

| Autoware.Auto Lecture 11: | LGSVL Simulation



About

Purpose

What you will learn from this lecture:

- Features and Capabilities of the LGSVL Simulator and how to install, build, configure, and use it
- How to use the LGSVL Simulator with Autoware

Agenda:

- Introduction and features of the Simulator
- Installation of the Simulator
- Getting Started, User Interface, Configuration
- Running Simulation with Autoware.Auto
- Automation and Python API
- Advanced Topics
- Additional Information

Background

Presenter: Steve Lemke

- Principal Engineer @ LG America R&D Lab

LGSVL Simulator

- Mission
 - To provide an open simulation platform for autonomous driving/future mobility where a lot of companies and industries can collaborate to achieve their goals while reducing time and cost fundamentally

Photorealistic Scene Generation with Unity 3D engine

- Unity High Definition Render Pipeline
- Physics-based modeling of multiple lighting sources



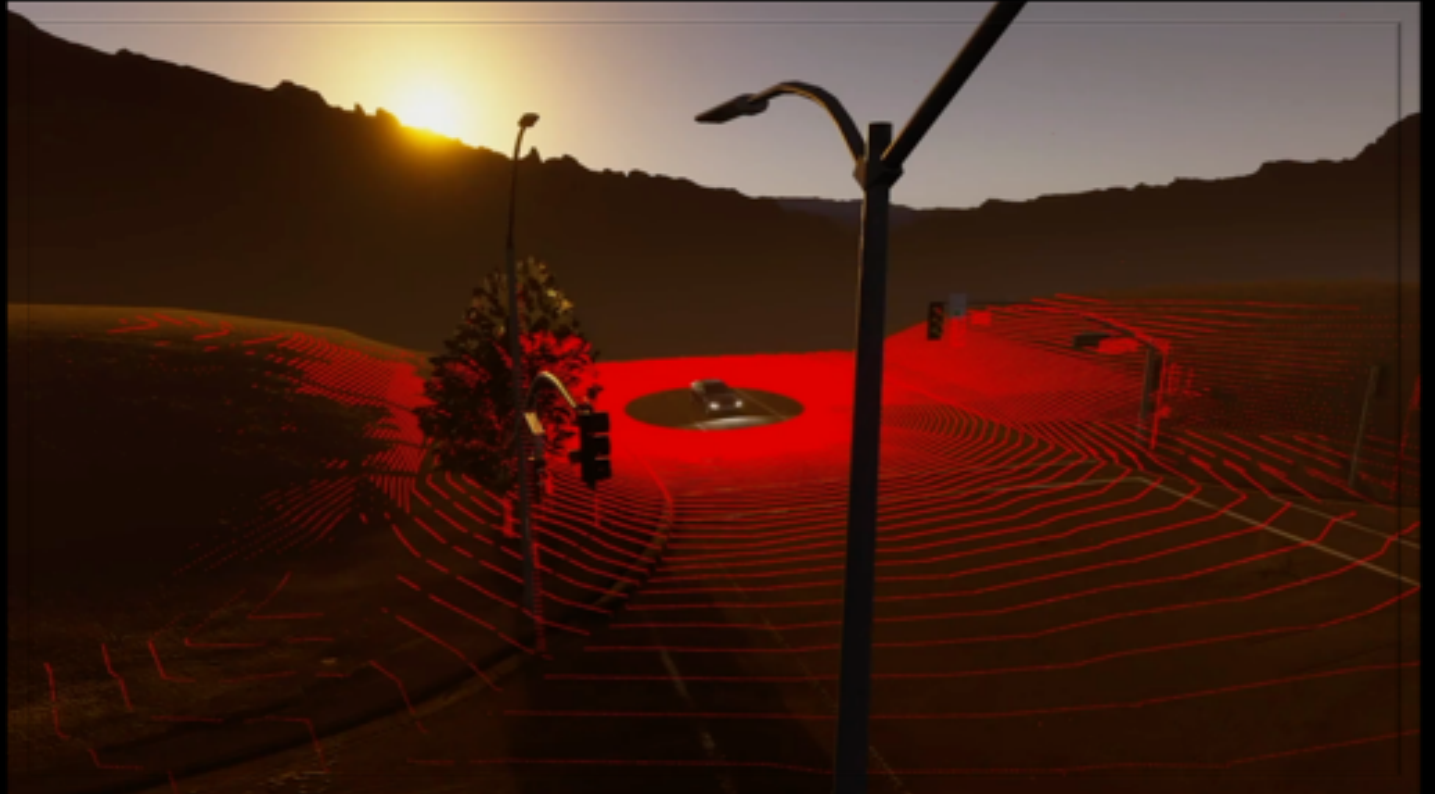
Out-of-box Integration with AD Systems

- Support for ROS, ROS2, CyberRT runtime framework for AD and Robotics systems
- Out-of-box integration with Autoware.AI and Autoware.Auto (and other AD stacks)



