Fraunhofer
IOSB

FRAUNHOFER INSTITUTE OF OPTRONICS, SYSTEM TECHNOLOGIES AND IMAGE EXPLOITATION IOSB

INTELLIGENT TRANSPORTATION SYSTEMS

RESEARCH AND DEVELOPMENT FOR AUTOMATED DRIVING, AUTONOMOUS SYSTEMS AND HUMAN-MACHINE INTERACTION

The scope of mobility is constantly expanding into a complex system of systems that increasingly connects humans by, and with technology.

To achieve efficient, seamless, ecological and safe mobility systems, future solutions must take into account a broad perspective – from dynamics over artificial intelligence and big data analysis to human-machine interfaces.

We are your partner for:

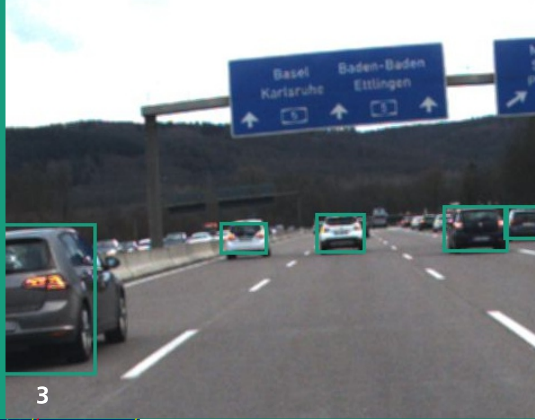
- Development of automated systems
- Interior and exterior sensor processing and fusion
- Situation interpretation and human-machine interfaces
- Verification, functional safety and SOTIF
- Simulation, testing and validation
- Privacy-safe traffic and reference data collection

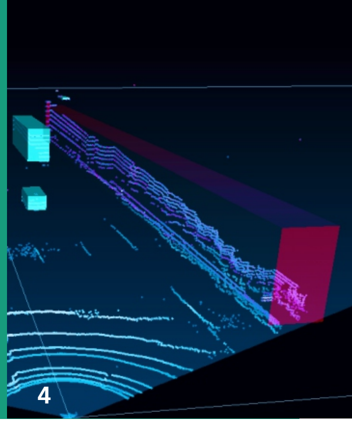
Fraunhofer Institute of Optronics, System Technologies and Image Exploitation IOSB

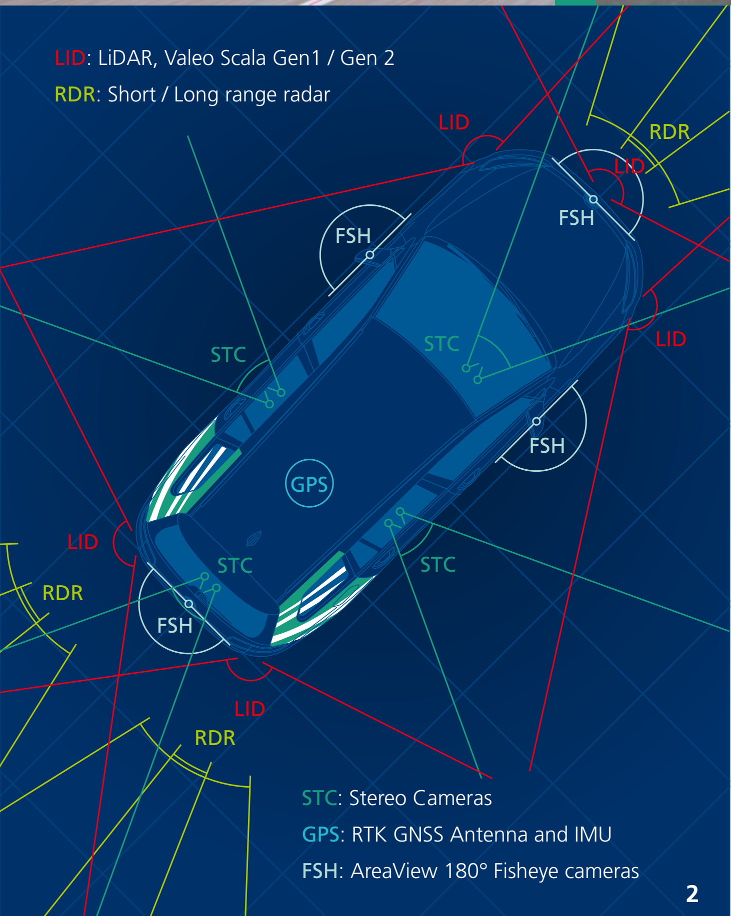
Fraunhoferstraße 1
76131 Karlsruhe
Germany

www.iosb.fraunhofer.de

s.fhg.de/iosb-autonomous







1 The combustion (left) and electric (right) VERTEX vehicles.

2 Default sensor setup for the two vehicles.

3 Object detection by convolutional neural networks.

4 Object detection and tracking in LiDAR point clouds.

Developing and testing automated driving with flexible and adaptable hardware and software

