Developing External Interfaces for Automated Vehicles: Preliminary results from the European interACT project

Natasha Merat, PhD
Chair, Human Factors of Transport System, Leader, Human Factors and Safety Group, Institute for Transport Studies, University of Leeds, UK
Project facts

- **Programme:** EU/H2020-ART04 - *Safety and end-user acceptance aspects of road automation in the transition period*
- **Duration:** 36 months
- **Period:** May 2017 – April 2020
- **EU Funding:** 5.527.581 €
- **Coordinator:** Anna Schieben, DLR
- **Partners:** 8 industrial and academic partners from 4 European countries (Germany, Italy, Greece, UK)
- **Project Officer:** Begona Munoz (INEA)
- **US - EU twinning project:** AVIntent (NHTSA)
Integrating automated vehicles in mixed traffic

interACT project overview
The challenge

Achieve a safe, highly accepted and efficient integration of Automated Vehicles in mixed traffic environment

1st Objective
Psychological models

2nd Objective
Intention recognition & behavioural predictions

3rd Objective
CCPU & safety layer

4th Objective
Novel HMI elements

5th Objective
Methodology for assessing the quality of interaction
Identification of suitable use cases

Common definition of use case and Scenario

Workshops to identify relevant use cases

Rating and agreement of addressed use cases

- relevance for safety
- frequency of occurrence
- relevance for traffic flow
- need for interaction with human road user
- Realisation in demo vehicles
- Realisation in driving simulator
1st Objective:
Psychological models – results achieved

- Observational studies successfully conducted in three EU countries
- Data used:
  - to refine user requirements for the design of explicit and implicit communication strategies for AVs
  - to improve the situation assessment algorithms of the AV by providing a set of communication signs and behaviours intuitive to humans;
  - to design suitable algorithms for the CCP Unit, which ensures the AV behaves in an intuitive, expectation-conforming manner
- Further details: https://www.interact-roadautomation.eu/cad-webinar-series-ix-interact-project/
1st Objective: Psychological models – results achieved

Generalizable Findings

• Occurrence and necessity of interactions depends on the situation and a variety of other influences, such as traffic density, time of day and specific traffic conditions.

• Explicit communication (e.g. gesturing, flashing lights etc.) happens rarely - most potential interaction-demanding situations are resolved before they actually arise, mostly by adjusting kinematic motion.

• Cooperation, communication and thus interaction between human road users takes place at low speeds, usually below 20 km/h.

• At higher speeds conflict avoidance is predominant – pedestrians use large enough inter-vehicle gaps to cross without expecting the second vehicle to adapt.

• Self reports ≠ reality: Some pedestrians reported that they use some sort of visual information from the driver – even when the driver could not have been physically perceived.

See Lee et al., submitted
The challenge

- Achieve a safe, highly accepted and efficient integration of Automated Vehicles in mixed traffic environment

4th Objective
Novel HMI elements

- Created a “catalogue of interaction messages”
  - AV will turn
  - AV turns
  - AV will start moving
  - AV has detected me etc.

- Must be clear, not distracting, visible, perceivable in daylight/rain/snow, for different speeds etc.

Informed by:
- Our observation studies
- Current designs from others
- Informed by discussions at various standardisation/regulatory fora, such as UNECE, OICA, ISO, SAE, CLEPA etc.
Main design decisions

• Vehicle behaviour:
  – Use as main communication means to communicate the intention clearly
  – Adapt vehicle behaviour when there is a “give way” intention by the AV

• eHMI design strategy:
  – eHMI supports the smooth interaction with AVs
  – Same eHMI designs suitable for different urban scenarios
  – Only communication in situations that do need interaction, e.g. no communication such as “AV will not give way”
  – No advice/suggestions such as “walk”
4th Objective:

Novel HMI elements

- Provides research and solutions on how to design interaction strategies required for the three-way cooperation between all agents

- Under development:
  - 360° LED light band
  - Directed signal lamp
  - On-board HMI LED band and additional displays

[Willrodt et al. 2017; Kaup, 2019]
4th Objective:
Novel HMI elements

- Design the integrated interaction strategy and define messages (continuing from Sorokin et al., 2019)

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<tr>
<th>Next manoeuvre</th>
<th>Intention-based design</th>
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<tr>
<td>AV will start moving</td>
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<td>AV starts moving</td>
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<th>Cooperation Capability</th>
<th>Perception-based design</th>
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<td>AV gives way</td>
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<th>Environmental perception</th>
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<td>AV has detected (one or more) other/specific TPs</td>
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D4.1: [https://www.interact-roadautomation.eu/projects-deliverables/](https://www.interact-roadautomation.eu/projects-deliverables/)
Intention-based design

AV gives way

AV will start moving
Perception-based design

AV has detected other TPs
Perception-based design

AV has detected other TPs
4th Objective:
Testing the novel HMI elements

• In total 10 different studies conducted so far at BMW, DLR and ITS Leeds, testing different eHMI and on-board HMI variants

• Research on:
  – Understanding the messages conveyed by Automated Vehicles (Lee et al., 2019)
  – Effects of eHMI on pedestrian and vehicle-AV interaction (Dietrich et al., 2019; Weber et al., 2019)
  – Comparison of different eHMI design variants (perception vs. intention based) (Kettwich et al., 2019)
  – Potential negative effects of eHMI designs
  – Multiple-actor scenarios
  – Effect of different urban scenarios on eHMI design

Lee et al. (2019)
Publications

Understanding the Value of External HMI in Communication of Intent by Automated Vehicles
Room: Crystal E/F
Wednesday, July 17, 2019: 1:30 PM - 5:30 PM

<table>
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<tr>
<th>Speaker(s)</th>
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<tr>
<td>Andy Schaudt</td>
<td>Project Director, Automated Vehicle Systems</td>
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<td>Virginia Tech Transportation Institute</td>
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<td>Josh Domeyer</td>
<td>Engineer</td>
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<td>Toyota Collaborative Safety Research Center</td>
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<td>Satoshi Kitazaki</td>
<td>Director, Automotive Human Factors Research Center</td>
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<td>National Institute of Advanced Industrial Science and Technology</td>
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<td>Azra Habibovic</td>
<td>Senior Researcher</td>
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<td>RISE Research Institutes of Sweden</td>
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<tr>
<td>Natasha Merat</td>
<td>Professor, Human factors and transport systems, Institute for Transport Studies</td>
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<td>University of Leeds</td>
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<td>Sid Misra</td>
<td>Co-founder and CEO</td>
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<td>Perceptive Automata</td>
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Upcoming activities of interACT
The challenge

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5th Objective
Methodology for assessing the quality of interaction
5th Objective:

Methodology for assessing the quality of interaction

- Measuring cooperation capabilities of AVs with other road users is a new area of research.
- Develop methodologies required to measure and quantify how the on-board user, the AV and other road users establish and use each-others’ intentions and behaviour
- Impact assessment, safety and user acceptance
Want to find out more?

• Come to our Final Event: 1\textsuperscript{st} of April 2020!
Thank you

@NatashaMerat

http://interact-roadautomation.eu

Anna Schieben
Project Coordinator
Anna.Schieben@dlr.de

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