



The Roadmap towards
Continuous Validation of
Sensor Models

10.11.2025



We Enable Autonomous Driving

Real world data is limited and too costly,
our Credible Simulation is the key.

The Path to Validated Simulation

Our Credible Simulation Portfolio

No Trust in Simulation

Credible Simulation

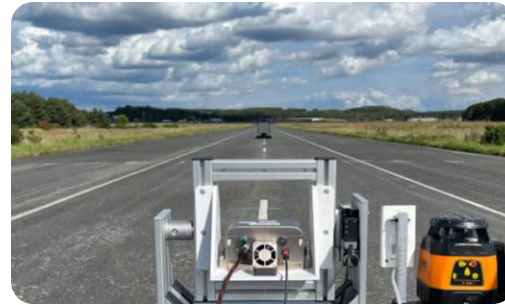
01



Requirements Assessment

- Simulation architecture
- What is the ODD?
- What is SuT?
- Relevance analysis of sensor effects

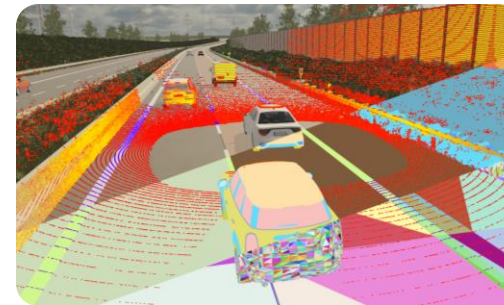
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Sensor Measurements

- Wavelength-dependent Material BRDFs
- Sensor performance to DIN SAE SPEC 91471
- Weather influence

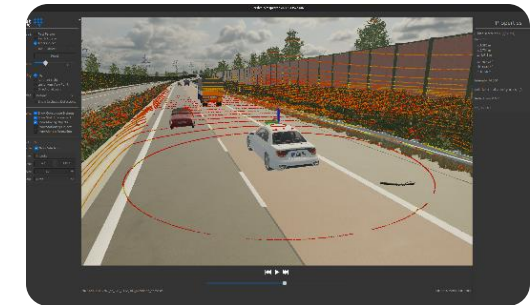
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Sensor Modeling

- 3D environment with material properties
- Individually packaged models
- Recreate real behavior

04



Sensor Model Validation

- Validate 3D models and material data
- Re-simulate measurements
- Compare real / synthetic

The Path to Validated Simulation

Software Supported Efficient Development

Simulation

Sensor Model Development Library

Physical sensor simulation using efficient ray tracing. Can be embedded in different models.

Analysis

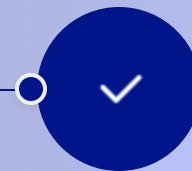
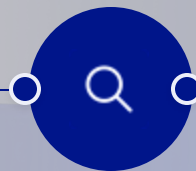
Simspector[®]

Manual inspection of 3D assets and/or synthetic sensor data. Researching effects and issues.