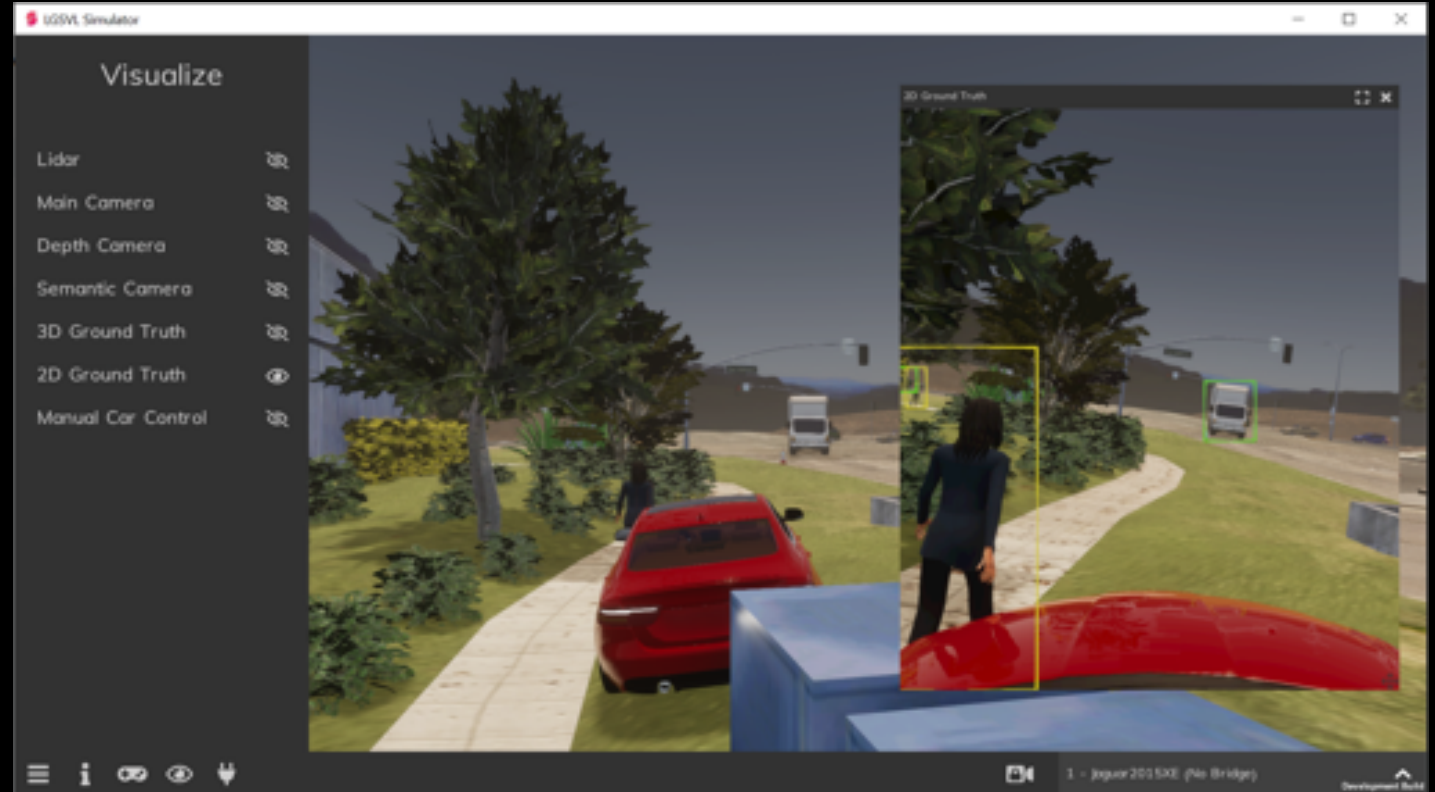
GPU based High Performance Sensor Simulation

- Physical Sensors
 - ✓ Cameras
 - ✓ LiDAR
 - ✓ Radar
 - ✓ GPS
 - ✓ IMU



GPU based High Performance Sensor Simulation

- Physical Sensors
 - ✓ Cameras
 - ✓ LiDAR
 - ✓ Radar
 - ✓ GPS
 - ✓ IMU
- Virtual Sensors
 - ✓ 2D Ground Truth



