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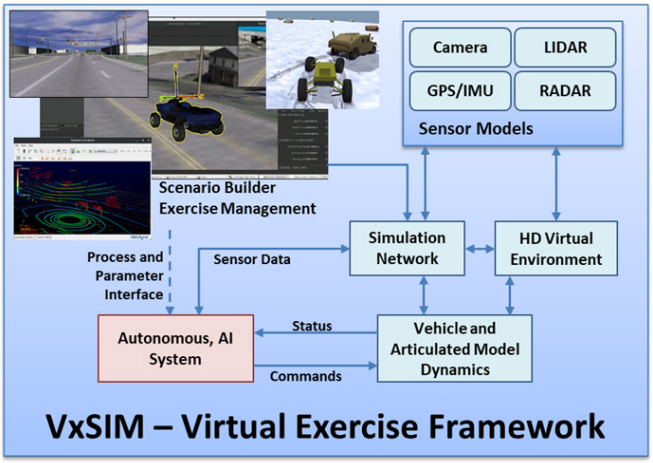
From Surf to Autonomous corridor, DDT's Virtual Twins Allow Smart Simulation, Integration

By Jennifer Reisch

Engineering and applied technology firm Dynamic Dimension Technologies LLC (DDT) has a long history of providing high-fidelity simulation software, robotics, and data science solutions to the Navy and other military branches. Currently through SBIR topic N181-077, DDT is developing the Water incorporated, Autonomy enabled Virtual vehicle testing Environment (WAVE) module for its virtual experimental simulation environment (VxSIM). VxSIM is a high-fidelity, multi-physics-based simulation framework to test and train autonomy and artificial intelligence algorithms and systems in the loop.



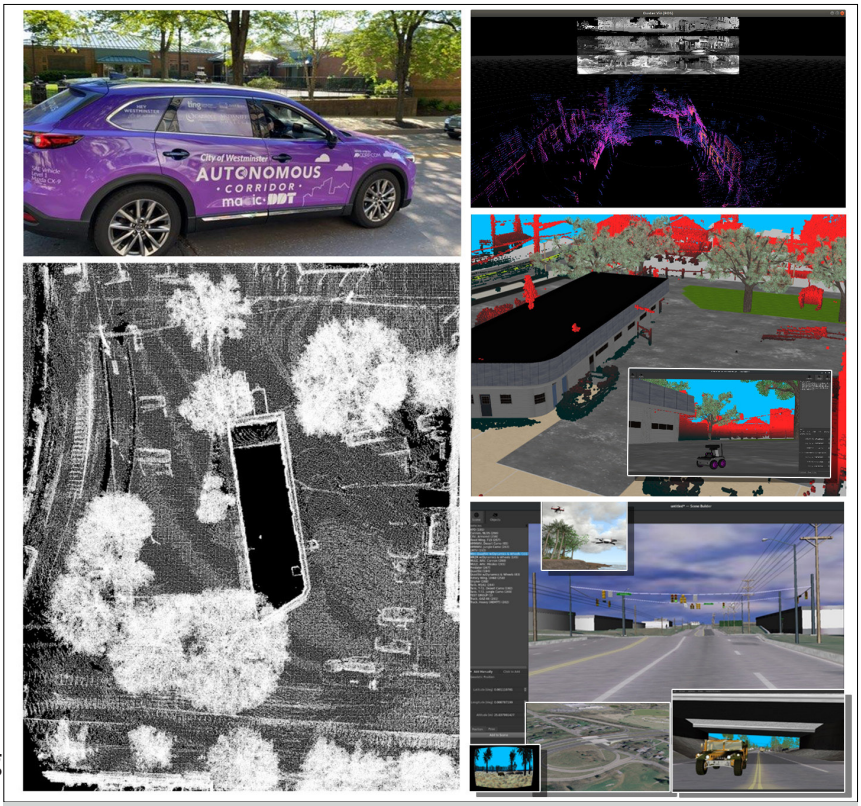
VxSIM supports challenging autonomous vehicle situations, including off-road environments, and also provides a foundation for new technology innovations such as physics-based transfer learning which can significantly improve machine learning and artificial intelligence (AI) applications. VxSIM includes an intuitive GUI, a multi-physics simulation solver for accurate platform modeling, soil modeling, hydrodynamics, etc., sensors (e.g., LIDAR, RF, IR, EO, GPS, IMU), communication interfaces, and simulation controls for real-time or non-real-time batch or Monte Carlo analysis. DDT's innovations center on simulation technologies for development, testing and training autonomous systems, with the capability for rapid creation of 3D geo-specific virtual environments for physics-based simulation and digital twin interactive technologies.

DDT's SBIR will provide the Navy with an accurate, high-fidelity simulation environment for the littoral domain that can be used to develop, test and train autonomy-enabled systems for land, air, sea and undersea operations, enabling more robust autonomy systems, improved search and surveillance effectiveness and more accurate decision-making tools. This system supports development of new vehicle designs by testing new design systems and algorithms virtually with wave surf interactions, fully representing wave curls and associated physics. DDT has deployed its software to several Naval centers, but COVID-related restrictions have slowed progress on the SBIR, said Karl Leodler, president and CEO of DDT.

