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From interactIVe to AdaptIVe: Evolution of automated driving

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Outline

- From assistance systems to automated driving systems
  - Research activities
  - Challenges
  - Deployment issues
- The interactIVe outcomes
  - Objectives and automation areas
  - Lessons learned
- Automated driving in AdaptIVe

Automated driving | research activities

Input sources

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

Automated driving | European projects

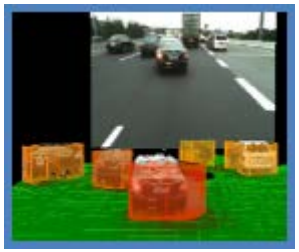
- active interventions
  - continuous support
    - transitions among automation levels (user in the loop)
      - cooperative support of neighbouring vehicles
      - cooperative support of the infrastructure

Adapt!/Ve Automated Driving

…level of automation is set dynamically

…resilient to different types of system and human failure

Automated driving | challenges

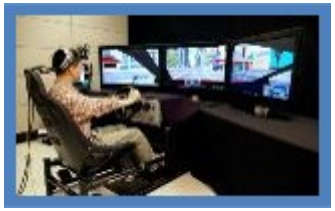


Real-time environment perception

- **reliability** of sensing has to be **quantified;**
- reliability has to be **improved** for real life conditions (e.g. adverse weather conditions + complex traffic scenarios);

Automation control strategies

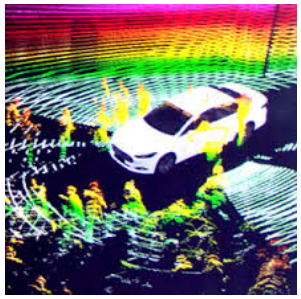
- Up to now focus on longitudinal control; **Lateral control** systems are predominantly advisory
- Complex use cases like **overtaking**, **lane merging** and **crossroad** entering/exiting need more investigation



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**;

Automated driving | deployment issues

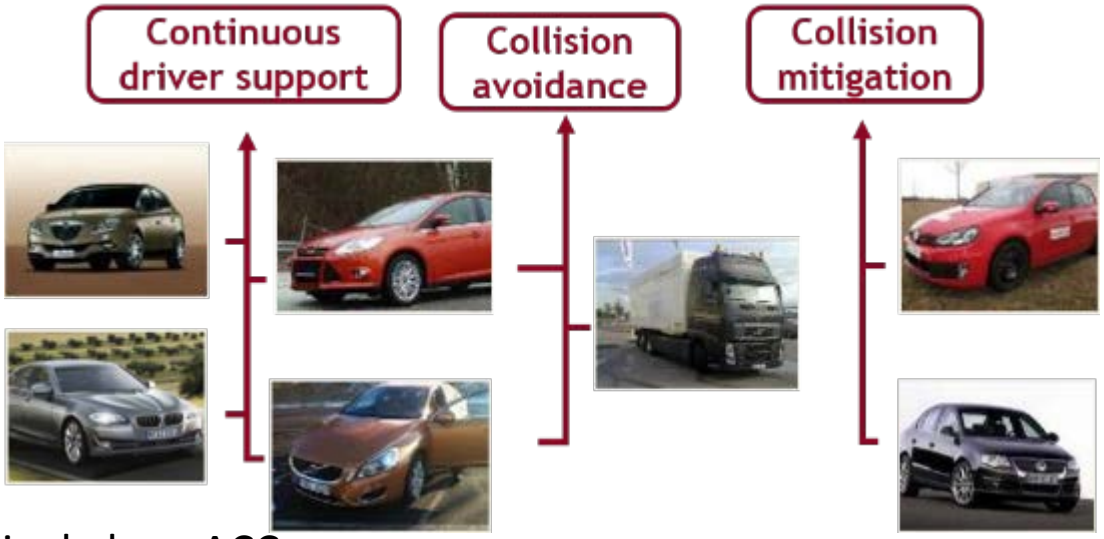


- legal and regulatory framework that implies that the driver must always be in full control of the vehicle

Geneva Convention on Road Traffic requires every vehicle to “have a driver” who is “at all times…able to control it””**---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".**

- high cost of the sensors required for the full environmental perception
- immature testing and evaluation in unconstrained real conditions

interactIVe



Current systems:

- independent functions for a dedicated task
- multiple expensive sensors
- mostly inform and warn up to single lane ACC

interactIVe

➢ Active intervention poses “hard” real-time requirements for application data processing & sensor fusion modules

- Design of a **unified perception framework** for multiple safety applications
  - Different sensor types and products attached based on the ***plug-in concept***
- Advance research on path control algorithms for **active collision avoidance** and **mitigation**
- Advance research on IWI strategies: **intervention transition** modes