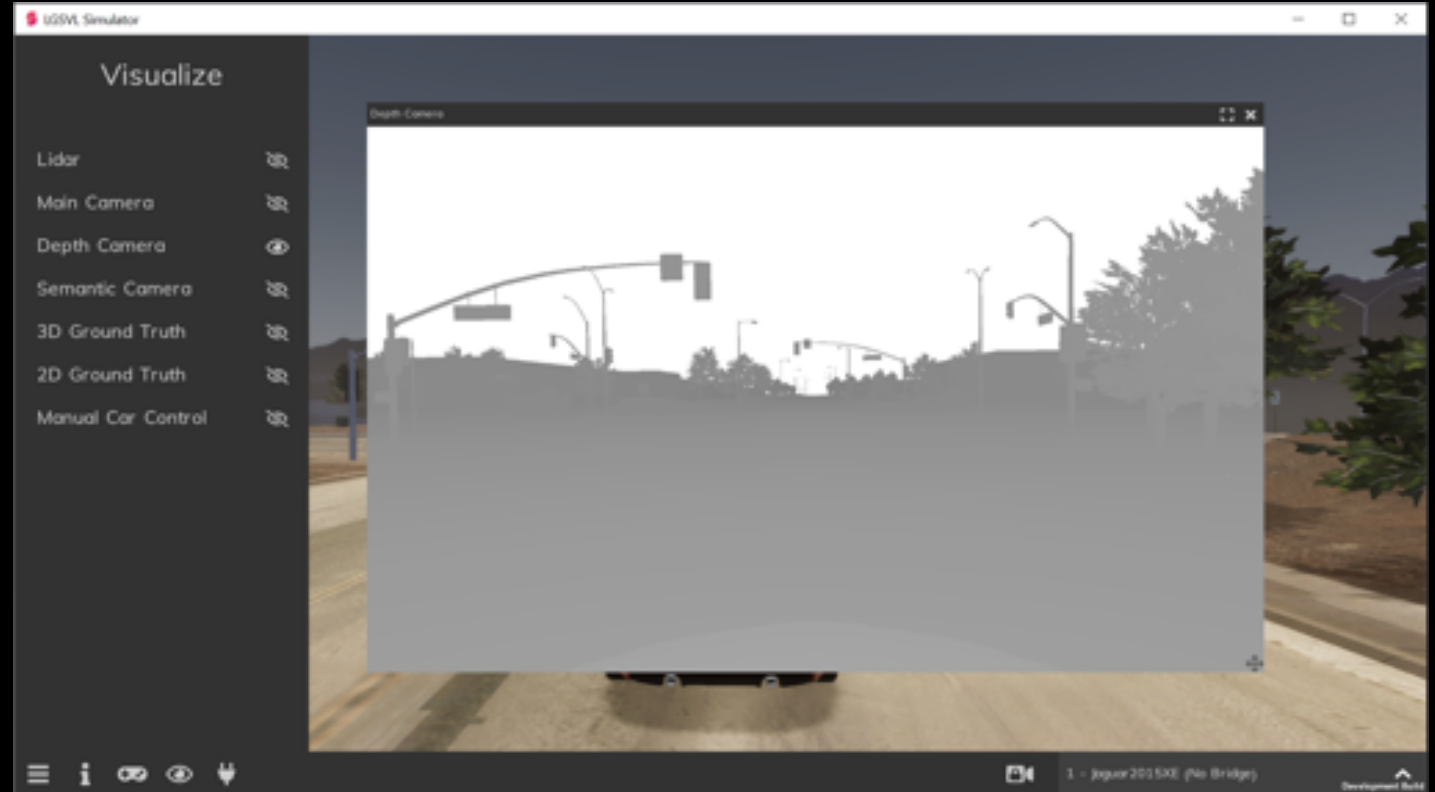
GPU based High Performance Sensor Simulation

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 - ✓ 2D Ground Truth
 - ✓ 3D Ground Truth



