Position Paper on:

Human Factors

Introduction

Road transport is an essential part of society but the burden of traffic crashes, congestion, and pollution is enormous. Automated driving has the potential to resolve these problems. Several vehicles already automate longitudinal and lateral control but still require a capable driver to monitor the automation (SAE[1] level 2). Car makers already announce the next automation levels (SAE levels 3&4) allowing drivers to take their eyes off the road and engage in other activities. In SAE level 3 the driver is still expected to be able to resume control appropriately in a reasonable time frame. In SAE level 4, vehicles will transition to minimal risk when drivers fail to resume manual control.

The above deployment of level 4 automation in cars and trucks, which still have steer and pedals, is currently the primary focus of the automotive industry. In parallel, we see an increasing number of projects focussing on driverless vehicles and functions (Citymobil, GATEway, WEpods, UBER) aiming to integrate autonomous transport systems into complex real-world urban environments. These include driverless buses and taxis which are no longer equipped with steer and pedals. These also include driverless operation in parking and vehicle sharing. In "driverless" operation some level of remote human supervision is foreseen, for instance by means of a control room. Driverless vehicles will initially have a limited operational design domain and will hence also be level 4 in the SAE definition. Once they can safely cover "all" public roads they will reach level 5.

The CARTRE theme group on Human Factors addresses the interaction of automated vehicles with drivers/passengers and other road users with a focus on higher automation levels (in particular SAE level 4 & 5) on all types of public roads including complex urban conditions. The primary focus of the Human Factors theme group is safety. The highly related aspect of Acceptance of automation by individual users and by society is addressed by the user acceptance theme group in CARTRE[2].

Challenges

In 2040 we envision a transport system with a great penetration of driverless vehicles, sharing the road with pedestrians and cyclists. These pedestrians and cyclists may well be equipped with real-time communication enhancing the safe interaction with automated vehicles. 24/7 transport is available for everyone in many regions. We may still have hubs connecting transport modes, for instance using fast rail for long distance, and driverless pods for last mile transport tuning the supply to the demand. As automation technology matures, door2door automated driving may even cover all the demand as most public roads will allow SAE level 5 automation.

Manual driving may still be allowed, but probably not on all roads and times, and automation may have the authority to overrule the driver and prohibit the driver from dangerous actions. The use of old-timers (=current vehicles) may be constrained to private properties or limited public roads section and time periods. A majority of vehicles will be "public" or "shared" but it may still be possible to have a private automated vehicle that can be customizable to the clients' wishes. Control rooms could act as supervisors of automated vehicles' traffic being able to arrange technical assistance, social assistance to users, and may interact with other road users.

Based on this vision CARTRE theme group on Human Factors has collected and structured key challenges in the field of human factors of automated driving have structured the Human Factors challenges in 3 lines

1-Automated vehicles allowing manual driving

1. SAE J3016 (2016). Surface Vehicle Recommended Practice. Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles. http://standards.sae.org/j3016_201401
2. CARTRE Thematic Interest Group User awareness, users and societal acceptance and ethics, driver training

How can we ensure a safe evolution towards a future where manual driving is the exception?

A. How can we predict and deal with effects of vehicle automation on humans such as misuse, skill degradation?
B. How can we shift control from the driver to the vehicle automation and return control back to the driver?
C. How can we make the vehicle automation adaptable to user needs and states?
D. How can driver state monitoring contribute?
E. How can automation overrule the driver and prohibit the driver from dangerous actions, in an acceptable and legal manner?

2-All automation levels including driverless vehicles

How can we ensure a safe interaction with all kinds of other road users?

F. How can we develop vehicle control strategies which are intuitive and acceptable for other road users?
G. How can communication using visual, auditory or wireless modes contribute to a safe and acceptable interaction?
H. How can remote supervision contribute to (perceived) safety and acceptance?
I. How can remote control takeover and deal with abnormal situations?

3-Design and verification

Can we sufficiently understand the human interaction with automation to propose systematic approaches for design and verification?

J. How can we systematically design and evaluate automation and human machine interfaces to ensure a safe and acceptable interaction?
K. How can human factors evaluation be incorporated in legal and consumer test procedures?

Research topics

The CARTRE Human Factors expert community strongly encourages further research and innovation in the following research areas:

- Study how humans interact with automated vehicles in several scenarios, focus on urban areas.
- Conceptualise new interaction means for automated vehicles (external HMI), especially with surrounding traffic participants and develop methods to design the safe, intuitive interaction of AV with other road users.
- Focus on SAE level 4 automation rather than level 3, and addressing automation versus human conflicts in cases where the human fails to adequately resume control. Should the automated system be able to postpone driver take-over (SAE level 3/4) and how should this be realized (freeze steering wheel, disconnect steering wheel, put enormous counter torque on steering wheel, etc.)?
- Find design solutions and standards for Human Factors challenges such as misuse, skill degradation, level of trust and acceptance, motion-sickness during non-driving activities in highly automated vehicles.
- Study the benefits of adaptability of AVs to different user needs, user states and user groups.
- Study how new traffic environments can enhance the acceptable introduction of AV.
- Use first data of field studies such as L3 Pilot to study human automation interaction.
- Study and design remote control for AVs.
- Work towards harmonized Human Factors/HMI design and test procedures ensuring the safe and acceptable human interaction with AVs, to be included in consumer and legal test procedures.

As a Human Factors community we aim to ensure a safe and acceptable introduction of automation on public roads. This will enable a drastic reduction of fatalities and injuries, and a greatly improved mobility. These will only be achieved if Human Factors is well integrated in the design and verification of automated vehicles. We welcome active contributions of current and future initiatives helping to achieve key Human Factors insights for higher levels of automated driving.