

Edge Simulation for Advanced Development Systems

Contents

- ❖ [Overview](#)
- ❖ [The Importance of Environmental Simulation](#)
- ❖ [Dell Technologies Collaboration with monoDrive](#)

Overview

Fueled by semiconductor advances and a spread in software ecosystems, autonomous technology innovation continues to accelerate. Increasingly, system validation is deployed in edge environments outside of data centers and cloud. Edge is deployed with semiconductor and systems enhancements, the intensity of massive data generation and consumption, and the need for software to operate in real time. One important use case includes AI-enabled computer vision and sensor fusion to enable perception system training and validation for autonomous and safety critical systems. You can think of autonomous systems as capabilities that are AI enabled for perception, prediction, planning, and control. Examples include:

- Autonomous Vehicles
- Robotic Process Automation
- Virtual Agents

Today's Advanced Driver Assistance Systems and Autonomous Driving (ADAS/AD) vehicles lead the advancements in autonomous system innovation.

A key emerging requirement for all autonomous systems development, and now a requirement for ADAS/AD, is high-fidelity environmental simulation. Environmental simulation creates a virtual world in which the system under test operates for testing and development. High-fidelity physics-based environment simulation is an essential component of development for any autonomous system.

Dell Technologies is performing research innovation in this emerging area with key ecosystem partners like monoDrive and others.

The Importance of Environmental Simulation

Unlike deterministic software systems, autonomous systems are developed and trained through AI learning frameworks. These frameworks consume labeled training data, and the AI system adapts to provide the optimal response through a process called Network Training. Once the system is developed and trained, it is essential for the system that is under test to perform in a new environment that is not seen during the Networking Training process. The Network Validation process determines if the system makes the right or optimal decision and performs accordingly. This process is especially important for systems like ADAS/AD that are life-safety critical.

The ADAS/AD development cycle must ensure the safety of the vehicle and passengers. NHTSA believes that advanced crash avoidance and mitigation technologies will dramatically increase the safety of a vehicle.¹ One key automotive safety technology that falls into the advanced crash avoidance category is the Automatic Emergency Braking (AEB) system. The vehicle perceives and predicts that it will impact another vehicle or object, so a decision is made within milliseconds to activate the braking system in order to avoid an impending collision. This action requires the receipt of input from multiple sensor systems (camera, radar, lidar, and ultrasonic), interpretation of the meaning of the data, and then performing the appropriate action. ADAS/AD systems require testing and operation in real-world conditions for tens to hundreds of millions of kilometers to ensure that they can safely operate. The systems must also be validated using thousands of targeted safety scenarios like AEB. But once in production, the vehicle's models will decay and will require upgrades while enhancements will require reverification.

The thorough testing of autonomous capabilities with real vehicular systems is not only cost prohibitive, but often, impossible to validate without environmental simulation. It is much more cost effective and flexible to use high-fidelity simulation systems that harness the power of compute and storage to automate environmental and scenario testing.

The simulation system needs to operate and process immense levels of data (up to ten terabytes/hour per system under test), and react within a short timeframe. It also needs to meet other key requirements:

- Physics based: Must follow the same rules of nature as we all do the application of force, motion, and the reaction to gravity. The simulation environment needs to correctly model material and channel effects in ultrasonic (20 to 80 kHz), electromagnetic frequencies (24 GHz to 79 GHz), and infrared optical wavelengths (905 to 1550 nm).
- Photorealistic: Must match spectral imaging, white balance, color space, lens distortion, color depth, and exposure time to appear authentic to the system under test.
- Interactive: Interactions must be realistic and interactive with the environment, adjusting as the system under test is stimulated and reacts to the environment.

