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Experimental vehicles FASCar®-II and FASCar®-E

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Abstract: The main goal of the large-scale research facility FASCar® are scientific studies and analyses in the field of driver assistance and vehicle automation. This includes also studies of human behavior, acceptance studies, test of new assistance systems and automation, as well as user friendliness. FASCar® makes it possible to test and analyze innovative systems and developed functions in a simulated or even real traffic environment.

1 Introduction

Active interventions can make driving safer - used incorrectly, however, they can also cause danger. The Institute of Transportation Systems therefore developed driver assistance according to the driver's requirements and needs. To find out if the driver reacts correctly to the intervention of a new assistance system, test rides with a car capable of active interventions are the last logical step of development. These test rides can be performed by using the large-scale research facility FASCar®. This article provides an overview of the experimental vehicles FASCar®-II and FASCar®-E.

2 Technical Description

The large-scale research facility FASCar® consists of two experimental vehicles called FASCar®-E and FASCar®-II. The main difference between FASCar®-E and FASCar®-II is their special area of operation. FASCar®-E is developed for testing in real traffic environment and it has a road approval. FASCar®-II

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instead, caused by its hardware, can only be driven on test sites, but in exchange it offers a higher level of active interventions and a futuristic human machine interface (HMI).

2.1 FASCar®-E

The FASCar®-E is an electric 7^{th} generation Volkswagen Golf. It is equipped with a 115-hp electric motor. Considered all the build in technology its range is approx. 130 km (80miles). Its main goal is the research in the field of automation in public urban scenarios. For this research purpose the vehicle is modified with additional Sensors, a new HMI and a lateral and longitudinal control system.

2.1.1 Sensors

For environment recognition and vehicle localization FASCar®-E is equipped with four laser scanners and three long range radars which are mounted in front and rear bumpers of the vehicle, as well as an inertial measurement unit (IMU) with GPS aiding. A C2X-System is used for vehicle-to-infrastructure and vehicle-to-vehicle communication.

Figure 1: FASCar®-E

2.1.2 Human Machine Interface (HMI)

A free configurable dashboard display replaces the original instrument cluster, which is mounted in the glove compartment for safety purposes. With this free configurable dashboard new HMI concepts can be validated.

Figure 2: Free configurable dashboard display.

2.1.3 Lateral and longitudinal control

FASCar®-E can be controlled by a controller area network (CAN) interface in longitudinal and lateral direction. For longitudinal control the signals of the adaptive cruise control (ACC) are rerouted to be able to accelerate the vehicle with +2m/s^2 to -3m/s^2 by software. For lateral control the signals of the active park assist are used. Especially the use of the original equipment manufacturer's own systems for lateral and longitudinal control enables the use of this vehicle on public roads.

2.2 FASCar®-II:

The FASCar®-II is a Volkswagen Passat which has a 2.0 Diesel engine. It is equipped with the same set of sensors as FasCarE. Hardware differences between both vehicles are the lateral and longitudinal control System as well as the HMI.

Figure 3: Free configurable dashboard display.

2.2.1 Lateral and longitudinal control

To achieve a maximum intervention FASCar®-II is equipped with a throttle paddle and a prototype of a brake booster which support full longitudinal control without any restrictions. For lateral control and new HMI concepts a steer-by-wire system is integrated in the vehicle. It allows on the one hand an active control of the vehicle wheels without a turning of the steering wheel and on the other hand a turning on the steering wheel without turning the vehicle wheels. This advantage can be used for new HMI concepts, automated security interventions and it enables FASCar®-II not only to be used on test sites, but also in a simulator like the VR-Lab (virtual reality laboratory), see Figure 4.

Figure 4: FASCar®-II inside VR-Lab

2.2.2 Human Machine Interface (HMI)

Besides a free configurable dashboard display such as FASCar®-E, a steering wheel for HMI purposes replaces the original one. It has several free programmable and illuminable buttons, which can be read out by a wireless connection to a PC.

Figure 5: Steering wheel of FASCar®-II.

3 Project Application Exampels

The large-scale research facility FASCar® was and is used in several projects. This only a short overview of some of the projects FASCar was involved in:

3.1 InteractIVe

The Project interactive stands for accident avoidance by active intervention for Intelligent Vehicles The European research project interactIVe took the next step towards the goal of accident-free traffic. interactIVe developed advanced driver assistance systems (ADAS) for safer and more efficient driving. interactIVe introduced safety systems that autonomously brake and steer. The driver is continuously supported by interactIVe assistance systems. They warn the driver in potentially dangerous situations. The systems do not only react to driving situations, but are also able to actively intervene in order to protect occupants and vulnerable road users. Seven demonstrator vehicles – six passenger cars of different vehicle classes and one truck – were built up to develop, test, and evaluate the next generation of safety systems (Heesen et al., 2015).

3.2 HAVEit

The project HAVEit aimed at the realization of the long-term vision of highly automated driving for intelligent transport. The project developed, validated and demonstrated important intermediate steps towards highly automated driving. HAVEit significantly contributed to higher traffic safety and efficiency usage for passenger cars, busses and trucks, thereby strongly promoting safe and intelligent mobility of both people and goods (Flemisch et al., 2011). The significant HAVEit safety, efficiency and comfort impact was generated by three measures:

- Design of the task repartition between the driver and co-driving system (ADAS) in the joint system.
- Failure tolerant safe vehicle architecture including advanced redundancy management
- Development and validation of the next generation of ADAS directed towards higher level of automation as compared to the current state of the art.

3.3 MobiFAS

The example of browsing the internet with a tablet PC allowed researchers of the Institute of Transportation Sysems to investigate how and under what circumstances control should be handed over from the vehicle to the driver. In case the vehicle is approaching a construction site distraction of the driver can become a problem. In order to safely navigate the vehicle in this situation the driver has to interrupt his or her activities and prepare for taking over responsibility for steering the vehicle. Even today every fourth car driver is distracted by the use of mobile devices during his drive. This can have catastrophic effects. How can a driver of a highly automated road vehicle be integrated in the driving task in a comfortable, fast and effective way? These answers are given by the MobiFAS project (Lapoehn et al., 2016).

3.4 Valet parking

Automation of vehicles provides new opportunities to develop novel concepts for an optimal combination of public and individual transportation as well as the introduction of electrical cars that need coordinated recharging. A typical scenario of such a concept might be automatic drop-off and recovery of a car in front of a train station without taking care of parking or re-charging. Such new mobility concepts require among other technologies autonomous driving in designated areas. The objective of this project is to develop a smart car system that allows for autonomous driving in designated areas (e.g. valet parking, park and ride) and can offer advanced driver support in urban environments (Löper et al., 2013).

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