RESEARCH REPORT
ABOUT Automotive

Active Safety Systems: 2017 edition

THE BLUEPRINT FOR TOMORROW'S AUTONOMOUS MOBILITY LANDSCAPE

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STATUS QUO: SAFETY REQUIREMENTS & REGULATIONS

2.1 PHILOSOPHY OF INTEGRATED SAFETY

As explained in chapter 1, the process of vehicle safety does not start after an actual crash has occurred. Nowadays, safety standards are being designed to take into consideration accident avoidance and mitigation techniques in all phases of driving. If we compare the performance of vehicles on the market just a couple of years ago with that of current vehicles, the progress made in this discipline is stark.

Before we discuss the implications of different phases of driving on vehicle safety requirements, it is imperative to understand those phases. Werkmeister et al. in a paper titled 'A Balanced Active & Passive Safety Concept for New Vehicle Generation' explained[1] various driving phases. A simplified version of their phase model along with safety requirements has been shown in shown in Table 1.

TABLE 1 Phase model for driving safety

Phase	Philosophy	Safety Requirements
Stage 1: Before driving	The driver is alerted beforehand about the on-road situation. The information can be obtained by on-board sensors and infotainment apps.	• Imminent traffic. • Alternative routes. • Weather report. • Vehicle health report. • Seating position, mirror adjustment etc. according to route.
Stage 2: Normal driving	Make driving stress free with dynamic and continuously monitor the ambient environment.	• Distraction-free Human Machine Interface (HMI). • Advanced lighting option (if visibility is low). • Advanced cruise control (ACC). • Windshield de-icing options (in snowy weather). • Suspension control, heading control etc.
Stage 3: Warning phase	Drivers are informed about any safety deficit in a timely manner and required to take necessary action to avoid any accident.	• Real-time driver feedback. • Steep cornering. • Over-speeding. • Lane diversion. • Harsh braking/acceleration. • Entering/leaving tunnel.
Stage 4: Pre-crash phase	Sensors detect a high probability of an imminent crash and intervene autonomously, without requiring any explicit action from driver.	• Activate restraint systems. • Adjustment of belt configuration, seat positions. • Pedestrian detection system.
Stage 5: CRASH phase	All sorts of occupant safety systems are activated.	• Multiple airbags. • Vehicle crashworthiness. • Pedestrian protection system. • Anti-whiplash systems. • Child protection systems. • Padded dashboards. • Pop-up dashboards. • Contact adhesives (patent Google).
Stage 6: Post-crash phase	Rescue measures are taken to deal with the secondary impacts of the accident.	• eCall. • Fire suppression. • Tank integrity. • Roadside assistance.

Source: Werkmeister et al/ABOUT Automotive

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SENSOR FUSION: A TECHNOLOGICAL OVERVIEW

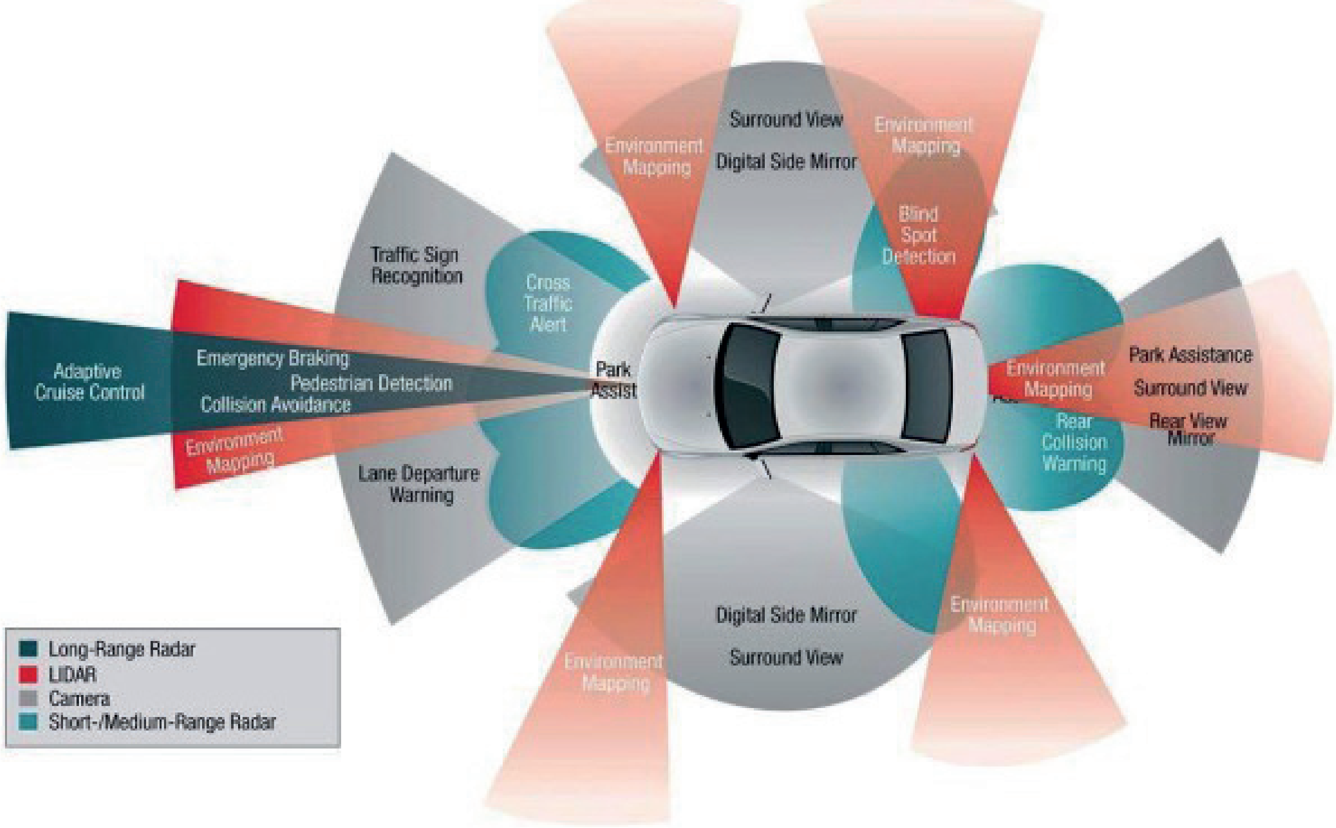
3.1 WHY PERCEPTION IN A PRE-CRASH SCENARIO IS CRUCIAL