¹ <https://www.safercar.gov/Vehicle-Shoppers/Safety-Technology/aeb-1>

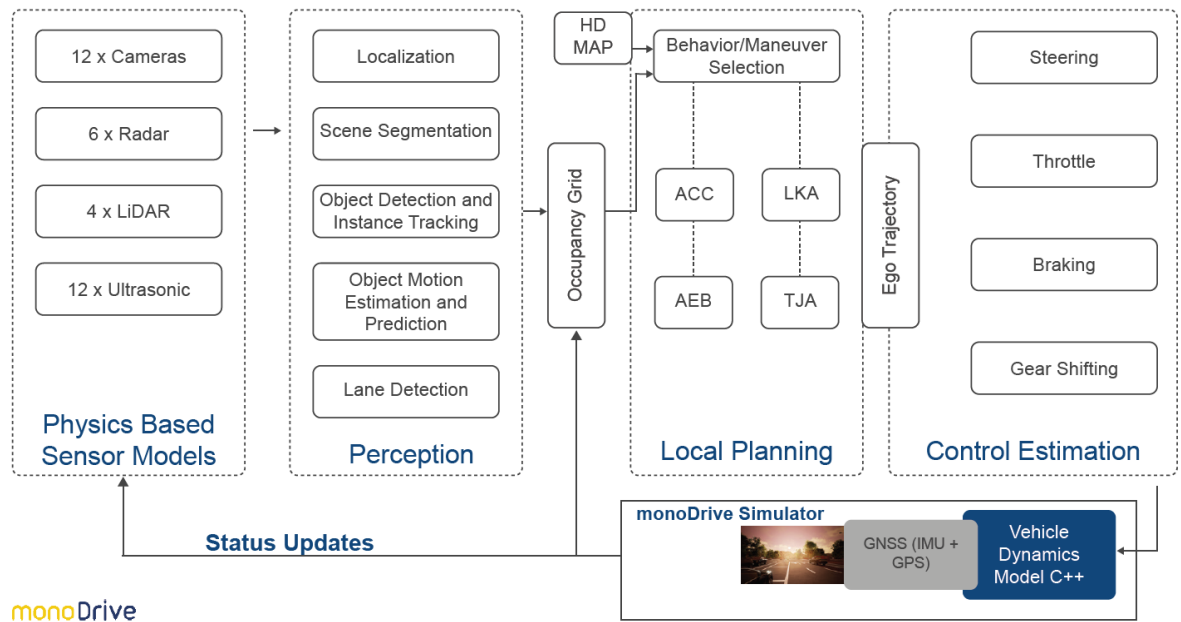


Figure 1. Example End-to-End Perception, Planning, and Control

When the simulation system is remote or in the cloud, the conditions cannot be effectively managed. They are most optimally performed in edge environments on optimized platforms that are grouped with systems that are tested under latency-controlled conditions. All ADAS/AD systems require this capability as a fundamental component of the development process. Further, all autonomous systems require the flexibility of simulation to define unique scenarios for development and integration testing.

Dell Technologies Collaboration with monoDrive

To meet customer demands for high-fidelity simulation, Dell Technologies works closely with monoDrive to explore environmental simulation deployment at scale. monoDrive has an innovative physics-based, photorealistic simulation capability for ADAS/AD. Also, monoDrive has developed a library of sensor models that accurately emulates real world radar, lidar, camera, and ultrasonic products that are currently in production. To facilitate the rapid creation of high-fidelity simulation worlds, the monoDrive Real to Virtual (R2V) product provides the capability of converting images, lidar, and GNSS inputs to create digital twins of real-world scenarios.

Dell Technologies has integrated its industry-leading PowerEdge server platforms with the monoDrive simulation products to optimize the scalable execution of high-fidelity simulation, and scenario testing. Dell Technologies has also worked with monoDrive to deploy this solution with a Kubernetes cloud-native micro-service design and deployment pattern. The collaboration focuses on research and development in the management of data pipelines from edge to core to cloud, and management of thousands of simulation scenarios using the Dell Technologies PowerScale storage system, and DataIQ for local dataset management. This work allows Dell Technologies and monoDrive to effectively manage the complexity of scenario description, data catalog, data transforms, and data movement from edge to core to cloud for ADAS/AD data life cycle management.

This research provides insight into how to optimize execution of current ADAS/AD development toolchains, and how to build future capabilities that are essential in the development of modern autonomous systems.



The information in this publication is provided as is. Dell Inc. makes no representations or warranties of any kind with respect to the information in this publication, and specifically disclaims implied warranties of merchantability or fitness for a particular purpose. Use, copying, and distribution of any software described in this publication requires an applicable software license.

Copyright © 2020-2021 Dell Inc. or its subsidiaries. All Rights Reserved. Dell Technologies, Dell, EMC, Dell EMC and other trademarks are trademarks of Dell Inc. or its subsidiaries. Other trademarks may be trademarks of their respective owners. Published in the USA December 9, 2020
FY21Q4_0051_edge_simulation_for_advance_dev_systems_whitepaper_012721.

Dell Inc. believes the information in this document is accurate as of its publication date. The information is subject to change without notice.

Author: Jeff White, iCTO; Said Tabet, Distinguished Engineer; James Singer, Engineering Technologist; George Currie, Senior Software Principal
Engineer: Celite Milbrandt, CEO-monoDrive