While the Navy is exploring WAVE for surf simulations, the City of Westminster, home to DDT, has also been using the SBIR technology to build a virtual twin of the 11-mile smart autonomous corridor the city is building. Westminster formed a technology non-profit, the Mid-Atlantic Gigabit Innovation Collaboratory (MAGIC), which is working with DDT to scan routes so autonomous shuttles can operate on a circuit, connecting a retirement community, local colleges, the YMCA and the downtown area.

"We have extended our SBIR M&S for testing autonomous vehicles to become a digital twin for autonomous corridors and a basis for smart city infrastructure," Leodler said.

Leodler developed plans to create a shuttle system that is integrated throughout the city. "We talked about how we can do this as a virtual twin, which is a subset of a digital twin environment. It's a full three-dimensional environment where we can also run simulations and simulation-based testing. As the project grew, we started uncovering more and more ways we could leverage what we've been doing in our SBIR, spinning off new capabilities.



Top Left: Data gathering; Top Right: Raw sensor data; Left: Localization and alignment; Right Middle: Data processing, segmentation & formatting; Right Bottom: VxSIM digital-twin

"What we're doing is building a model of the city in a virtual environment; all the buildings, offices, the streets, the traffic lights, stop signs, everything is there. We're scanning the 11-mile corridor of the city and converting that into a virtual environment. Once connected, we can view the traffic lights, any of the traffic camera systems, anything that is a city asset and share the data within this environment, giving us comparison to the baseline data of the city. When we start integrating with autonomous systems, we'll first do it through a simulation aspect with a software in the loop of the autonomy systems running on the streets in town."

In Westminster one of the challenges for the autonomous shuttle will be crossing railroad tracks. "The route goes across a railroad track that cuts cattycorner through an intersection where trains come through a few times a day. We're not aware of autonomy systems having dealt with an intersection that includes train tracks, so we'll leverage our simulation environment to train the autonomy systems as well. When connected our virtual environment could pull the train schedules so the digital twin can send an alert when a train is coming through. We could also adjust the shuttle timing and schedule to make sure it's not near the intersection when the train is coming through town," Leodler explained.

"In our SBIR we worked on rapid area-of-interest creation involving obtaining sensor data and leveraging that sensor data to support the creation of a hi-fidelity hi-definition 3D environment for the simulation. That's translated to running our scanners in the area around town and collecting data and testing out our new algorithms to clean and process the data.

It's turned out pretty well.

"For the autonomy corridor we're using our 64-beam lidar mounted on a vehicle to scan the area; then we segment the data and convert to an open format for visualization and use in our simulation and digital twin. Our detail scans capture the phone and power lines very clearly, along with the roads, curbs, signs, etc. When running our digital twin in live mode with our connected autonomous robot, we can get point cloud streaming updates and object detections on-the-fly."

Because the autonomous system will continue to scan the corridor as it runs, the system can alert the city to problems such as potholes that have developed. "Our electric company has expressed an interest in looking at our data to determine if trees are encroaching on power lines and need to be trimmed. If they can leverage this environment we're putting together, they can reduce their costs associated with sending people out to check their powerlines. Since we can clearly see the trees and the power lines in the data, we can implement some AI to detect whether or not the trees are encroaching on the powerlines. All these autonomy systems have cameras and lidars which can feed updates into our baseline model. From there we'll be able to see the growth of the trees over time, so we can apply AI to predict when trees will need trimming," Leodler said.

"We're hoping this digital twin environment has a lot more potential. A digital twin is the first step toward a smart city infrastructure. It allows data and information to pass back and forth in a more rapid and more comprehensive fashion, and it can be used to improve safety, to improve the community security, and it will also help to improve energy efficiency and clean air initiatives. For example, we'll have ability in our digital twin to watch the traffic and the stop lights. This can keep cars from idling unnecessarily while waiting for a light to change when there's no cross traffic, limiting the gas and exhaust emissions. We can optimize the traffic lights once we have connectivity with them; we can write the AI to look at traffic signals and optimize the light timing based on traffic conditions, so you don't have to sit and wait for the light to change when no traffic is coming."

Emergency vehicles can also take advantage of data from the corridor to better route plan how to get to their location of the emergency and avoid traffic and construction areas en route.

"We've also had interest in our digital twin technology coming from facilities and warehousing. We've been asked if our digital twin could be used to improve warehouse logistics and how a digital twin and a smart warehouse could be integrated together. There are people out there doing scanning and digital twin warehouse automation technologies, but no one is using a simulation framework for it. That's a differentiator for us: having the ability to run live interactive and also do a simulation at the same time," Leodler said.

For more information about DDT, visit the company website at:

www.dynamicdimensiontechnologies.com