Working on research, legal and deployment issues in Europe for Automated Vehicles
Towards automated vehicles (Intro)

- Research activities in Europe
- Challenges
- Deployment issues

The AdaptIVe Research project

- Background
- Conception
- Application domain
- Features
- Work in progress
  - Function classification and legal aspects in Response 4 work
Towards automated vehicles

Input sources

- Sensors: radar (short/long range), camera (mono-, stereo-), laser scanner, ultrasonic, INU
- Digital maps
- Wireless communication (V2I, V2V)
Towards automated vehicles

Challenges

Real-time environment perception
- **reliability** of sensing has to be quantified;
- reliability has to be **improved** for real-life conditions (e.g., adverse weather conditions + complex traffic scenarios);
- Data fusion - perception algorithms

Automation control strategies
- Up to now focus on longitudinal control; **Lateral control** systems are predominantly advisory
- Complex use cases like overtaking, lane merging, and crossroad entering/exiting need more investigation

Human factors
- Driver becomes a **supervisor** of a system instead of a **manual controller** of the vehicle
- In partial and high automation, a capable driver is still required to resume manual control
- Profound insight is needed into the **determinants** of the quality of the **interaction** of the driver with the automated vehicle
- Most knowledge in relation to driver behavior is based on driving simulator studies and not real traffic conditions.
Towards automated vehicles

Deployment issues

• Vienna convention terms “driver” and “control” allow for open interpretations (CARS Stanford study)
  ○ A recent amendment has been made this year by the U.N. Working Party on Road Traffic Safety which would allow a vehicle to indeed drive itself, as long as the system “can be overridden or switched off by the driver“.

• Legal framework evaluation efforts by EU projects:

Many different stakeholders...this process is difficult and time consuming.
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Background

- Code of Practice for Driver Assistance Systems
- Partial automation incl. minimum risk maneuver in case of function problem
- BASt study on levels of automation — introduces speed range, automation function duration dimensions — discusses legal evaluation
- Integrated perception platform
- Active interventions for wide range of highway scenarios
- Aspects of shared control between the system and the driver
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Conception

- active interventions
- continuous support
- transitions among automation levels (user in the loop)
- cooperative support of neighbouring vehicles
- cooperative support of the infrastructure

...level of automation is set dynamically

...resilient to different types of system and human failure
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Concept

...level of automation can be set dynamically
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Application domain

- suited for mixed traffic
- real world complex environments
- provide adaptive support based on the driving task demand (bidirectional V2V also included)
- design “take over requests” based on system and driver state
- deployable in a short to medium time
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Levels of driving automation

<table>
<thead>
<tr>
<th>LDW</th>
<th>LKA</th>
<th>Parking Assistance</th>
<th>Traffic Jam Chauffeur</th>
<th>Parking Garage Pilot</th>
<th>Robot Taxi</th>
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</thead>
<tbody>
<tr>
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<td></td>
</tr>
<tr>
<td>level 0</td>
<td>level 1</td>
<td>level 2</td>
<td>level 3</td>
<td>level 4</td>
<td>level 5</td>
</tr>
<tr>
<td>No automation</td>
<td>Assisted</td>
<td>Partial automation</td>
<td>Conditional automation</td>
<td>High automation</td>
<td>Full automation</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, national road law)
- Extra risk with respect to product liability
  - "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/
The AdaptIVe: work in progress

Functions (1/2)

- Lane Following
- Lane Change (and overtaking)
- Stop&Go Driving
- Speed / time gap adaptation at a motorway entrance ramp
- Cooperative merging with speed adaptation
- Cooperative merging with lane change
- Danger spot intervention
- Predictive automated driving
- Enter and exit of a motorway
- Cooperative response on emergency vehicle on duty

BMW CONTIT VTEC VW

- Lat./long. control
- Lane change support (handle delays due to lane obstruction)
- V2I, V2V included
- Driver take-over situations
The AdaptiVe: work in progress

Functions (2/2)

- Park Assistant - Pholova app
- Construction Site Manoeuvre (simulation)
- Automated Parking Garage Pilot
- City Cruise
- Supervised City Control
- City Chauffeur
- Partially Automated Urban Driving

- Lat./long. control
- Low speed scenarios for parking apps with the driver both inside/outside the vehicle
- Complex urban scenarios incl. roundabout, traffic lights and intersections: lane change support, V2I for specific use cases
Response 4: work in progress

Functions’ classification

- Classification by level of automation and speed is not sufficient for further work in new vehicle models.
- Additional parameters are needed.
- Collect and structure parameters, limit to essentially needed ones.
Response 4: work in progress

Next steps

- Verify selection of classification parameters
  - from legal perspective
  - from functional safety perspective
  - from human factors perspective
  - Verify applicability with AdaptIVe functions

Result:
Final set of parameters for further work in Response 4
Response 4: work in progress

Legal aspects

- Cover relevant legal areas for industry
- Assess national laws for main target markets (Europe and overseas)
- Need for harmonization
- Built on function classification

<table>
<thead>
<tr>
<th>Vienna Convention</th>
<th>National Regulatory Law</th>
<th>Homologation -&gt; UNECE</th>
<th>Liability</th>
<th>Data privacy and data security</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Product liability/tort law</td>
<td>Ownership, Use, Tampering</td>
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<td>Criminal liability</td>
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Thank you.