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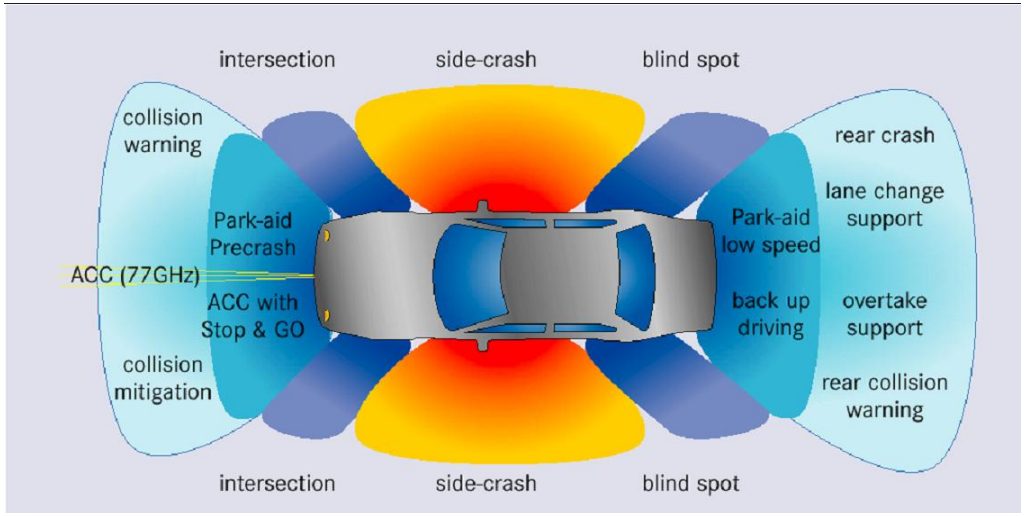
Technical feasibility of safety related driving assistance systems



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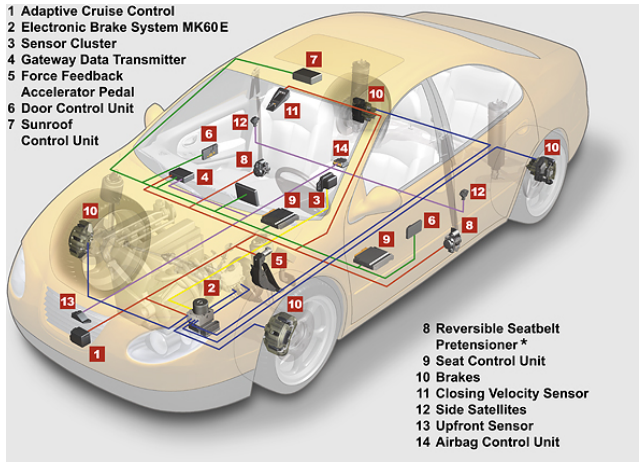
Abstract

This paper explores the technical feasibility of five functions of driving assistance systems to contribute to road traffic safety, to reach stated EU road traffic safety targets. Enabling technologies, their maturity level and development path, with a view on possible large-scale implementation, are addressed. State-of-the-art and potential of enabling technologies like positioning, radar, laser, vision and communication are analysed from a technical perspective, and possible obstacles for large-scale dedicated driving assistance systems implementation for road traffic safety are discussed.

Keywords: driving assistance systems, safety, sensor technologies, communication, autonomous systems, co-operative systems

Measures for improving traffic safety

- legislation and regulation
- change of driving behaviour promoted by enforcement, information, education and driving instruction
- vehicle related measures
  - – passive components, e.g. car structure, head restraint, seatbelts and airbag
  - – active components, e.g. quality of tyres, electronic stability control (ESC), anti-lock braking (ABS)
  - – driving assistance systems
    - infrastructure based (v2i)
    - non-infrastructure based
      - – autonomous system
      - – co-operative system (v2v or IVC)
  - – telematics
- physical road infrastructure related measures



Overview of safety related driving assistance systems (1)

system function	definition and/or description	level	impact
navigation system	provision of vehicle positioning, route calculation and route guidance	I + S	lon
adaptive cruise control (ACC)	automatic control of speed and distance in relation to the proceeding vehicle in the same lane	C	lon
adaptive light control (ALC)	dynamic aiming headlamps and situation adaptive lighting	S	lon
vision enhancement	assist the driver's vision capability in adverse lighting and weather conditions by providing enhanced visual information.	S	lon
lane keeping assistant (LKA) (= lane departure avoidance)	assist the driver to stay in lane (on unintentional lane departure or road departure) by warning (e.g. by rumble strip sound) and/or semi-control of the vehicle (by force feedback on the steering wheel) and/or full control	W / C	lat

I: information, W: warning, C: control, S: support, lon: longitudinal, lat: lateral

Overview of safety related driving assistance systems (2)

system function	definition and/or description	level	impact
lane change assistant (LCA) (= lateral collision avoidance)	for change-of-lane manoeuvres, provide information about vehicles in adjacent lanes, and/or warning for potential collision, and/or vehicle control in case of imminent collision	I / W / C	lat
legal speed limit assistance	assist the driver in keeping within (static or dynamic) legal speed limits	I / W / C	lon
curve speed assistance	assist the driver in keeping within an appropriate and safe speed in a curve	W / C	lon
dangerous spots warning	assist the driver by providing information or warning on a dangerous location (based on accident statistics) at inappropriate speed	I / W	lon
stop and go (S&G)	assist the driver by taking over full vehicle control in congested stop-and-go traffic at low speeds (automated lane keeping and platooning)	C	lon

Overview of safety related driving assistance systems (3)

system function	definition and/or description	level	impact
anti-collision systems	warn the driver in case of an imminent forward collision, and/or provide automatic control of the vehicle in such situation	W / C	lon
intersection collision avoidance (ICA)	avoid collisions at intersections by warning or control - two types are foreseen: - based on radar and/or vision - based on vehicle positioning and short-range communication - requires all participating vehicles to be equipped	W / C	lon
intersection negotiation	regulate motor vehicle traffic at intersections based on vehicle positioning and short-range communication in all participating vehicles	C	lon
autonomous driving	fully automated driving in controlled motorway situations at all speeds by full lateral and longitudinal control	C	lat + lon

Conclusion

Of the various technologies that are discussed in this paper, navigation is mature and speed assistance options are in development, pointing the way to large-scale implementation. However, complete and up-to-date coverage of speed limits in digital map needs to be organised. In general, the introduction of integrated speed assistance and navigation may reduce the need for, and urgency of the various other systems that are being developed, as most safety effects will be achieved cost-effectively by these two integrated systems. Furthermore, they may establish a platform in the vehicle for future integration of other driving assistance system applications, as well as contribute to traffic flow improvement. Other technologies that are mature and could be easily large-scale applied are lane keeping by use of magnetic line marking and computer vision.

The other discussed technologies (based on radar, laser, video imaging, communication and/or satellite positioning) are promising, and can also contribute to traffic safety, but need still considerable improvement in robustness, reliability and cost. The difficulties do not only relate to the sensor technologies that are being employed, but also to other design parameters, like e.g. the algorithms for reliable detection of VRUs. Systems based on v2v communication and vehicle positioning seem conceptually to be the most promising, although they do not take into account VRUs.