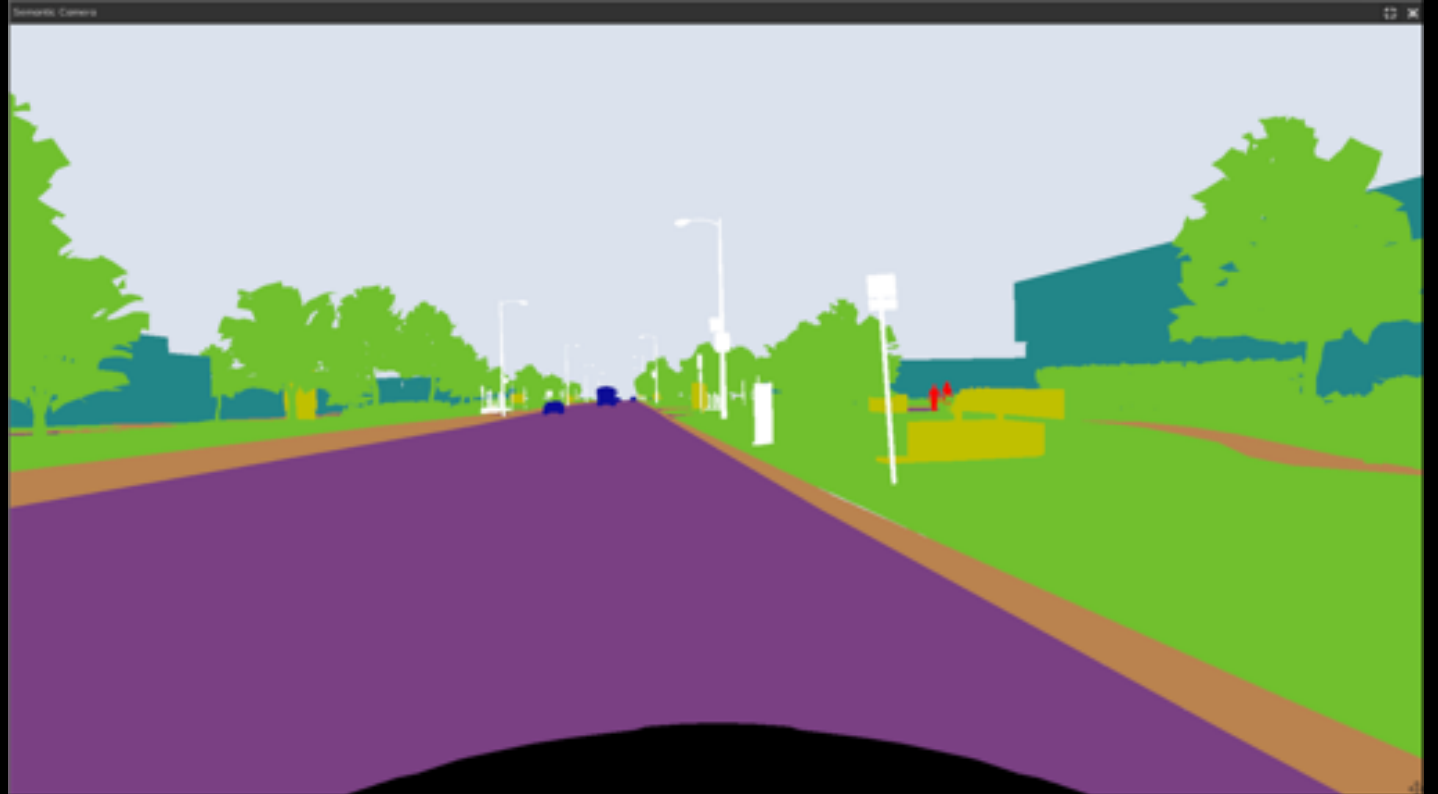
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 - ✓ Depth Camera