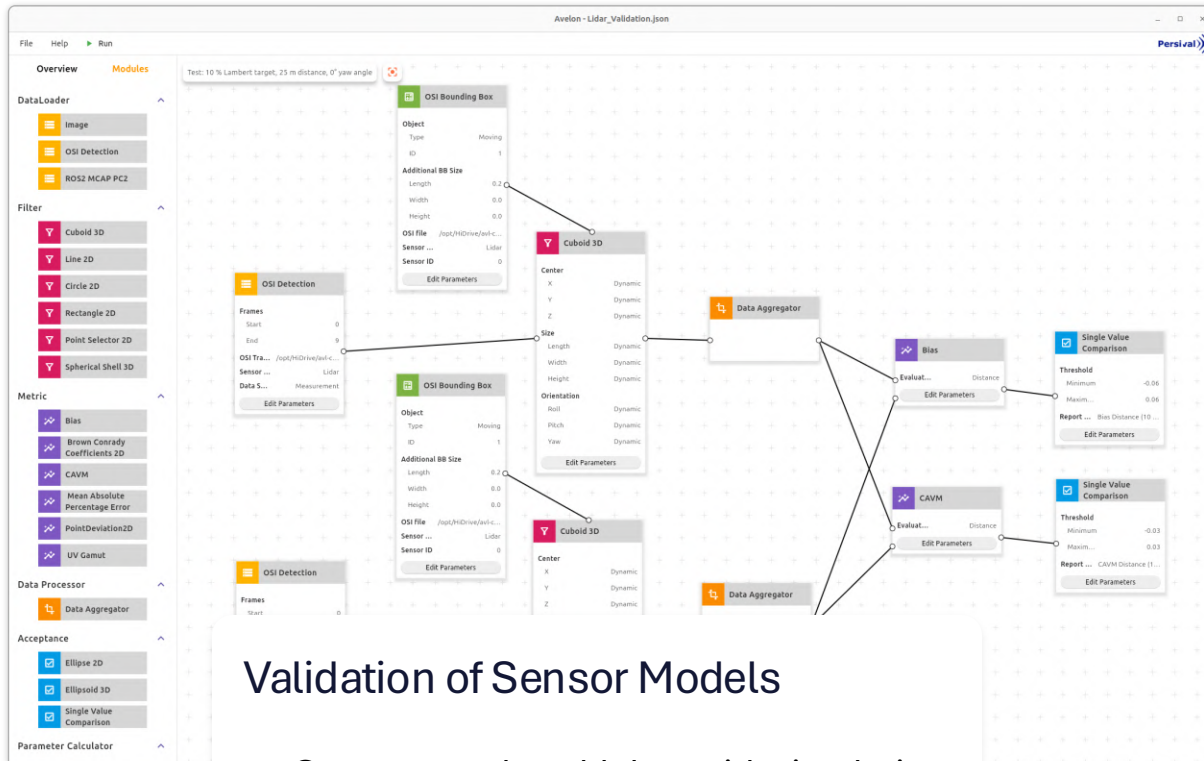
Validation

Avelon[™]

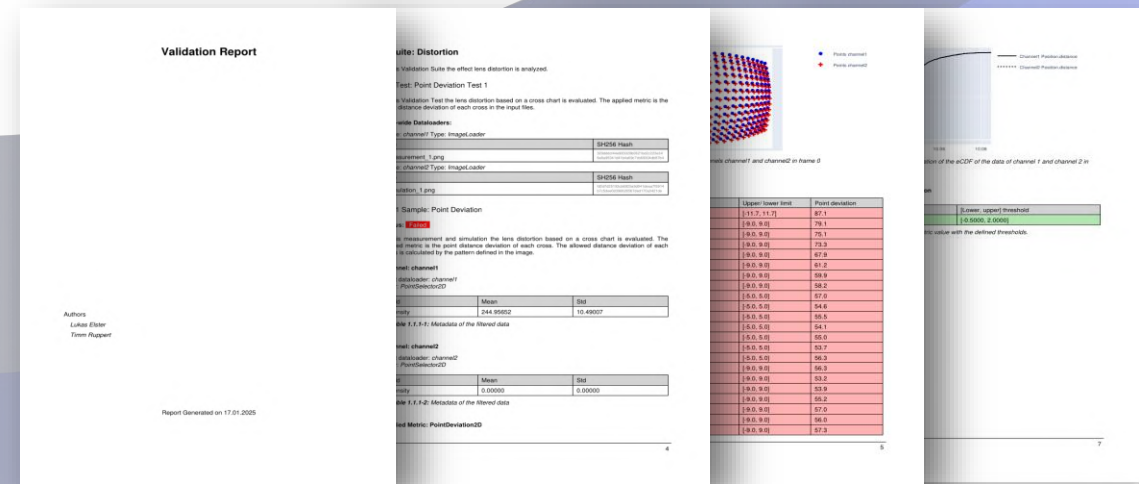
Comparison against real sensor data: Can synthetic sensor data be used for the intended purpose.



