Open Invited Session on

"Challenges and Future Directions of Autonomous Driving"

Registration Code: uevan (to be used when submitting your papers)

Organized by

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Abstract

Recently, the trend of automated driving systems (ADS) is a growing application field that offers the potential for a safe and efficient future of mobility. Nonetheless, based on the SAE J3016 Level 3 or higher level, ADS must handle changing traffic conditions during operation. A variety of subsystems have to sense and comprehend the environment while correctly predicting the behaviour of other road users. Hazardous situations must consistently be recognised to choose the safest trajectory. In addition, the ADS has to be attentive to enter a safe state in case of leaving the operating limits. For this reason, combining all subsystems into a unified and functioning self-driving system is a significant challenge, providing the opportunity to continuously improve an ADS's capabilities. At the same time, the safety of the occupants and compliance with standards and road regulations must always be achieved. This invited session will allow academic and industrial researchers to exchange their ideas and thoughts to find common problems and solutions for developing and safeguarding ADS.

Detailed Description

The mobility on our roads is constantly changing. With the passage of time and the increase in computer technology at the end of the 20th century, digitisation is increasingly becoming the focus of the automotive industry. Vehicles are becoming more efficient, comfortable, and safer. These advantages in mobility are due in part to the development of driver assistance systems. Current driver assistance systems that take over subtasks from the human driver are, for example, adaptive cruise control, lane departure warning, and emergency brake assistants. A primary goal of current automotive research is not only to bring other assistance systems to market, but also to develop a holistic ADS that can independently recognise and solve any situation in road traffic without human assistance. In order to provide a structure for the autonomous progress of vehicles, SAE J3016 defines five automation levels. The higher the level, the higher the resulting autonomous capability of the vehicle is. The grand ambition of ADS with SAE Level 4 or higher with highly automated and complex systems has great potential to improve our mobility. In the future, such vehicles should be able to operate fully autonomously in various cities and areas to counteract a shortage of drivers or to optimise the transportation of goods. To make this possible, the current capabilities of autonomous systems on the road must be increased and surpass those of a skilled human driver. At the current state of the art, approved ADS are only within the range of partial autonomy, and thus, between SAE J3016 Level 3 and 4. Therefore, it is necessary to strive for increased research and development for the set goals of higher SAE J3016 levels.

Nonetheless, this task accommodates significant challenges for ADS, such as research on take-over requests (TOR) and human-ADS interface implications. The current research on TOR and its regulations still needs to be reviewed. A Level 3 system must account for the liability of driving several seconds autonomously after a TOR, while the occupants and other traffic participants must be secure. After exiting the operational design domain (ODD), which describes the operating limits of an ADS, minimum risk condition (MRC) manœuvres have to be executed. When an MRC occurs, the ADS system must reach a safe state so that the occupants and other road users are not exposed to any risk. Critical scenarios like manœuvring on a freeway from the left lane to the shoulder on the right can be a risk for other traffic users. Therefore, there is a need for commensurate hazard analysis and risk assessment (HARA) to ensure that such a manœuvre does not risk others. Other research gaps are existing HARA practices and the need for ADS safety analysis. Many approaches, standards, and regulations in the automotive industry are focused on single vehicle failures only, such as the fault-tree analysis (FTA), IEC 61025, failure-mode effect analysis (FMEA), US Federal Motor Vehicle Safety Standards

(FMVSS) or Functional Safety Standard ISO 26262. Current methods are not easily transferable to autonomous driving because an ADS must consider a safety analysis in the context of the ADS driver's behaviour and the reaction of other drivers on the road. Another aspect to discuss is ADS without passengers, such as small vehicles carrying food or even hazardous goods, and autonomous trucks carrying oversized payloads. Compared to an ADS intended to carry passengers, ADS with only freight transport have different requirements in terms of comfort and safety analysis since the risk to passengers does not have to be taken into account.

In addition to the examples already mentioned, there are many other aspects like the general development of an ADS, operational challenges, or the interoperability between transport systems that need to be considered. For this reason, it is essential to bring together academic and industrial researchers to jointly explore potential solutions for current development and resolution of complex problems in ADS. Therefore, this open invited session seeks to find new approaches, limitations, surveys, challenges, and future directions for developing and safeguarding ADS.

The topics of interest include, but are not limited to:

- Research gaps between existing HARA practices and the need of ADS safety analysis
- Review of research related to take over requests (TOC)
- Trajectory planning and review on minimum risk condition (MRC) manœuvres
- Behavioural prediction of other vulnerable road participants
- Deep learning, sensor fusion and other methods which incorporate hazard analysis in the driving control loop
- Comparing (hazardous) freight ADS with passenger carrying ADS
- Definition and monitoring of the operational design domain (ODD) of an ADS
- V2X communication protocols for connected ADS and auxiliary applications (*e.g.*, remote control)
- Cybersecurity and privacy aspects
- Surveys on the current state of the art and open topics about ADS

Proposed TC: 7.5. Intelligent Autonomous Vehicles