

AVxcelerate Sensors

Sensors Simulation Overview

Ansys AVxcelerate provides physics-based accurate sensor simulation. It comes with a full set of parametric physics-based sensor model: camera, LiDAR, and Radar as well as with user interface and interconnectivity to user development and validation ecosystem.

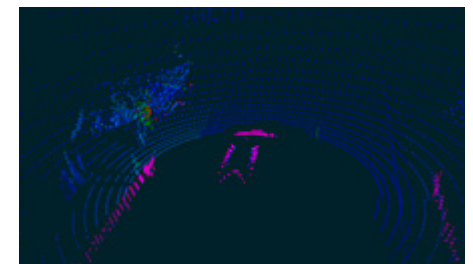
/ Optical Camera sensor

Ansys AVxcelerate includes a high-fidelity, real-time, physics-based simulation of cameras. The software contains a parametric model of camera, which enables you to simulate every actual camera. This model simulates all components such as the lens system, imager, and post-processing. For automotive front-facing cameras, the windshield can also be considered in simulation.



The simulation considers the optical properties of the environment in visible range, along with the optical properties of the lens system (distortion, chromatic aberration, etc.) and the optoelectronic properties of the imager (color filter array, dark current noise, etc.). Thanks to the control API, with the addition of user plugins, the simulation can manage dynamic adaptation (autoexposure, white balance, thermal incidence, etc...). Accurate night- and day-time simulation provides optically validated luminance and colorimetry for direct sky visualization, improving the accuracy of perception-in-the-loop simulation and testing possibilities.

The camera simulation generates raw images, which are used to test and validate camera-based perception algorithms either as models (model-in-the-loop) or software (software-in-the-loop) or software on chip (hardware-in-the-loop). Along with raw data, camera provides ground-truth information (pixel segmentation, 2D bounding boxes, etc.) to validate detection against reference data.



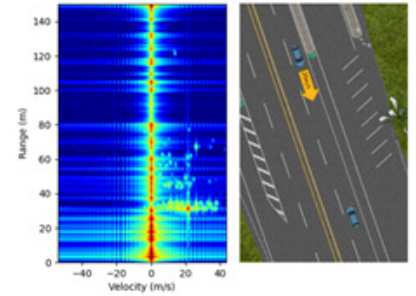
/ LiDAR sensor

Ansys AVxcelerate integrates the simulation of physics-based LiDAR model. The LiDAR model is designed to accurately reproduce the behavior of the laser emitter, including pulse shape angular distribution, power, beam divergence and the behavior of the optic and electronic of the receiver. Interaction with environment considers optical properties of material at laser bandwidth (905- 1550nm). All types of lidar technology (rotating, solid-state, flashing, etc.) can be parameterized in the software as well as complex firing sequences.

You will benefit from powerful ray-tracing GPU accelerated capabilities to simulate Lidar sensor, raw output made available through a dedicated API. Provided waveform type of output allow to challenge Lidar signal processing software. Whereas point cloud outputs combined with ground-truth segmentation provides a unique way to generate virtual sensor information during real-time drives and use the information to develop perception algorithm as part autopilot software stack.

/ Radar Sensor

Radar is prevalent in driver assistance systems thanks to its high precision and exceptional scalability. Ansys AVxcelerate Sensor provides a radar model (Ansys Real-Time Radar, aka. RTR) based on Shooting Bounce Ray (SBR) technique from Ansys HFSS high frequency electromagnetic simulator modeling interaction in electrically large environments.



The parametric model considered radar layout (Rx and Tx positioning, number of channels, interleave mode, etc.) to fit to specific automotive radars device including Multiple Input Multiple Output (MIMO) and multi-mode (SRR, MRR, LRR) waveform capability applied to current (24,77 GHz) technology or future (138 GHz). The raw data collected out of the radar model - either preprocessed range doppler map or I/Q complex data - is used to efficiently stimulate the Digital Signal Processing (DSP) algorithm part of radar ECU. It allows to quickly improve the accuracy and robustness of automotive radars in edge cases.

The high-fidelity physics-based radar simulation benefits from GPU accelerated ray-tracing engine to run in real-time while considering the dielectric properties (up to surface roughness) and electromagnetic interaction. This leads to being able to simulate complex phenomena's such as micro-doppler effects on vehicle wheels! Also, users can artificially induce the gain and noise while controlling the signal to noise ratio (SNR) to validate the robustness of their radar digital signal processing (DSP).

/ Co-Simulation

Test of sensor system in realistic situation, advanced scenarios and with vehicle dynamics can be addressed in co-simulation with simulators. Ready to use connector to IPG Automotive CarMaker and Carla are provided. In CarMaker, via an API, users can seamlessly create the terrain with all optical and dielectric properties automatically applied to the objects.