The basic premise for any pre-crash perception system is to make use of more anticipatory and descriptive sensors than the current accelerometer-based approach to detect a collision beforehand. The system then communicates this information to the vehicle and its occupant protection systems and takes appropriate actions to prevent the collision from happening.

Koopman et al. in a paper[1] titled 'Pre-Crash Sensing Countermeasures & Benefits' categorized the traditional pre-crash sensing systems in two forms; reversible and irreversible.

The first category encompasses features that are activated just before a potential crash, but usually have the capability of being reset in case the crash does not occur. Examples include airbag pre-arming, non-pyrotechnic seat belt pre-tensioning, bumper extension or lowering, and emergency autonomous braking.

FIGURE 5 Sensors used in Active Safety



Source: TRW

for monitoring different states of alertness. A variety of metrics have been proposed and refining the most relevant metrics for fatigue monitoring is likely to be a focus of future research for aftermarket system development.

Some vehicle manufacturers are using CAN-based drowsiness monitors using a wide range of vehicle control measures. These systems may have a place in the market as an OEM offering to be used by automotive manufacturers and as an aftermarket option to fleets.

The costs associated with driver drowsiness and distraction devices vary substantially ranging from $150 to $2,000 (Forseman et al.).

CASE STUDY

AUTONOMOUS EMERGENCY BRAKING (AEB)

WHAT IS AEB?

AEB systems are part of advanced 'pre-emptive' safety technologies that takes the functionality of a collision warning system to the next level. As previously explained in Chapter 4, FCW systems monitor the ambient traffic ahead of the road and issues a warning if a collision is detected. AEB systems add the 'mitigation' part on top of FCW systems and intervene by braking the car automatically should the driver fail to either acknowledge the warning or take necessary action. Euro NCAP further simplified[12] AEB systems by defining each of its elements on its official website;

- ***Autonomous*** – the system acts independently of the driver to avoid or mitigate the accident;
- ***Emergency*** – the system will intervene only in a critical situation; and
- ***Braking***– the system tries to avoid the accident by applying the brakes.

AEB systems improve safety in two ways: firstly, they help to avoid accidents by identifying critical situations early and warning the driver; and secondly they reduce the severity of crashes which cannot be avoided by lowering the speed of collision and, in some cases, by preparing the vehicle and restraint systems for impact.

HOW DOES IT WORK?

Generally, AEB systems use millimetre wave radar, stereo cameras (mostly), LiDAR alone or a combination of any two or three of these to monitor their environment and detect potential threats. The 'perceived' information is then fed to complex algorithms that analyse the sensor data to identify collision partners by collating it with the vehicle's motion data, their relative position, speed and therefore the collision threat (see Figure 23). The speed range within

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- Discussion about connectivity between one vehicle and another (V2I) and between a vehicle and the infrastructure (V2I);
- An examination of the fusion of sensor systems that now constitute active safety principles and the innovations that have been recently introduced;
- Developments in ADAS and active safety applications; and
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