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 - ✓ Segmentation Camera



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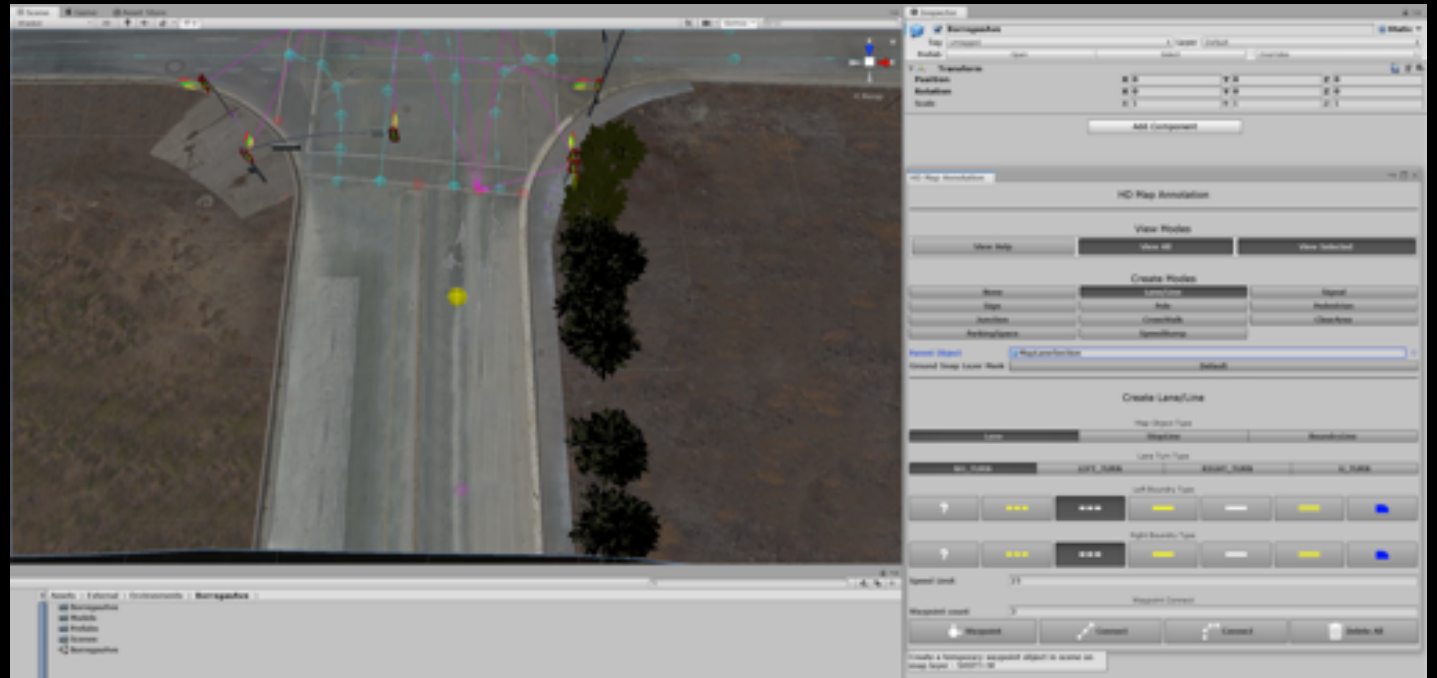
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Other features

- Road/map annotation editor:
 - ✓ Import of HD maps from Lanelet2, OpenDRIVE, Apollo
 - ✓ Export of HD maps to Lanelet2, Autoware Vector, OpenDRIVE, Apollo



Feature list

- We introduce new features/upgrades when announcing a new release
- LG plans to launch LGSVL Simulator Premium later this year:
 - ✓ Simulation platform that offers the tools and services needed for systematic and scaled testing which is fully integrated into a company's development workflow
 - ✓ Contact us for more information or a demo: contact@lgsvlsimulator.com

Feature	Free (Open-Sourced version)	Notes
Local simulation	✓	
Deterministic simulation	✓	
Default content	✓	Default maps, vehicles, 1-2 sensor plugins
Default bridges	✓	ROS2, ROS, CyberRT
HD map annotation	✓	Requires valid Unity license
HD map import/export	✓	Requires valid Unity license
Distributed simulation	✓	
Point cloud map import	✓	
Content creation	✓	Build simulator, maps, vehicles, plugins Requires valid Unity license
Python API	✓	
Sensor plugin support	✓	
Bridge plugin support	✓	
Vehicle dynamics extensibility	✓	
NPC behavior extensibility	✓	
Support for FMI/FMU	✓	
Ground truth data generation	✓	

Installation of the simulator

System Requirements

Recommended system

- 4GHz Quad core CPU
- Nvidia GTX-1080 (8GB memory)
- Windows 10 64-bit (or Ubuntu ~18.04)



External Links for more information

- 1) System requirements: <https://www.lgsvlsimulator.com/docs/getting-started/#getting-started>
- 2) GPU drivers and libraries: <https://www.lgsvlsimulator.com/docs/getting-started/#downloading-and-starting-simulator>

Installation of the simulator

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Install drivers and LGSVL Simulator

GPU drivers and libraries

- Install latest Nvidia drivers
- Install libvulkan (on Linux)
- Install nvidia-smi (on Linux)

