AdaptIVe: Automated driving applications and technologies for intelligent vehicles

Jens Langenberg

Graz
30 September 2015
### Facts

<table>
<thead>
<tr>
<th>Budget:</th>
<th>EUR 25 Million</th>
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</thead>
<tbody>
<tr>
<td>European Commission:</td>
<td>EUR 14.3 Million</td>
</tr>
<tr>
<td>Duration:</td>
<td>42 months (January 2014 - June 2017)</td>
</tr>
<tr>
<td>Coordinator:</td>
<td>Aria Etemad, Volkswagen Group Research</td>
</tr>
<tr>
<td>8 Countries:</td>
<td>France, Germany, Greece, Italy, Spain, Sweden, The Netherlands, United Kingdom</td>
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</tbody>
</table>
29 partners
Motivation for automated driving functions

Zero emission
- Reduction of fuel consumption & CO₂ emission
- Optimization of traffic flow

Demographic change
- Support unconfident drivers
- Enhance mobility for elderly people

Vision zero
- Potential for more driver support by avoiding human driving errors
/// Potentials for automated driving

Drivers are supported in demanding or repetitive tasks. Travel comfort increases.

Vehicles dynamically adapt the level of automation according to the current situation.

Vehicles react more effectively to external threats.

Vehicles are resilient to different types of system and human failure.
Structure

Subproject 1: Integrated project (IP) management

Subproject 2: Response 4
Legal framework

Subproject 3: Human-Vehicle Integration
Collaborative automation

Subproject 4: Automation
in close-distance scenarios

Subproject 5: Automation
in urban scenarios

Subproject 6: Automation
in highway scenarios

Subproject 7: Evaluation
framework for automated driving applications
Demonstrators and Functions

- e.g. automated parking, parking assistance, ...
- e.g. intersections and traffic lights, urban roundabouts, ...
- e.g. cooperative merging, predicted driving, danger spot intervention, ...

Minimum risk manoeuvre
## Levels of driving automation acc. to SAE and VDA

<table>
<thead>
<tr>
<th>Level</th>
<th>LDW</th>
<th>LKA</th>
<th>Parking Assistance</th>
<th>Traffic Jam Chauffeur</th>
<th>Parking Garage Pilot</th>
<th>Robot Taxi</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td>No automation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>Assisted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>Partial automation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td>Conditional automation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td>High automation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td>Full automation</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Driver in the loop**
- No significant change with respect to existing driver assistance systems

**Driver out of the loop**
- Not in accordance with regulatory law (Vienna Convention of 1968, national road law)
- Shared responsibility for control between driver and system
  ➔ need for action

Source: SAE document J3016, “Taxonomy and Definitions for Terms Related to On-Road Automated Motor Vehicles”, issued 2014-01-16, see also http://standards.sae.org/j3016_201401/
Automation in highway scenarios: Innovation

- Improve energy efficiency using information of traffic control systems, digital maps and vehicle sensors, **predictive automated driving** style
- Particular manoeuvres like the minimum risk manoeuvres **transparently indicated** to other traffic participants
- Fault-tolerant and resilient **system architecture** for highly automated driving functions
Automation in highway scenarios: Innovation

- **V2V communication** protocols based on ITS G5 will be specified to enable dialog and negotiations before and during lane change or filter-in manoeuvres.
- **Driver take-over situations** e.g. from “partial automated” to “driver only” or “conditional automated” to “driver only” demonstrated and evaluated.
Level 3 Highway Chauffeur

- **Conditional automated driving** up to 130 km/h on motorways or similar roads
- From entrance to exit, on all lanes, incl. overtaking
- Driver must activate the system, but does not have to monitor the system
- Driver can at all times override or switch off the system
- Take over request in time, if automation gets to its system limits
- **Safety benefit** via relief of the driver: no exhausting, manual driving during long distance driving
- **Comfort benefit** via relaxing and use of selected infotainment functionalities
Functions Level 3 Highway Chauffeur

- Level 0: No automation
- Level 1: Assisted
- Level 2: Partial automation
- Level 3: Conditional automation
- Level 4: High automation
- Level 5: Full automation

- Enter and exit highway
- Cooperative response to emergency vehicles
- Following lane and vehicle
- Lane change and overtaking manoeuvre
- Stop & go driving
- Speed and time-gap adaptation
- Cooperative merging
- Danger spot intervention
- Predictive automated driving

Minimum risk manoeuvre

Autocontact 2015, Graz
Automation in highway scenarios:
Filter-in manoeuvres

This situation is hard to solve for an automated vehicle of the first generation!
Automation in highway scenarios: cooperative driving

Within AdaptIVe, a cooperative automated driving vehicle will send / receive and process the following information via vehicle-2-vehicle communication:

- status information
- information about the environment (collective perception)
- information about intention
Filter-in manoeuvres: Phase 1
Find a Gap!

sharing information about the environment (collective perception)
Filter-in manoeuvres: Phase 3
Conduct manoeuvre!
Transitions of control between automation and driver

As long as there are no fully autonomous systems, systems always have to interact with humans at different times and to different degrees.

Goal: Safe and efficient transitions
Human Factors: Ironies of Automation

- Automation takes over tasks that humans find annoying or are bad at
  - But: Operator has to monitor if the system is doing the right thing
- The more reliable the automated system, the lesser the human has to intervene and correct the automation
  - But: The lesser the human has to intervene, the harder it will be
Tasks

- Develop **high-level use cases** for test and development throughout the project
- Collect **research issues** on the interaction of drivers with automation in vehicles that currently remain uninvestigated or unresolved
- Conduct **experiments** in different laboratory settings, including dynamic driving simulators, and, if suitable, also instrumented test vehicles
- Create **functional requirements** and decision strategies for collaborative automation in particular situations
Thank you.

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// Timeline

**Timeline**

![Timeline diagram](image)

- **Jan 14**: Scenarios for legal aspects
- **Jan 15**: Use cases, Sensor fusion
- **Jan 16**: Midterm evaluation of HVI, Demonstrators equipped
- **Jan 17**: Final results, Definition of legal aspects
- **Jun 17**: Impact analysis

**AUTOCONTACT 2015, Graz**

25 | 30 September 2015
// Objectives

- Demonstrate automated driving in complex traffic environments taking into account full range of automation levels.
- Enhance perception performance in complex scenarios by using advanced sensors. Add support by cooperative and communication technologies.
- Provide guidelines for the implementation of cooperative controls involving both drivers and automation - for collaborative automation.
- Define and validate specific evaluation methodologies. Assess the impact of automated driving on European road transport.
- Evaluate the legal framework with regards to existing implementation barriers.
Within AdaptIVe a catalogue of Human Factors Requirements including categories of Agent State, Awareness, Arbitration and Action was established to see if automated vehicles will achieve the goal of safe transitions!

<table>
<thead>
<tr>
<th>Action</th>
<th>Axes</th>
<th>How to realize</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR31 Easy to deactivate Automation, but also prevent unintended de-activation</td>
<td>long</td>
<td>Double actions (buttons etc.) and placed at different locations</td>
<td>Buttons, switches etc. Visual and audio messages.</td>
</tr>
<tr>
<td></td>
<td>lat</td>
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<td>lat</td>
<td>Double actions (buttons etc.) and placed at different locations</td>
<td>Buttons, switches etc. Visual and audio messages.</td>
</tr>
<tr>
<td>FR34 Sounds should be distinguishable from other sounds</td>
<td></td>
<td>Double actions (buttons etc.) and placed at different locations</td>
<td>Audio</td>
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</table>