RESEARCH NEWS

Dynamic risk management

On the road with autonomous vehicles — safe and reliable

An important challenge for the acceptance of autonomous driving is to ensure the safety of road users without risking a loss of speed. A team of scientists from the Fraunhofer Institute for Experimental Software Engineering IESE, the Fraunhofer Institute for Cognitive Systems IKS, and the University of York has now developed a dynamic risk management system as part of a reference safety architecture. This provides a vehicle with a better understanding of current driving hazards. AI capabilities are used to analyze and account for influencing factors such as the driving behavior of other road users.

With today's state-of-the-art technology, building self-driving cars that are safer than human drivers would result in a loss of speed and comfort and further decrease the acceptance of autonomous mobility. This was the result of a study by the Insurance Institute for Highway Safety, an American traffic safety organization that regularly publishes research on autonomous driving. Pilot studies by German automakers also confirm passengers' perception that autonomous vehicles are mostly slow and hesitant. A key challenge to introducing autonomous systems onto the market is thus to ensure safety without limiting speed and comfort so much that acceptance disappears.

In the LOPAAS project (Layers of Protection Architecture for Autonomous Systems), Fraunhofer IESE, Fraunhofer IKS and the University of York, all central research institutions in the field of safety assurance of complex (software) systems, are pursuing the goal of enabling autonomous vehicles to drive faster and more safely. The results of the project will then be incorporated into standards for technology transfer purposes. The partners are pooling their expertise to develop a reference safety architecture and arguments for automated driving and autonomous systems. Fraunhofer IESE is contributing its expertise in dynamic risk management, which enables autonomous systems to assess and control the risks of their options for action in a situation-specific manner, while ICS is focusing on trustworthy AI-based situation detection as well as runtime monitoring of the associated uncertainties. The University in York is contributing its expertise in systematically generating comprehensive and traceable safety reasoning.

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New safety concepts for robotaxis and highway pilots

The project partners are developing innovative safety concepts for the two major application areas: on the one hand, for robotaxis and roboshuttles — self-driving cars for one or more passengers — and, on the other hand, for highway pilots integrated into private cars, i.e., software that can completely take over the driving and steering function on well-mapped highway sections in simple weather conditions. The safety concepts are being investigated using specific usage scenarios of a highway pilot. With this digital "safety engineer," the research teams are bringing on board a system that makes automated driving more efficient for the various use cases while guaranteeing safety. Adapted to the traffic situation, the digital safety engineer reacts individually and influences the user's driving behavior and driving experience. In doing so, dynamic risk management assisted by AI enables anticipatory driving, maintaining the required distances to other vehicles and preventing hard braking.

Dynamic risk management dispenses with the calculation of worst-case scenarios

"Current approaches assume worst-case scenarios to ensure optimal safety. Among other things, they are based on calculations of physical laws governing how objects move. However, this leads to reduced speed of the vehicle. It is also difficult to correctly assess multiple risks that can occur simultaneously, such as a pedestrian suddenly appearing on the left of the vehicle and a cyclist on the right side of the vehicle," says Dr. Rasmus Adler, Program Manager Autonomous Systems at Fraunhofer IESE and project manager of LOPAAS. "The aim is to implement an understanding of risk in vehicles that does not calculate the worst case and thus does not overestimate all risks." For this purpose, the research team uses causal Bayesian networks to represent the joint probability distribution of all risk-relevant variables as compactly as possible, allowing the system to understand the dynamic context.

The researchers' new methodology is already being applied in the field of intralogistics: A project with Hitachi focuses on safe and efficient collaboration between autonomous mobile robots and human workers in industrial warehouses (see link below). The underlying solution principle is to replace static worst-case assumptions, commonly used for safety design, with dynamic safety mechanisms that utilize knowledge about the specific current situation of a driverless transport system. For example, the assumption of how likely a person is to move in the intended direction of travel of a machine can be more accurately estimated based on the current work task or previous movement of people at that location. This also allows the system to better estimate whether or not proactive braking is actually necessary. Systems should monitor the relevant characteristics of themselves and their context, project these properties into the future, and draw conclusions about their impact on risk. "In simple environments like warehouses, our approach to dynamic risk management works very well. Hitachi plans to equip its driverless forklifts with this. We will be optimizing our methodology for complex traffic situations with robotaxis and autopilots until the project ends in June 2024. For this

purpose, we are also using AI and data-driven models, which are essential for environment recognition and object classification," says Adler.

More information on the Fraunhofer IESE project with Hitachi:
https://www.iese.fraunhofer.de/en/customers_industries/hitachi-success-story-autonomous-robots.html

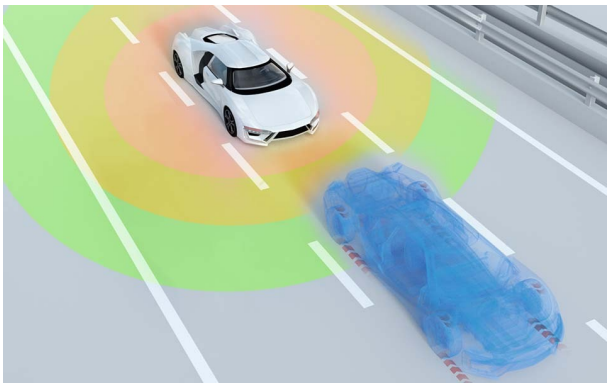

Fig. 1 Autonomous vehicles require a paradigm shift in safety engineering. The safety of passengers and road users must be ensured without risking any loss of speed.

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