LGSVL Simulator download

- <https://github.com/lgsvl/simulator/releases/latest>

External Links for more information

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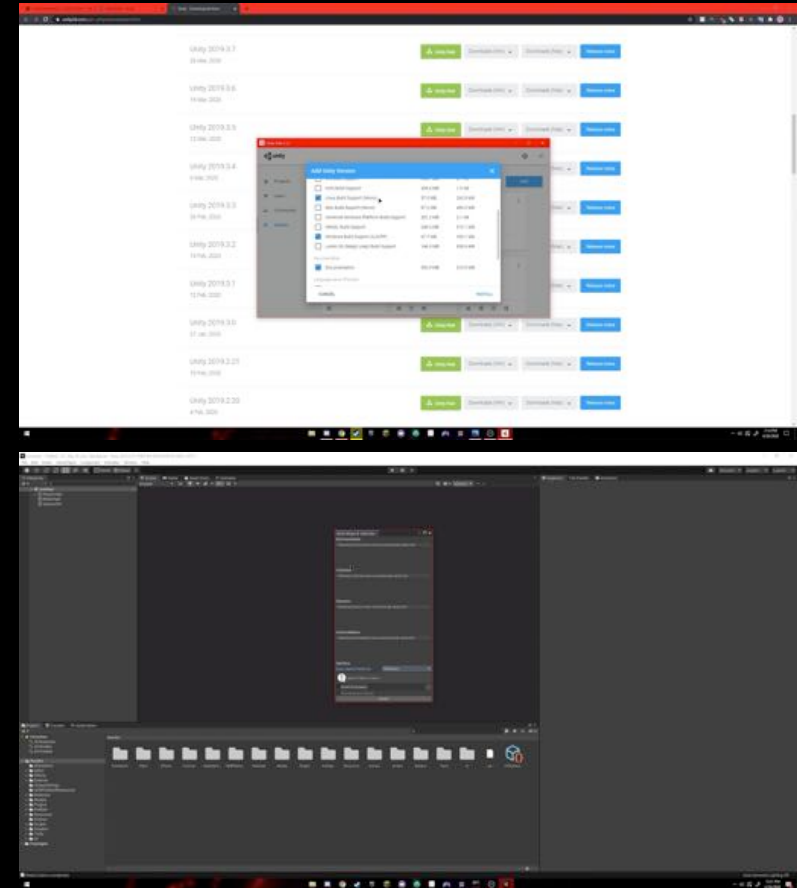
Building from source

Steps to build

- 1) Download and install Unity Hub
- 2) Download and install Unity 2019.3.3f1
- 3) Download and install Node.js
- 4) Verify git-lfs installation
- 5) Clone simulator from GitHub

Please refer to detailed step-by-step instructions

- <https://www.lgsvlsimulator.com/docs/build-instructions/>
- *(more on this later in “Advanced Topics”)*



Maps

Reference maps

- BorregasAve
 - ✓ A Digital Twin environment of a real-world suburban street block in Sunnyvale, CA
- AutonomouStuff
 - ✓ A Digital Twin environment of a real-world parking lot in San Jose, CA
- GoMentum
 - ✓ A Digital Twin environment of a real-world autonomous vehicle testing facility in Concord, CA



External Links for more information

- 1) Maps documentation: <https://www.lgsvlsimulator.com/docs/maps-tab/>
- 2) Maps content site: <https://content.lgsvlsimulator.com/maps/>

Vehicles

Reference vehicles

- Jaguar 2015 XE (Autoware)
- Lexus 2016 RX Hybrid (Autoware)
 - ✓ Configure the bridge type, if needed
 - ✓ Or create a new vehicle by downloading vehicle assets from the LGSVL content website



External Links for more information

- 1) Vehicles documentation: <https://www.lgsvlsimulator.com/docs/vehicles-tab/>
- 2) Vehicles content site: <https://content.lgsvlsimulator.com/vehicles/>
- 3) Autoware.Auto json configuration example: <https://www.lgsvlsimulator.com/docs/autoware-auto-json-example/>

Simulations

General tab

- Simulation Name: Name of the simulation
- Select Cluster: From the dropdown, select the cluster of computers that will run the simulation
 - ✓ Local Machine: Default (single machine simulation)
- API Only: Check this if the Simulation will be controlled through the Python API
 - ✓ Checking this will disable most other options as they will be set through the API
- Headless Mode: Check this if it is not necessary to render the Simulator in the main window
 - ✓ Checking this will improve performance

The screenshot shows a web form titled "Add a new Simulation" with four tabs: "General", "Map & Vehicles", "Traffic", and "Weather". The "General" tab is active. It contains the following fields and options:

- Simulation Name:** A text input field with the placeholder text "name".
- Select Cluster:** A dropdown menu with the text "Select cluster to run distributed simulation on several machines." and the selected option "Local Machine".
- API Only:** A section with the text "Simulation in API only mode is fully controlled by Python API. Map, Ego Vehicle and other parameters are defuned using API." and a checkbox labeled "Not using API to control simulation".
- Headless Mode:** A section with the text "In Headless Mode main view is not rendered. Use this mode to optimize simulation performance when interaction is not needed." and a checkbox labeled "Running in Normal Mode".

