VIRES at a Glance - Overview

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Founded: 10/1996
Staff: 25 → 30 (12/2017)

Markets

Certification: ISO 9001:2011

Focus on key product VIRES Virtual Test Drive®
Software tool-chain supporting the development, test and validation
of automated driving, driver assistance and active safety systems

Components
- traffic simulation
- scenario simulation
- image generation
- sensor simulation / stimulation
- database design tools
- SDKs
- etc.

Partner in Standardization Initiatives
OpenDRIVE™
OpenCRG®
OpenSCENARIO

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VIRES – Products and Services

**Products**

- **Task Control** (Framework)
- **Traffic Simulation Scenario Editor**
- **Image Generator v-IG**
- **Module Manager**
- **OdrGateway**
- **Operator Station**
- **Sound**
- **Road Designer**
- **ready-to-go databases**
- **Odr Manager**

**Industries**

**Key Task**

- **Scenario**
- **Visualization and Sensors**
- **Sensors, Dynamics Interfacing**
- **high freq. Road Contact**
- **GUI**
- **sound simulation**
- **database editor**
- **content**
- **road eval. library**

**Extension**

- **SDK for Render Plug-ins and ray-traced sensors**
- **SDK for ObjSensors, Dynamics, Custom Mod.**

**Services**

- **on-site integration**
- **adaptation**
- **user training**
- **custom-built databases and scenarios**
- **Participation in Specification Efforts**
- **User Support**
- **Tool Development**

**Industries**

**Projects**

- **PEGASUS**
  - German research project “automated driving”
- **Enable-S3**
  - European research project “automation”
Motivation
Motivation – Reality

Knowledge and Perception

listen

watch

feel

know
Motivation – Preparing for Reality

Ground Truth and Models

(infra)structure and traffic

sensor models

map data

driver models

vehicle dynamics

surface models

map data
Motivation – The Challenge

Similarity!
Our Role

information and comfort
information and support
warning and action
protection
automated driving
driver assistance
active safety
passive safety
Darwin

Systems

Sensors

Static and Dynamic Environment (e.g. traffic, weather, road conditions, vehicle dynamics)
Objectives
Objectives – Coherent Development

- **Software / Model in-the-loop**
- **Driver in-the-loop**
- **Vehicle in-the-loop**
- **Hardware in-the-loop**

**Algorithm**

<table>
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<th>setup</th>
<th>interaction</th>
<th>number of tests</th>
<th>speed</th>
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<td>large</td>
<td>non real-time</td>
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</tr>
<tr>
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<td>medium</td>
<td>real-time</td>
</tr>
</tbody>
</table>

**Driver**

- virtual
- real

**Dynamics**

- virtual
- real

**Sensors**

- virtual
- virtual

**Systems**

- virtual
- virtual
- virtual
- virtual

**Traffic**

- virtual
- virtual
- virtual

**portability and compatibility**

- Modules
- Configuration
- Record Data
- Scenarios

07/12/2017

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Objectives – Structured Development

- **Algorithm**
  - Software / Model in-the-loop
  - Driver in-the-loop
  - Vehicle in-the-loop
  - Hardware in-the-loop

- **Setup**
  - desktop / HPC
  - mockup
  - vehicle
  - test rig

- **Interaction**
  - autonomous
  - interactive
  - interactive
  - autonomous

- **Number of Tests**
  - large
  - moderate
  - small
  - medium

- **Speed**
  - non real-time
  - real-time
  - real-time
  - real-time

- **System Architecture**
  - layout and early test of data flow from perception, data fusion concepts, data timing concepts

- **Sensor Selection**
  - number / position of sensors; physical behavior; data to be provided by sensors

- **Algorithm Development**
  - driver models, traffic scenarios, sensor models, open-loop / close-loop tests

- **Bench-level Validation**
  - stimulation of real sensors by virtual environments; slave mode for test automation

- **Vehicle Integration**
  - stimulation of real vehicle by virtual environment

- **Vehicle Level Validation**
  - stimulation of real vehicle by virtual environment

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Workflow
Workflow – Overview

The Whole Story

- 3D Scene Definition
- Dynamic Content
- Animation
- Visualization
- Sensor Simulation
- Sensor Stimulation
- Customization
- Integration
- Operation
- Test Automation
- User Modules
- User Plug-ins
- External Entities
- 3rd-party Frameworks

OpenSCENARIO
OpenDRIVE
OpenCRG
Workflow – Overview

3D Scene Definition

Dynamic Content

Animation

Visualization

Sensor Simulation

Sensor Stimulation

Customization

Integration

Operation

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Workflow – Environment Simulation

3D-World
Workflow – Environment Simulation

3D-World – Resembling Reality

Use Standards!