VERTEX – Vehicles for Research and Technology Experiments

Fraunhofer IOSB's VERTEX research vehicles (two Volkswagen Golf VII, one electrical and one combustion engine-driven) are equipped and licensed for automated test driving on public roads in the EU. Both vehicles feature redundant 360° equipment of various environmental sensors, including camera, radar and LiDAR technology, as well as the ability to access the vehicles' CAN bus for automated longitudinal and lateral control.

The »test vehicles for technology experiments« are used in research projects for automated and connected driving, cyber-secure cooperative driving via imaging light communication, for collecting reference data for simulation models, and in the field of human-machine interaction.

Contact

M.Sc. Jens Ziehn
Fraunhofer IOSB
Systems for Measurement, Control and Diagnosis (MRD)
Fraunhoferstr. 1 | D-76131 Karlsruhe
Phone +49 721 6091 – 633
jens.ziehn@iosb.fraunhofer.de

Recognizing the activities of driver and passengers for safe handovers and advanced occupant monitoring systems

Advanced Occupant Monitoring & Activity Recognition

In automated driving, the vehicle decides what it needs to do — it steers, brakes and accelerates. However, until vehicles are capable to work completely driverless, semi-automated vehicles support whoever is at the wheel to give them more and more freedom. Therefore, the vehicle must be intelligent on three levels:

1. It must be able to interpret traffic,

2. it must monitor what is going on inside the vehicle, and

3. interact with the driver.

Technology developed by Fraunhofer IOSB **(1)** identifies the facial features as well as the current body poses of the driver and the passengers, and **(2)** determines current activities, intentions and occupations of the driver and the passengers.

5 Body pose-based activity recognition of the driver.

6 Driving simulator at Fraunhofer IOSB, providing a multi-sensor environment to conduct user studies and develop advanced occupant monitoring systems.

Machine learning algorithms analyze the camera data in real time to determine whether the driver is, e.g., on the phone, playing with children or looking at a passenger's cellphone. From the images, the system creates a digital representation of the situation in the cabin. This includes skeletons of the driver and the passengers.

Contact

Dr.-Ing. Michael Voit
Fraunhofer IOSB
Interactive Analysis and Diagnosis (IAD)
Fraunhoferstr. 1 | D-76131 Karlsruhe
Phone +49 721 6091 – 449
michael.voit@iosb.fraunhofer.de

Aerial images for privacy-safe data collection, behavior modeling and sensor reference technology

Aerial Images – A New Solution for Validation of Safety-Critial Driving Functions

One particular challenge in the development, testing and validation of safety-critical automated driving functions in mixed traffic is data acquisition in actual driving situations – both for human behavior modeling and for sensor development.

Traffic scenarios are highly complex, and future automated driving functions must consider a wide variety of interactions between human traffic participants and automated vehicles, such that development and testing require large amounts of annotated data of high-resolution, dynamic traffic scenarios.

Collecting this data purely from ground sensors poses various challenges, such as occlusion, limited range, complex processing and privacy. These challenges can be addressed by dedicated airborne data acquisition.

7 Ultralight airplane Flight Design CTSW used for recording

8 High-resolution aerial images provide a wide view of the scene while allowing to localize and track traffic participants at centimeter accuracy and frame rates of around 20 Hz.

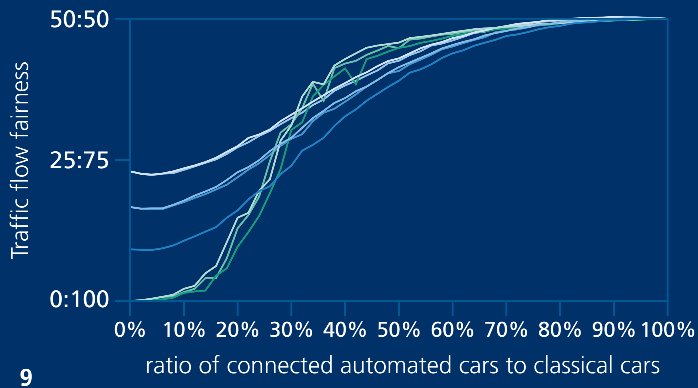
Aerial images enable the observation and large-scale analysis of a complete traffic situation with all influencing traffic objects at the same time, without the risk of influencing and affecting the observed traffic behavior with a ground-based sensor platform. The acquired data provides a high and constant spatial resolution of object positions at centimeter level, and of their dynamic behavior, without the necessity of removing privacy-critical data such as license plates or faces.

