design and validate the set of customized and user-centered messages to communicate with the driver, called "concurrent abbreviation" [2]. The goal of this approach is to ensure an interaction that is balanced between

efficiency, safety and user satisfaction, given the non-secondary role of affective aspects in the acceptance of highly automated vehicles by the general public [6].

The main objectives of **ADAS&ME** ("Adaptive ADAS to support incapacitated drivers & mitigate effectively risks through tailor made HMI under automation") are to develop driver and rider state adaptive Advanced Driver Assistance Systems for L2, L3 and L4 automation. The principal idea is to enhance the safety and comfort of transitions by considering the driver / rider state before and during transitions and to use automation as a backup for incapacitate drivers and riders. ADAS&ME addresses automation of busses, trucks, passenger cars and PTW in dedicated use cases. Dedicated workpackages address the classification of environmental situation and driver state. Transitions are designed with intuitive HMI elements using visual, acoustic and new kinesthetic feedback to guide the occupants through the transitions in both directions.

The workshop seeks to address the issue of Human Machine Interface in self-guided vehicles starting from the experience of the two projects described here. It is intended to discuss how the two projects, including the delineation of the interaction concepts, the adopted design methodology and the expected forms of assessment, can provide a major contribution to the reflection on this topic and to its scientific growth as well as potential identification of possible future scenarios.

Proposal for the workshop schedule

Starting from these premises, the workshop has three main goals:

- **discuss the current Human-Machine Interaction findings for highly automated**

vehicles: through a review of theoretical framework and listing the major themes related to the interaction between humans and automated vehicles; design concepts and expected assessment strategies will be introduced to obtain feedbacks from the audience and further solution able to improve the research path;

- **disseminate the first concepts and findings emerged in the AutoMate and ADAS&ME projects:** including the approach, the expected results and the issues found in the early stages of the two projects;
- **raise new and unresolved issues related to the interaction with autonomous vehicles:** to obtain observation on uncovered or partially addressed issues.

In order to achieve these goals a number of 20 participants, selected from industry, academia and regulation bodies, is expected to attend the workshop.

Before the workshop

A part of the audience of the workshop will be invited to join by the organizers: this choice comes from the interactive nature of the workshop, in which the public is asked to actively participate to the activities addressing the emerging issues and giving an expert point of view to the discussion. Moreover, the workshop will be published on the two projects websites and the social media pages, to raise the awareness on this activity. A registration link will be provided to complete the enrollment. Before the workshop, the final list of speakers, presenters and moderators will be communicated on the same platforms.

During the workshop

The workshop will begin with a keynote speech, made by a leader in the user interface research community to explain the current challenges in the automotive research and development industry. Then, the workshop will start with the presentation of the two projects, made by workshop organizers to introduce the concepts and the current state of the art on the theme of in-vehicle interaction design. Later, a discussion on these topics will be performed to obtain the first feedback. In this phase the audience will be asked to introduce themes considered as relevant in the interaction with autonomous vehicles. The goal of this discussion is also that new issues will emerge, not considered before. The order of the topics discussed in the following phases will be prioritized.

This general discussion will be followed by a cyclical session of discussion, in which:

- an introduction on a specific topic, covered by the projects or relevant for the domain, is given by a moderator;
- a discussion panel on the introduced theme and/or a practical collaborative design phase will involve the audience in the debate on relevant and particular topics or the realization and discussion of concepts and sketches.

These steps are expected to be repeated four or five times, depending on the available time. The duration of each cycle is expected to be about 30 minutes, respectively 10 minutes for the introduction and 20 minutes for the discussion and design phase. Among the topics considered for the discussion, which will also include potential solutions, concepts and evaluation strategies, are:

- the **transition of control**, including HMI solutions, strategies and modalities to perform the handover from the system to the driver and from the driver to the system, taking into account the criticality of the situation;
- **HMI definitions nomenclature**, defining a sort of glossary of the terms related to the HMI issues;
- The **driver state monitoring**, including the drowsiness, attention, fatigue and visual distraction detection, and the HMI strategies to keep the driver in the loop, including “nudging” solutions to push him in the correct direction toward countermeasures;
- The **cognitive model** to train the autonomous vehicle system;
- The **multimodal interaction strategy**, i.e. the selection of the right sensorial channel to enhance the communication between the driver and the vehicle
- The role of **trust in automation**, the techniques to measure it, the role of this issue to enhance the acceptance of automated vehicles and possible HMI solution able to increase the trust level;
- The **concept of Level of Automation**, evaluating the effectiveness of this nomenclature, considering that it could be mostly a “technical perspective” rather than a final users way of thinking;
- The relation between **humans and artificial systems learning theories**, i.e. can we learn from how humans (e.g. children) are trained?

As stated before, other issues raised from the interaction with the audience could be added.

The workshop structure is described in the figure below:

After the workshop

The workshop outcomes, including minutes and sketches, will be uploaded on the projects website. Other dissemination activities will be further considered.

Expected Outcomes

The workshop will bring significant benefits in the debate on vehicle interaction, especially on autonomous driving as it first outlines a traditionally ergonomic approach aimed at highlighting the major human factors problems and design approach, that is, how to

design the interfaces of these systems considering the elements discussed in the debate.

Secondly, it highlights the way in which the HMI design cannot be limited to a dedicated product or limited research experience, but how it can develop and mature within an entire multi-year project, which involves different partners with different perspectives of scientific and industrial character.

This is also an opportunity for vehicle components to be built and tested on the road, which will enable future developments in the direction of what might be the presumed and significant problems in terms of testing and assessment of this type of vehicle.

The workshop format provides an opportunity for a mutual exchange of knowledge and experience: in this perspective, an important outcome will be the definition of a common nomenclature, essential for the definition of consistent solutions.

The workshop will also promote the technologies currently under consideration by the projects, and it will be possible to highlight the way in which new interaction technologies, preventive safety systems and machine learning themes can contribute to the enhancement in the field of innovation of autonomous driving vehicles.

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