Safe and Dynamic Driving towards Vision Zero
Advanced Driver Assistance Systems – Pacemaker for Automated Driving

Dr.-Ing. Peter E. Rieth, Continental Division Chassis & Safety

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## Assisted towards Automated Driving

### Definitions

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
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<tbody>
<tr>
<td>Level 0</td>
<td>The driver continuously accomplishes either lateral or longitudinal control. The other/remaining level.</td>
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<tr>
<td>Level 1</td>
<td>The driver continuously (throughout the complete trip) accomplishes longitudinal (accelerating/breaking) and lateral (steering) control.</td>
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<td>Level 2</td>
<td>The system takes over lateral and longitudinal control (for a certain amount of time and/or in specific situations). The driver must permanently monitor the system.</td>
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<tr>
<td>Level 3/4</td>
<td>The system takes over lateral and longitudinal control for a certain amount of time in specific situations. The driver need not permanently monitor the system as long as it is active.</td>
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<tr>
<td>Level 5</td>
<td>The system takes over lateral and longitudinal control completely within the individual specification of the application. The driver need not monitor the system.</td>
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Source: BASt-study - Definitions of Automation and Legal Issues in Germany, 25th July 2012, Tom M. Gasser / Daniel Westhoff, German Federal Highway Research Institute
The basics
If a car assists you or drives you automatically, it has to…
Assisted towards Automated Driving (Level 1)

Roadmap

One Sensor, one Function

Front Short Range Lidar
- Warning/prefill and warning initiated driver emergency braking/steering functions or autonomous emergency braking (crash avoiding up to 30 kph)
- Airbag deployment with discrimination

Front Mono Camera
- Lane Departure Warning
- Lane Keeping Assist
- Traffic Sign Recognition
- Intelligent Headlamp Control

Front Long Range Radar
- ACC with Stop&Go
- Run-up warning / mitigation / avoidance

Side Short Range Radar
- Blind Spot Warning
- Lane Change Assist
- Rear Cross Traffic Alert, Safe Exit

Front Stereo Camera
additional:
- Pedestrian Protection
- Magic Body Control

Human Assisted driving in simple scenarios
Assisted towards Automated Driving (Level 1)

Roadmap

Multiple Sensors (fusioned), Advanced Assist Functions

Fusion of Front Short Range Lidar & Front Camera (SRL-CAM)
- Warning / prefill and warning initiated Driver emergency brake / steer assistance
  or autonomous emergency braking (collision avoidance up to 50 kph)

Fusion of Camera & Front Long Range Radar & C2X Comm *
- Warning/prefill and warning initiated Driver emergency brake / steer assistance in entire speed range or autonomous emergency braking (collision avoidance up to 50 kph)
- FSR-ACC with automated Stop&Go
- Potential for Magic Body Control
- Potential for networking with V2X and backend communication *
- Potential for Intersection / Turning Assist *

* under development
Assisted towards Automated Driving (Level 2) Roadmap

Multiple Sensors, Partially Automated Driving

Fusion of Camera & Front Long Range Radar & C2X Comm. *
- Highway Companion

* under development

- Human Assisted driving in complex scenarios
- Partially Automated driving at lower speed in simple scenarios

2000  2013  2016  2020  >2025
Automated Driving
Motivations & Success Factors

Motivation 1:
Converting driving time to higher valued time

Success depends on consumer valued benefit/cost ratio

Motivation 2:
Accident-free driving, the prerequisite for Motivation 1 (boosting Vision Zero)

Success depends on economic valued benefit/cost ratio
(e.g. 174 bn. €* economic saving potential in EU should be motivation for politics)

Acc. to European Commission, Directorate General Information Society and Media, Informal document No.: ITS-13-07 (13th session of ITS, 23 June 2006, agenda item 3.) in 76% of the cases the human is solely to blame of all road accidents. 174 bn € = 229 bn € * 0.76
Assisted towards Automated Driving

Roadmap

Level of Automation

Safety ADAS pacemaker for Automated Driving

- Human Assisted driving in complex scenarios
- Human Assisted driving in simple scenarios
- Partially Automated driving at lower speed in simple scenarios
- Highly Automated driving at lower speed in complex scenarios
- Fully Automated driving at higher speed in complex scenarios

Jump (Liability, Fallback)

2000  2013  2016  2020  >2025
Continental Automated Driving
Example: Test Drive in Nevada
Thank you for your attention!
Safe and Dynamic Driving towards Vision Zero
Accident situation in the EU\(^1\) –
Accidents with injuries and fatalities by kind of accident

- **350,000 accidents w/ injuries and fatalities** will be addressed by one of the AEB system
- Considering accidents with property damage only e.g. additional **1.100.000 accidents**\(^2\) are addressed in Germany.

\(^1\) Source: IRTAD 2003, Interpolation to 2010 using national statistics

\(^2\) 22% out of ~5 Mio. accidents w/ damage only; Bosch Accident Research Analysis 2009, AZT/Bosch database 2004-07
Distribution of the driver behaviour prior to rear-end crashes based on German data using GIDAS

Typical AEB-functions:

- Driver Warning
- Braking support
- Automatic braking

- 100% All rear-end collisions
- 20% Emergency braking, but too late
- 49% Insufficient braking force
- 31% Inactive, no braking

1) Bosch Accident Research Analysis of GIDAS database, ESV 2009, Paper No. 09-0291
Benefit of AEB (avoidance potential) with example on AEB Inter Urban based on German data using GIDAS

AEB systems have a high potential to reduce **rear-end collision accidents**.

1) Bosch Accident Research Analysis of GIDAS database, ESV 2009, Paper No: 09-0281
   Results shown assuming realistic driver model
Synergies and Additional Benefit using AEB technology

**AEB**

<table>
<thead>
<tr>
<th>City</th>
<th>Inter Urban</th>
<th>Pedestrian</th>
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<tr>
<td>Functions based on lidar/radar/video technology</td>
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</table>

**Benefits for the society**

**Reduction of:**

1. Rear-end collisions
2. Accidents involving vulnerable road users

→ Reducing number of fatalities and injuries and property damage cost

**Additional reduction of:**

3. CO₂ Emission
4. Traffic Jams
5. Risk of rear-end collision
6. Accidents caused by speeding
7. Accidents leaving carriageway and collisions with vehicle moving laterally in same direction