The acquisition by light or ultralight aircraft allows to follow groups of vehicles even at highway or motorway speeds, and record data continuously over hours, long ranges, and from high altitudes – reducing occlusion, and covering large footprints if desired, for example 1 km².

In order to analyze a rather high amount of data the IOSB employs and develops AI-based methods for localization, object recognition and tracking, as well as referencing these objects to HD maps, for example in the OpenDRIVE format. Together with partners a pipeline for automated integration into several simulation frameworks for safety testing is being developed.

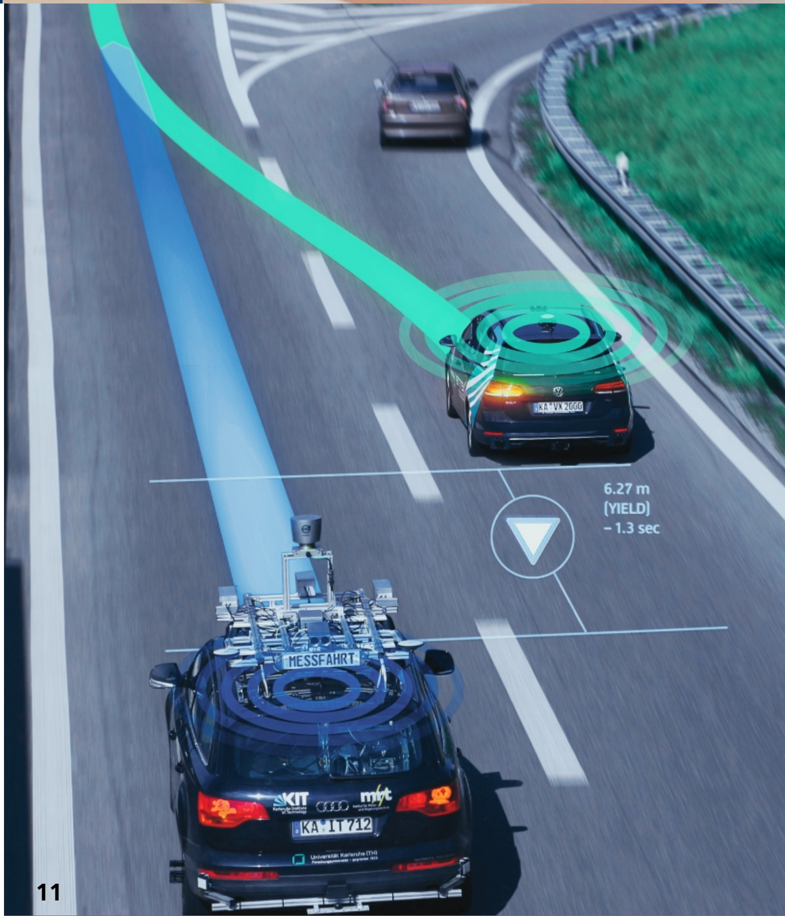
Contact

M.Sc. Jens Ziehn
Fraunhofer IOSB
Systems for Measurement, Control and Diagnosis (MRD)
Fraunhoferstr. 1 | D-76131 Karlsruhe
Phone +49 721 6091 – 633
jens.ziehn@iosb.fraunhofer.de



9


10



11

Aiming at a holistic view of an evolutionary introduction of connected automated driving

iFORESEE – Introductory Concepts for Connected and Cooperative Cars

While »autonomous« automated cars are already part of a foreseeable future, the perspective for »connected« or »cooperative« cars is considerably less certain: Connected vehicles require a critical mass of available communication partners – and while clear benefits have been shown for densities of better than 50% connected cars in traffic, reaching such densities may take more than a decade in Germany alone. It is yet uncertain, how connected and cooperative features can provide market value for customers while densities still grow to this level, and thus, how such systems can be introduced to the market.

Researching this topic, the Fraunhofer IOSB together with partners from Fraunhofer ISI, Fraunhofer ICT, KIT, FZI, HKA have developed concrete cooperative driving functions which already add value at low densities of connected cars in traffic and low levels of automation (SAE levels 1–3), and which support an evolutionary growth of the share of connected and cooperative vehicles in traffic. Thereby, the project aims both at the development of new technologies and at a detailed analysis of the effects of such systems on user acceptance, traffic flow, society and market.

more information: **www.i.4c.network**

9 The project goal is to develop connected driving functions that provide added value even at low numbers in traffic.

10 Developed solutions range from negotiating the right of way in urban bottlenecks without traffic lights...

11 ... to automated rendezvous and merge functions.