At the bottom right, there are two buttons: "Submit" and "Cancel".

UI Design could be updated

External Links for more information

1) Simulations documentation: <https://www.lgsvlsimulator.com/docs/simulations-tab/>

Simulations

Map & Vehicles tab

- Interactive Mode: Check this to enable Simulation controls
- Select Map: From the dropdown, choose the map that will be used
- Select Vehicle: From the dropdown, choose the vehicle that will be spawned
 - ✓ Bridge Connection String: If the chosen vehicle has a Bridge Type, an IP:port must be provided to the bridge host
- +: Adds an additional vehicle. Vehicles will spawn in Spawn Info positions of the map in order

The screenshot shows a web interface for adding a new simulation. The title bar says 'Add a new Simulation'. There are four tabs: 'General', 'Map & Vehicles' (which is selected), 'Traffic', and 'Weather'. Under the 'Map & Vehicles' tab, there are three sections: 'Select Map' with a dropdown menu labeled 'select a map'; 'Select Vehicles' with a dropdown menu labeled 'select a vehicle' and a text input field for 'Bridge connection string' with a clear button (X); and 'Interactive Mode' with a checkbox labeled 'Simulation will not run using Interactive Mode'. At the bottom right, there are 'Submit' and 'Cancel' buttons. A red text annotation 'UI Design could be updated' is placed above the 'Submit' button.

External Links for more information

1) Simulations: <https://www.lgsvl simulator.com/docs/simulations-tab/>

Simulations

Traffic tab

- Use Predefined Seed: Check this and enter a seed [int] which will be used deterministically control NPCs
- Enable NPC: Check this to have NPC vehicles spawn at the beginning of the Simulation
- Enable Pedestrians: Check this to have Pedestrians spawn at the beginning of the Simulation

Add a new Simulation

General

Map & Vehicles

Traffic

Weather

Use Predefined Seed

Using pre-defined random seed makes simulation deterministic. Vehicle colors, traffic behavioral decisions and other randomized events will happen the same way while using the same seed.

☐ Use different random seed everytime

Enable NPC

☐ NPC is disabled

Random Pedestrians

When enabled Pedestrians start to roam around randomly across the map during the simulation.

☐ Pedestrians are disabled

Submit

Cancel

UI Design could be updated

External Links for more information

1) Simulations: <https://www.lgsvlsimulator.com/docs/simulations-tab/>

Simulations

Weather tab

- Time of Day: Set the time of day for the Simulation
- Rain: [0-1] set how much rain should fall
- Wetness: [0-1] set how wet the roads should be
- Fog: [0-1] set thick fog there should be
- Cloudiness: [0-1] set how much cloud cover there should be

Add a new Simulation

General

Map & Vehicles

Traffic

Weather

Time of day

Set time of day during simulation.

00:00

Rain

Raining introduces particle droplet effects falling from the sky and camera post post-processing effects.

0

Wetness

Wetness covers the road and sidewalks with water.

0

Fog

Defines amount of fog and other particles in the air.

0

Cloudiness

Defines amount of clouds during simulation.

0

Submit

Cancel

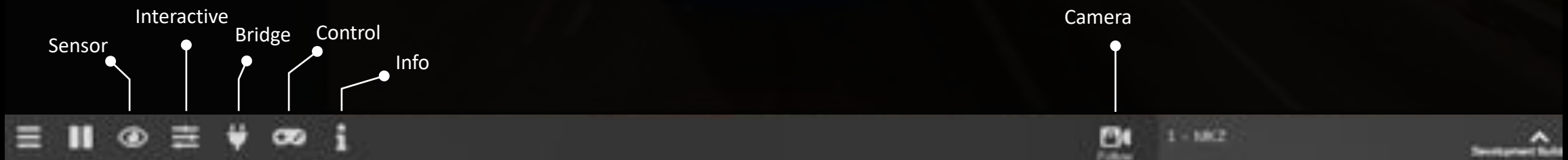
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External Links for more information

1) Simulations: <https://www.lgsvlsimulator.com/docs/simulations-tab/>

Controlling the simulation

- Sensor: It lists all sensors on the selected vehicle and allows for the sensors to be visualized
- Interactive: It contains tools to change the environment of the Simulation while the Simulation is playing
- Bridge: It lists information on the bridge status as well as all published and subscribed topics
- Control: It lists all the keyboard commands in the simulation. See Keyboard Shortcuts for more details
- Info: It lists the build info as well as any errors, logs, or warnings that are created in the current simulation
- Camera: It indicates if the view is currently a follow camera or free-roam camera