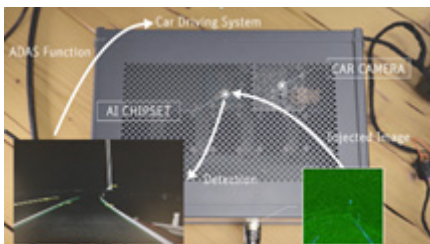


Thanks to a public API based on Google Protobuf and gRPC standards, AVxcelerate can connect to driving simulation software of your choice using various development language such as C/C++, .Net or Python.

Low level API are available to take benefit of sensor solvers. Ansys Real-Time Radar solver is provided with a C API that allow for advance radar design validation earlier in the development process.

/ Software in the loop (SiL) connectivity

Simulation is designed to help validating perception software based on accurate sensors virtual outputs, Ansys AVxcelerate is provided with a set of APIs allowing to connect custom signal processing on top of raw sensor outputs. Based on Google Protobuf and gRPC standards, outputs can be access locally via SHARED Memory (SHM) or remotely on various development language such as C/C++, Python, Matlab/Simulink® or Ansys SCADE.

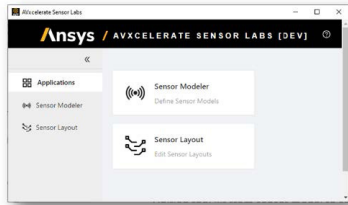
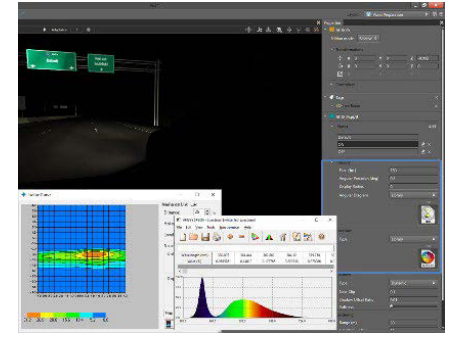


/ Hardware-in-the-loop (HIL) connectivity

Ansys AVxcelerate simulate raw sensor output so that it can feed actual smart sensors being tested on a hardware-in- the-loop (HIL) test bench. It connects to the image injection box, which replaces the actual imager (inter-integrated circuit, or I2C) with the virtual image. The injection box also manages high-speed connections between the imager and the car-to-infrastructure (C2I) processing chip. Compliant with Trentino box from Expleo and Camera module from NI.

/ Environment preparation

A data preparation tool is provided when custom environment or object are required within the scenario or what if a different material is used scenario. Data preparation tool allows to import 3D environment or object from marketplace, tools, or designer (as fbx or obj files format). It eases application of physic-based optical, near-IR, thermal and dielectrical properties to each sub-part. A library of classic material used in automotive scenario is provided with measures quantities. Optical sources distribution can be defined as IES files. By using an easy to integrate API, the data preparation tool can be used to create tracks, ego vehicles, traffic vehicles and static scenario assets with all optical and dielectric properties automatically applied to all objects.



/ Sensor model and layout creation

A Sensors Labs UI is provided to build a library of sensors model to be uses as part of the simulation. It allows defining all parameters of all the components of the camera, radar or lidar sensor model so that the model represent an actual sensor. Based on the customized sensor model library, you can define the layout of the sensor suite under test composed of multiple sensors at defined position around the vehicle.

/ Libraries of assets

About 150km of predefined environment such as highways, countryside, cities are provided. Various actors such as vehicles of different type and brand, pedestrians, road signs of various countries (DE, FR, IT, JP, SE, US, CN) with all physics-based properties defined are ready to be used in scenario. Environment and actors are available for a co-simulation usage with IPC Automotive CarMaker and Carla.



Ansys AVxcelerate Sensors Simulation				Sensor add-ons			Workgroup	Bundle	
	Prepost	Solve		Optical Camera	LiDAR	Radar		Premium	Enterprise
Sensor capabilities									
Sensor Camera Sensor				● ⁽¹⁾					●
Lidar Sensor					● ⁽¹⁾		● ⁽²⁾		●
Radar Sensor						● ⁽¹⁾			●
Multi Sensors		●						●	●
Solve capabilities									
Co-Simulation		●						●	●
SiL Connectivity		●						●	●
HiL Connectivity		●						●	●
Prep/Post tools									
Environment preparation	●							●	●
Sensor Models preparation	●							●	●
Libraries of assets	●	●						●	●

(1) One add-on per sensor device involved in a simulation and per GPU used for the simulation of the device.

(2) One workgroup per sensor device of any type (radar, lidar, camera) involved in a simulation and per GPU used for the simulation of the device.
Add-on an.

/ Ansys AVxcelerate Vehicle Simulation product line

- AVxcelerate for Headlamp

ANSYS, Inc.
www.ansys.com
ansysinfo@ansys.com
866.267.9724

© 2023 ANSYS, Inc. All Rights Reserved.