Workflow – Environment Simulation

3D-World – Resembling Reality

„hard“

reality

scans
maps
videos
data

Tools &
Converters

OpenCRG
OpenDRIVE

Logics

„soft“

reality

Geometry

Materials

Physics

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Workflow – Environment Simulation

**3D World**

- *generic* vs. *geo-specific*
- *country-coded* signs / signals / layouts
- analytical *ground-truth* data in OpenDRIVE
- *GPS* reference for localization
- *road surface* details
Workflow – Overview

Dynamic Content

- 3D Scene Definition
- Animation
- Visualization
- Sensor Simulation
- Sensor Stimulation
- Customization
- Integration
- Operation
Workflow – Environment Simulation

Scenarios – Sampling Reality

- Test Logs → Analyzer
- Rules → Generator
- Editor

OpenCRG
OpenDRIVE

OpenSCENARIO

functional scenario
logical scenario
individual scenario
Workflow – Overview

- Animation
- Visualization
- Sensor Simulation
- Sensor Stimulation
- Customization
- Integration
- Operation
- Dynamic Content
- 3D Scene Definition
Workflow – Environment Simulation

Animation – Resembling Situations

- OpenCRG
- OpenDRIVE

OpenSCENARIO

Traffic Simulation

- Systems Under Test
  - Vehicle Dynamics
- Live Data
- GPS Data
- 3rd Party Simulation
  - Traffic Flow Simulation
Workflow – Traffic Simulation

Traffic

- autonomous vs. deterministic behavior
- realistic traffic density and features
- microscopic and nanoscopic context
- unlimited number of external entities
- configurable driver models
- configurable vehicle dynamics
- pedestrian simulation

Diagram:

- Human Driver
- ADAS / HAD Function
- Custom Driver Model
- VTD Driver Model
- User Actions

Controller:
- Custom Vehicle Dynamics
- VTD Vehicle Dynamics
- Traffic Flow Simulation (e.g. SUMO)

3D Model

Entity
Workflow – Overview

- Visualization
  - Sensor Simulation
    - Sensor Stimulation
      - Customization
        - Integration
          - Operation
            - 3D Scene Definition
              - Dynamic Content
                - Animation
Workflow – Perception

Animation – Resembling Situations

OpenCRG → OpenSCENARIO → Traffic Simulation

Sensor Simulation → Sensor Stimulation → Visualization

Geometry → Materials

Systems Under Test
- Driver
- Vehicle Dynamics
- ADAS / HAD Systems
- Infrastructure

Traffic Simulation

Sensor Simulation

Vehicle Dynamics

ADAS / HAD Systems

Infrastructure
Visualization – Seeing Content

- low / high dynamic range
- real-time performance
- image output on monitor / network / shared memory
- customizable via SDK
- customizable material tables
- single-/multi-channel installation
- configurable distortion and blending
- fish-eye capabilities
- various weather and light conditions
Workflow – Perception

Visualization – For Engineers
Workflow – Perception

Visualization – For Eyes and Cameras
Workflow – Perception

**Sensor S(t)imulation - Concepts**

- **object lists** vs. **raw data** (logics vs. physics)
- **ground-truth** data
- **real-time** performance (and faster)
- multiple parallel instances
- **headless** simulation (e.g. for HPC)

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![Workflow Diagram](image.png)
Workflow – Perception

Sensor Simulation - Concepts
Workflow – Perception

Sensor Simulation – Providing Consistency
Workflow – Perception

Sensor Simulation – Implicit Ground Truth
Architecture
Architecture – VIRES Virtual Test Drive

Rigid Core – Soft Shells

- **one** simulation core for all stages and environments
  - inherent **compatibility** of key simulation data
- **customization** on various levels
- **integration** into existing setups
- **open interfaces** for interaction with 3rd party tools
- **real-time** and non-real-time operation
- **master / slave** modes (for co-simulation)
- use of (de-facto) **standards**
  - OpenDRIVE (road logics)
  - OpenCRG (road surface)
  - OpenSCENARIO (within 2017)
  - OpenSceneGraph and OptiX (graphics)
  - IES (headlight distribution)
Thank you!