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FRAUNHOFER INSTITUTE FOR INDUSTRIAL MATHEMATICS

1 *Interactive passenger car simulation with RODOS®*

INTERACTIVE DRIVING AND OPERATION SIMULATION WITH RODOS®

RODOS® – Robot based Driving and Operation Simulator

In simulation based vehicle development the goal is to analyze and optimize attributes such as energy efficiency, productivity, durability, and reliability. These studies require that all external influences exerted on the vehicle are taken into account, and are realistic. These external influences prominently include the interaction of the human operator with the machine.

With the help of an interactive simulator complex situations along with the driver's influence can be analyzed in detail and without risk to operator safety. The reproducibility, the ability to manipulate and control both the vehicle and the environmental parameters are of particular value.

At Fraunhofer ITWM, the world's first simulator for interactive operation – based on a 6-axis serial robot kinematics with 1000 kg payload – was developed and put into operation. The approach taken in the implementation strategy was to develop all core components of the simulator as an open system composed by modifiable and scalable modules. This requirement is met by circumventing so-called "Black Box" models, or closed third-party solutions, in the components such as: system control, real-time simulation, motion cueing, visualization, NVH-simulation, and measurement systems on operator.

ITWM provides turnkey simulator solutions for various applications and vehicles.

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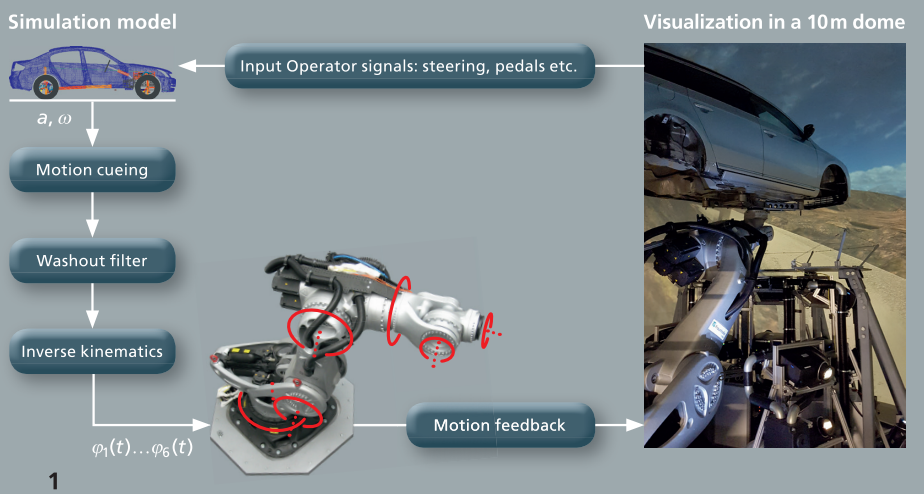

Advantages and benefits

- The simulator can be operated with cabins up to a weight of 1000 kg.
- The robot system allows large translations and very large tilt angles, so compared to Stewart-Gough platforms new applications can be developed. Human perception mechanisms are taken into account.
- The visualization system allows a field of view of 110° × 300° with correct accommodation of the eye.
- The motion cueing algorithms can be easily adapted to the simulation task.
- Various real-time vehicle models such as DSpace ASM®, Simpack RT® or VIGrade CarRealTime® can be easily integrated.
- Models of hydraulic, electronics, etc. can be integrated with Matlab/Simulink® or C++.
- In-house real-time tire simulation with CDTire® is coupled to the simulator.
- Full coupling of 3D point cloud scenarios (for tire simulation and visualization) is available.

Tasks which can be solved with RODOS®

- Make simulation results experiencable
- Developement of HMI assistance and automation systems
- Validation of new assistance systems together with experts
- Design of driver and operator models for complex scenarios
- Studies on driver experience
- Ad hoc variant tests of different vehicle configurations
- Development and proving of new automated driving concepts and functions
- Combination of hardware- and driver-in-the-loop tests e. g. for real driving emission analysis

Facts at a glance

- Motion system with 1000 kg payload (> 70 kW installed capacity)
- Maximum acceleration up to about 5 m/s²
- Frequency range up to 20 Hz with robot motion platform (400 kg cabin)
- Use of electrodynamic shakers for a frequency band from 5 Hz to 200 Hz
- Roll-, Pitch and Yaw angles up to ± 90° possible
- Visual simulation with 11520 × 3600 Pixel @ 120 fps (18 projectors)
- Resolution of 1,7 arcmin/OLP
- Surface brightness of 900 Lux (equivalent to the lighting of a TV studio)
- 3D point cloud scenarios optional usable (measured with REDAR)

1 *Schematic setup of the simulation system*

2 *Interactive tractor simulation with 3D laser scanned terrain*