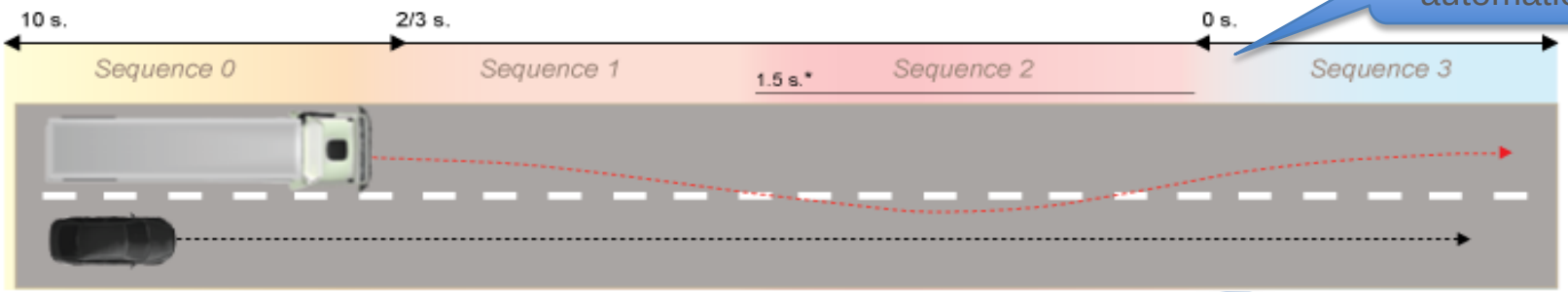
interactive | automation areas (1/2)

Partial + conditional automation (SAE)

- **integration of longitudinal and lateral support functions**
- **in a continuous and coherent way:** warning, advice, support, **temporary automatic vehicle control for collision avoidance**

interactive | automation areas (1/2)

Partial + conditional automation (SAE)



- Oncoming vehicle collision avoidance / mitigation
- Side impact avoidance (depicted above):
  - Lane Change Collision avoidance
  - Rear end collision avoidance
  - Run off road prevention (curve)
- Automated emergency braking
- Emergency Steer Assist

soft feedback on the steering wheel is provided supported by corrective steering

Auto-braking+ Evasive maeuver

Assisted mode: adapts its speed automatically to the curve radius ahead.

Achieve: optimized point of impact-- Any braking and/or steering intervention of the function can be overridden by the driver

interactive | automation aspects (2/2)

- **IWI strategies provide**
  - sequence of interaction
  - automation scale

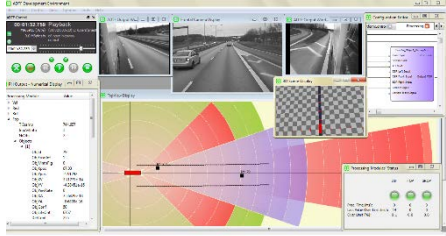
  …which allow the integration of a high number of ADAS

The **Driver Override Detection module** monitors the driver actions and decides if the driver is considered to be performing an action out of a predefined set that includes braking, steering, maneuvering and

- **Tests on System – User shared** control concept in highway, rural and urban environments with emphasis on haptic feedback

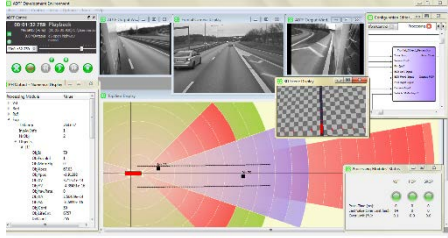
- **Legal aspects study**
  - vehicle type-approval for interactive functions according to relevant UN ECE
  - legal framework on EU-level

interactive | lessons learned (1/2)



- Often drivers start a reflexive reaction by counteracting the intervention to some extent:
  - Active interventions, especially when steering and braking are combined, requires further investigations with a larger set of subjects and situations.
  - The drivers should be allowed to overrule the functions. Which strategy is best depends on the function.
  - IWI strategies should ensure a smooth transition with regard to the different levels of human and system control. It appears convenient to group automation functions into modes of increasing degree of automation, as well as to the type of support and direction.

interactive | lessons learned (2/2)



- Obtain near real time perfrmance
  - **Real time OS** + **object-level fusion** (need for new sensors)
- Extensive evaluation of RunOfRoadPrevention
  - **Need for** common groundtruth data such as **road edge annotations**
- Longitudinal and lateral **optimal control models** for understanding driver's intentions can proliferate from **cognitive science based driver models**
- A very high reliability is needed for the **lane change manoeuvre** to ensure that the adjacent lane is free. Also, more efforts are needed to improve the **estimate of the vehicle position**, e.g. by implementing all the available signals and fully exploiting the GNSS techniques

Automation concept in AdaptIVe (1/2)

- Supervised automated driving deployed into **assistance**, **partial**, **conditional** and **high** automation
  - advanced parking applications;
  - stop&go functionality in high traffic/slow speeds
- **Full** automation will be studied for **special** situations:
  - return to a minimal risk condition;
- **Controlled and graceful degradation** from high to partial automation and from partial automation to driver assistance will be exploited as a strategy to manage complex scenarios in a robust and safe way.

Automation concept in AdaptIVe (2/2)

New features

- 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

→ …design and develop solutions for the automation of vehicles that will become **deployable in a short to medium time frame** in new vehicle models

Thank you!