Validation with Avelon



- ## Validation of Sensor Models
- Compare real world data with simulation data
 - Compare simulation data with other simulation data
 - Toolbox of metrics and acceptance criteria



Data Collection for Credible Simulation

Measuring the Real World to Validate the Simulation



Materials

- Measuring material properties.
- Wavelength-dependent.
- Measure in lab or on your test site.
- Patented measurement device.



Sensor Performance

- Based on DIN SAE SPEC 91471.
- Detection ranges with calibration targets und different angles.
- Range and angle separability.

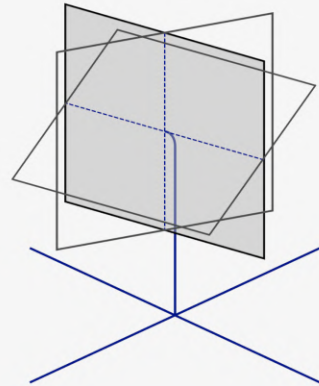
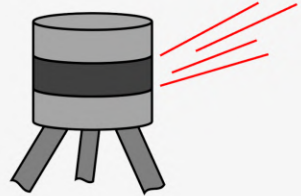


Weather Influence

- Automated setup.
- Long-term measurements.
- Impact of rain, fog, snow and sun.
- Impact on target visibility.

Sensor Performance Measurements

Quantify Lidar Performance according to DIN SAE SPEC 91471



Target Unit
with high precision
positioning and
changeable targets



Sensor Unit
with high precision
angular positioning
w.r.t. targets



Overview

Modules

Test: New Test 1



Validation with Avelon

DataLoader

- Image
- OSI Detection
- ROS2 MCAP PC2

Filter

- Cuboid 3D
- Line 2D
- Circle 2D
- Rectangle 2D
- Point Selector 2D
- Spherical Shell 3D

Metric

- Bias
- Brown Conrady Coefficients 2D
- CAVM
- Mean Absolute Percentage Error
- PointDeviation2D
- UV Gamut

Data Processor

- Data Aggregator

Acceptance

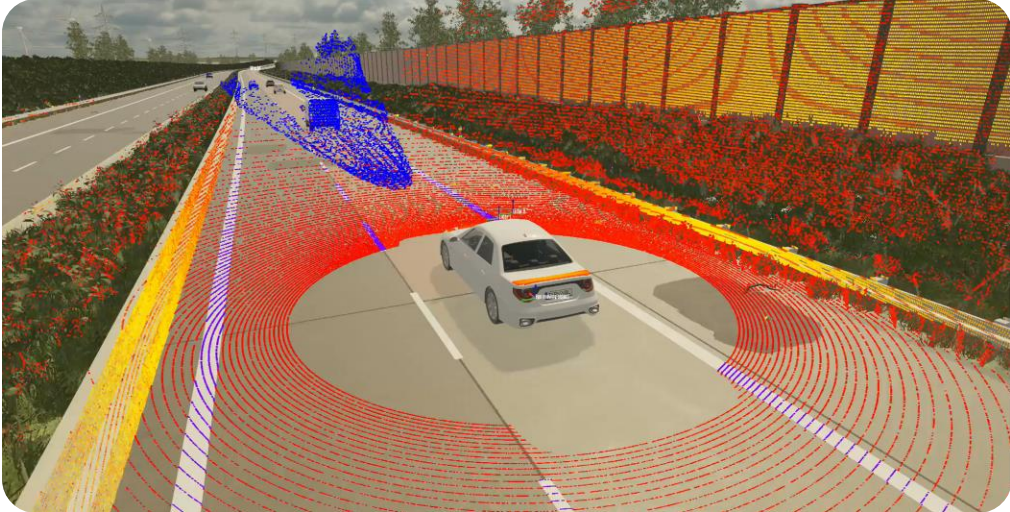
- Ellipse 2D
- Ellipsoid 3D
- Single Value Comparison

Parameter Calculator

- PSF Kernel
- OSI Bounding Box

Key Take-Aways

Credible sensor simulation is needed



Standardized measurements are crucial



Only validated sensor models are trustworthy



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Persival 

Visit us at our booth!