12

Flexible, open and modular solutions for developing and testing intelligent transportation systems

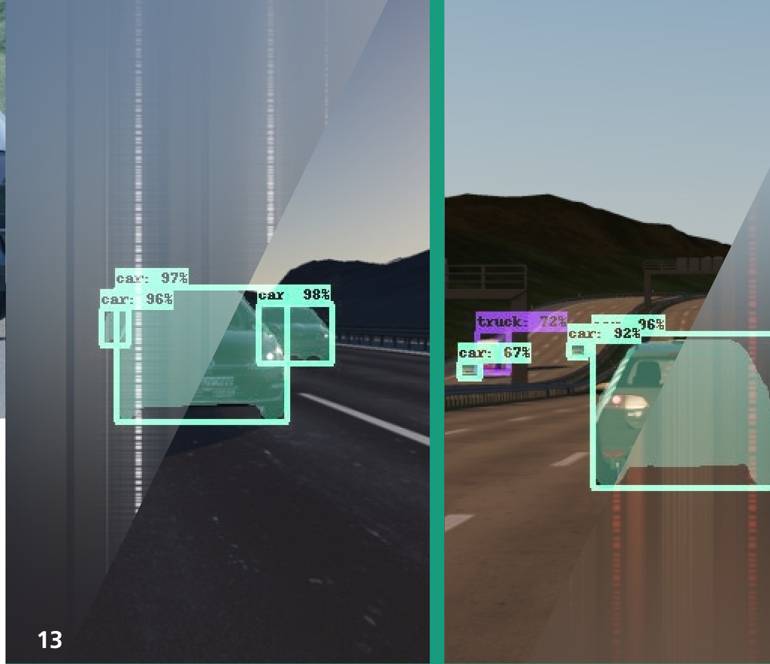
OCTANE – A Flexible Simulation Platform for Mobility Applications

OCTANE is a flexible and extensible open source simulation platform for mobility applications, and is being developed under the lead of Fraunhofer IOSB together with experts from various Fraunhofer institutes, universities and industrial partners. It provides a unique level of flexibility for customizing the simulation to the respective needs regarding computation time, result quality, usability and available data, thanks to a highly modular software architecture, an intuitive usability concept and the use of independent levels of detail, as well as a consistent physically-based modeling.

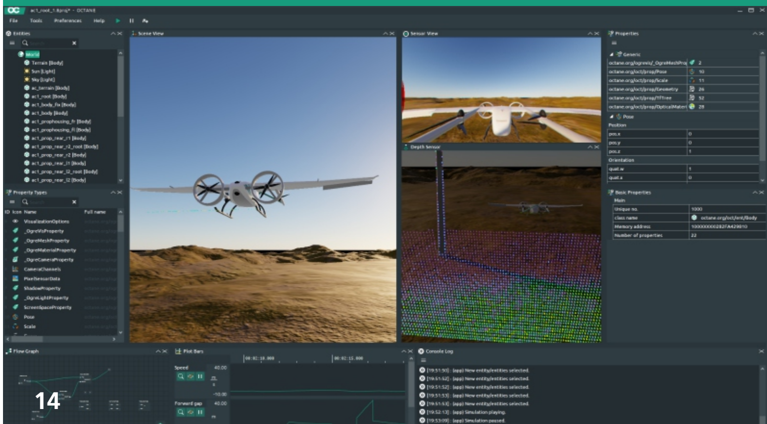
Current use cases include interoperable traffic flow and multi-body simulation, physically-based sensor data synthesis, and UAV simulation.

Contact

Dr.-Ing. Masoud Roschani
Fraunhofer IOSB
Systems for Measurement, Control and Diagnosis (MRD)
Fraunhoferstr. 1 | D-76131 Karlsruhe
Phone +49 721 6091 – 483
octane@iosb.fraunhofer.de



13


14

more information: **www.octane.org**

12 OCTANE supports flexible levels of detail – from detailed vehicle dynamics and physically-based raytracing...

13 ... to fast shader-based rendering that still preserves photometric properties, and reduced traffic simulation dynamics, for example for training and evaluating deep learning-based object detectors at large scales.

14 OCTANE provides a graphical user interfaces, as well as a modular API, Python script support, and the option to use the open source code as a library for highly customized applications.