External Links for more information

- 1) Controls menu: <https://www.lgsvl simulator.com/docs/simulation-menu/#controls-menu>
- 2) How to find Player.log file: <https://www.lgsvl simulator.com/docs/fag/#where-are-unity-log-files-located>

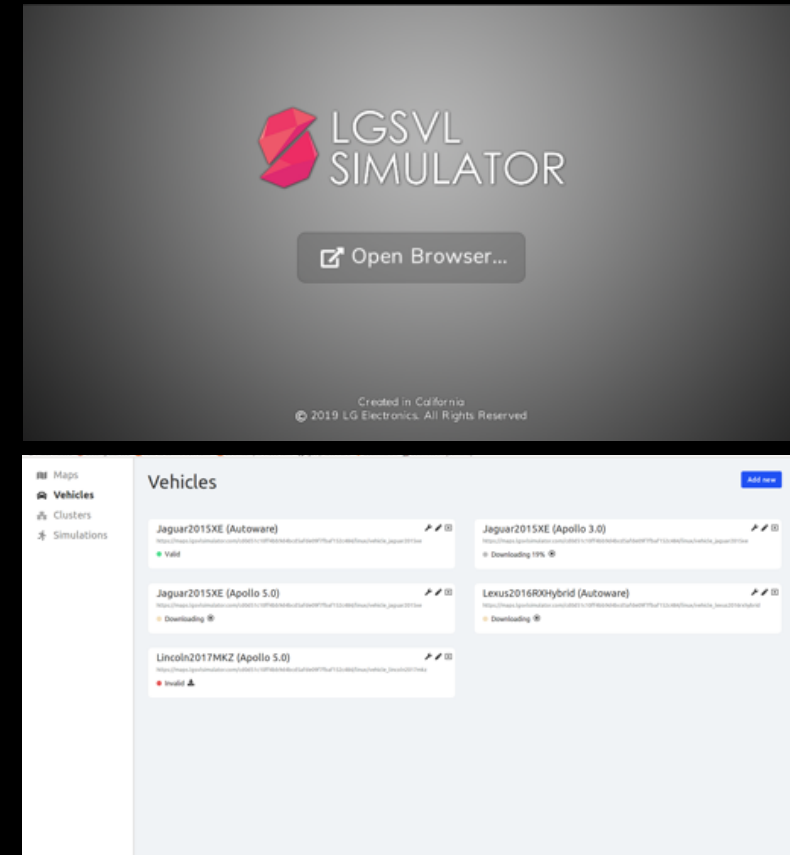
Hands-on with LGSVL Simulator

Agenda

We will now switch to “Hands-on” video for:

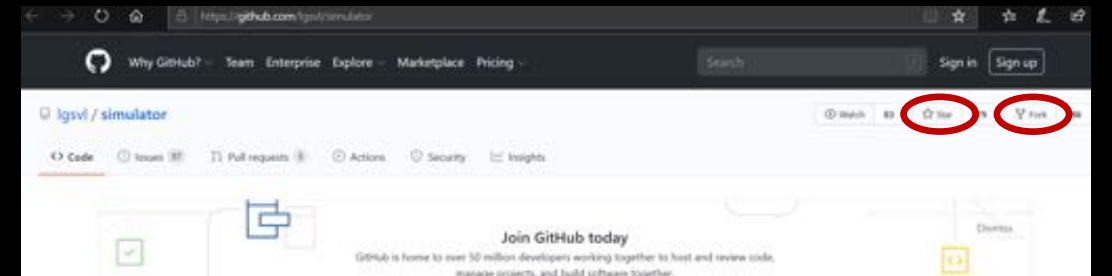
- User Interface and Configuration
- Running Simulation with Autoware.Auto
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Please refer to video lecture and notes attached to the lecture to review steps and command lines...



Helpful Links

- LGSVLSimulator website: <https://www.lgsvlsimulator.com>
 - ✓ Subscribe LGSVL Newsletter to get the latest updates
- LGSVLSimulator on GitHub: <https://github.com/lgsvl/simulator>
 - ✓ Star and Fork our GitHub page
- LGSVLSimulator on YouTube: <https://www.youtube.com/c/LGSVLSimulator>
 - ✓ Subscribe the channel to get the latest video clips and tutorials





contact@lgsvlsimulator.com