SAFETY ADAS - PACEMAKER FOR AUTOMATED DRIVING

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ABSTRACT

Automated driving is no longer blue sky thinking but progressively becoming a reality. The various levels of automation build on the ongoing enhancement of Advanced Driver Assistance Systems ADAS that ease the load (physically and mentally) on the driver in specific use cases. At assistance level, the driver is still obliged to permanently monitor the behavior of the vehicle. Driver Assistance Systems help in handling situations where cognitive or physical responses are overtaxed, be it at the stability level of driving, with Anti-lock Brake System ABS or Electronic Stability Control ESC, or at the guidance level, through "Safety ADAS" functions such as Emergency Brake Assist EBA or Emergency Steer Assist ESA.
At automation levels longitudinal and lateral guidance tasks are increasingly being taken over completely, with the significant change of the driver's role with regard to relieving monitoring obligation, consequently a shift of liability from the driver to the system/vehicle manufacturer.
The following paper provides an overview of the current state of knowledge of the various levels of automation from driver assisted vehicle operation to highly automated driving.

INTRODUCTION

Despite a tangible increase in the volume of traffic in the EU over more than a decade, the numbers of fatalities have been significantly reduced.

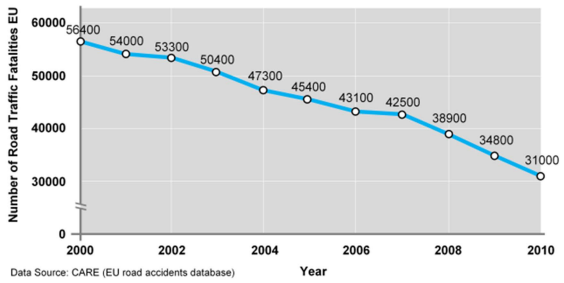

Figure1. Road Traffic Fatalities EU 2000-2010.

Along with traffic policy and road-safety education measures, the main contributory factors here have been safety technology measures such as the continuous improvement of active and passive vehicle safety (see Fig. 1).

Continental has demonstrated with the integral safety system ContiGuard® that further development in traffic safety must include – in addition to the individual active/passive safety domains – in particular the complete network and the integration of vehicle surrounding specific information as well as the Human Machine Interface HMI. ContiGuard® covers therefore all safety functions by integration of crash prevention and injury mitigation measures, vehicle surrounding sensors, Human-Machine-Interface (HMI) and Safety Telematics, including driver assistance (see Fig. 2). Instead of "Comfort ADAS", which adresses mainly enhanced driving comfort this paper considers "Safety ADAS", i. e. challenging driving situations where safety of the occupants and other road users is endangered.

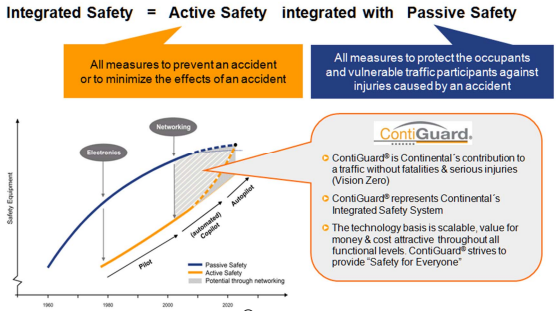

Figure2. ContiGuard® - Integration of active and passive safety.

Driver Assistance Systems (DAS)

At present, assistance systems are largely based on sensors within the vehicle itself, such as sensors for wheel speed, steering angle, longitudinal and lateral acceleration, yaw rate, roll rate, etc. (which serve primarily the assistance systems at the stability level).
Safety systems that have been introduced on a largely standardized basis, such as seat belts, electronic

braking and control systems, anti-lock brake systems ABS, front, side, and head airbags, brake assist features, and electronic stability control ESC already ensure stable, skid-free driving with short braking distances and offer comprehensive protection for the vehicle's occupants.
Driver assistance systems function at all three levels of the driving task: the stability level, cruise level, and navigation level (Fig. 3).

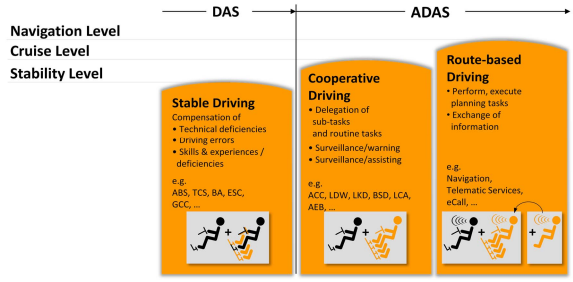

Figure3. The three levels of the driving task and their assistance systems.

