Challenges in Automated Driving

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# Automated Driving – Automation Levels

<table>
<thead>
<tr>
<th>SAE Level 0</th>
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- **SAE Level 1**: driver in control / function-specific automation *(Park Assist)*
- **SAE Level 2**: driver responsible / combined function automation *(Traffic Jam Assist)*
- **SAE Level 3**: driver available / limited self-driving automation *(Highway Pilot)*
- **SAE Level 4**: driver not available / high self-driving automation *(Urban Automated Driving)*
- **SAE Level 5**: driver not responsible / full self-driving automation *(Full end-to-end Journey)*

**Today available in production:** L2

- **no automation**
- **driver assistance**
- **partial automation**
- **conditional automation**
- **high automation**
- **full automation**

- **eyes ON**
- **hands ON**
- **eyes OFF**
- **hands OFF**
- **hands temp. OFF**

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Automated Driving – Automation Levels

LEVEL 0-2
- **Fail silent** – driver owns responsibility
- Singular driving strategy – changes induced by driver (e.g. lane change)
- **Task** driven automation
- **Sometimes** no idea what to do

.. My lane keeping works fine ...

LEVEL 3-5
- **Fail operational** – robust w/o driver
- Holistic driving strategy – always know, what next (vehicle initiated lane change)

... don’t way here, pass ...

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Environment monitored by driver Environment monitored by system (non-monitored)
L5 Urban Driving Challenge

1. First ACC function
   If “object in lane” then control distance
   ➔ simple rule based approach

2. L2 Highway Driving
   Situation classification (passing, following, …)
   using typical situation features and simple forecast models and rule based approaches
   ➔ basic machine learning approaches

3. L5 Urban Driving
   Holistic approach required – will not work with simple logic or rules based
   ➔ Artificial intelligence, CNN etc.
Safety Challenge: Interior of the Future
Implication on Occupant Safety

Highly variable occupant position

- Adapted restraint deployment strategy
- New set of actuators (Airbags)
Impact of Comfort Position on Occupant Safety
Interior Observation Challenge

Driver position & posture is mandatory for next gen. Passive Safety

Grey-scale Image for classification

Highly accurate 3-D position measurement
**Unknown Environment Conditions and Robustness**

**Implication:**
- No 100% complete forecast of situations, conditions possible
- Design of algorithms cannot be done simple by deriving from specification

**Approach:**
- V-model approach on architecture and principle functionalities of each building block
- Data driven / test driven optimization through field and fleet experience
Safety Requirements and Functional Limitations

State of the art 2016

1. ACC: QM, False Positive Rate (Drop-in): 0,5/100km >> ~ 10⁻¹/h

2. AEB: ASIL B, False Braking: 0/1Mio km (~1/1Mio in statistics) >> ~ 10⁻⁴/h
   > rated as functional limitation, can be handled by driver

Automated driving demand

Demand for fully automated driving (L5) – full ASIL C >> 10⁻⁹/h
   > no differentiation between failure and functional limitation

⇒ Safety requirements will massively change on the way to automated driving

⇒ Transferring brute force validation approach would require: 10⁹hrs driving or 10⁵ Mio km

⇒ New approach required
Autonomous Driving Additional Challenges

- Legal requirements
- Ethical considerations
- Enabling ecosystem
- Technological requirements
Sensor Set Evolution

EU NCAP 2018 - front

⇒ from singular use case to redundant multi technology 360° sensing
Machine Learning Applications

- General Data
- Radar + Lidar Raw Data Processing
- Camera Raw Data Processing
- Automated Driving Decisions + Predictions

Artificial Intelligence
New approaches required

AI (Artifical Intelligence)
- Deep Learning
- Machine Learning

Rule based or pure analytical approaches will not cover complexity

http://freedesignfile.com/21619-various-audio-wave-light-vector-backgrounds-set-03/
https://www.youtube.com/watch?v=g-dKXOIsf98
Semantic Segmentation

- Each pixel of an image is assigned to a specific class, like pedestrian, vehicle, bike, tree, traffic sign, ground
- Objects are also detected based on the relative position compared to other objects
- Semantic Segmentation is holistic approach to understand the environment of the ego vehicle
Semantic Segmentation Video
Neural Networks for Decision Taking

1. DETECT (SEE)
   Sensing Errors

2. PREDICT / DECIDE (THINK)
   Situative Errors

3. PLAN

4. ACT
New Airbag Solutions and Algorithms
Robustness

Overall system complexity

Size and controllability of situations and conditions

Restricted area vehicles  Commercial vehicles  Passenger cars

Vehicle class (number of units)
ZF Innovation Tractor
Autonomous operations and active safety

Autonomous Coupling

Active Surround View System
ZF ProAI

Artificial Intelligence for Everywhere
SUMMARY

• AD means tremendous complexity increase over ADAS

• Environment Perception is key technology & key limitation – all technologies will be involved

• Occupant safety becomes a game changer – old rules not applicable anymore

• Machine learning and artificial intelligence are key for sensing and situation assessment