These systems compensate for "technological deficits" in the driver's control of the car as a driving machine (one brake pedal, one gas pedal, one steering wheel, but four wheels that are braked, or two or four wheels that are driven or steered, examples: Anti-lock Brake System ABS, Traction Control System TCS, Brake Assist BA, Electronic Stability Control ESC and Global Chassis Control GCC).

From Driver Assistance Systems (DAS) to Advanced Driver Assistance Systems (ADAS)
New generations of vehicles are increasingly being equipped with sensors that monitor the vehicle's surroundings (see Fig. 4), such as those that measure distance (ultrasonic, radar, lidar) and imaging sensors (cameras). In the medium term, these "built-in" onboard sensors will be joined by others that make it possible to communicate with other vehicles (V2V) and the infrastructure (V2I).

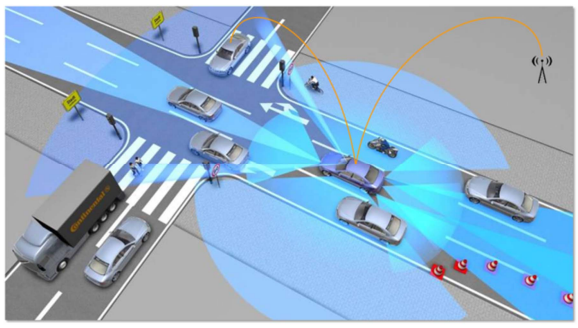

Figure4. Vehicle surrounding sensing - from basic to complex traffic scenarios.

These sensors will expand the "field of vision" of the vehicle's own built-in sensors by not only seeing farther, but even being able to look ahead to what lies "around the corner."

With Safety ADAS such as collision warning, active emergency braking, or lane departure warning and lane keeping – all of which are already offered today in many vehicles – the driver still does all of the driving himself or herself, with situation-specific assistance from these systems.

At the same time, driver assistance functions are becoming increasingly comprehensive, the networking of the functions increasingly intensive, and the physical vehicle operation by the driver is fading more and more into the background. For example, the lane departure warning feature is evolving into a lane keeping assistant that gives-by gentle torque overlay-the driver lane guidance and protects him with active steering intervention from unintended lane departure (see Fig. 5).

Figure5. Lane Departure Warning / Lane Keeping Device, Key Component Camera.

From Assisted Driving to Automated Driving
Automated driving relieves the driver from the task of driving, both physically and mentally, consequently eliminating human error – the sole cause of over 70 percent of traffic accidents. Thus automated driving subsequently leads to/targets accident-free driving. It builds on the Safety ADAS systems as described in the previous chapter.

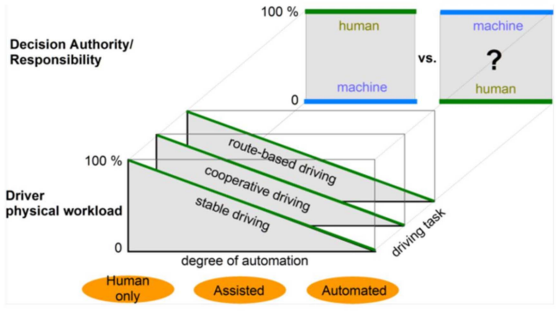

Figure6. Workload vs. Decision Authority/ Responsibility.

It needs to be distinguished whether the driver still has to take on at least a monitoring function, or whether the machine drives completely automatically, without any control by the human driver (see Fig. 6).

CONCLUSION

Automated driving gives the driver freedom to perform non-driving related tasks, making the car a highly attractive means of transportation (see Fig. 7). Time spent driving is no longer wasted, but becoming driver valued time. Safety ADAS forms the basis and in this way acts as a pacemaker for automated driving. Before this goal is reached, however, there are still numerous big challenges that must be overcome in terms of development in the field of surrounding area sensing and interpretation, control of the vehicle's movement and the safety architecture with regard to the consequences of system failures (requires fail-safe as fail-operational). Progress in electronics (computing power, memory, sensors and actuators) will make it possible to overcome these challenges. Electronic components and systems never experience a "reaction delay" – they are always wide awake.

Figure7. Roadmap – From Driver Assistance Systems to Automated Driving. Definitions according to BASt.

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