Research Report Summary

SAFER-SIM University Transportation Center, 69A3551747131

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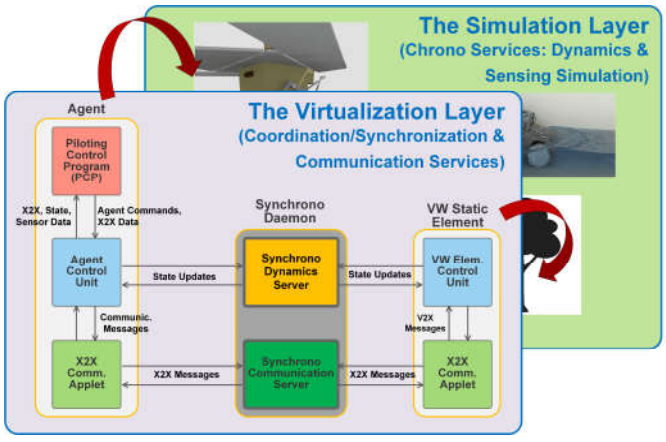
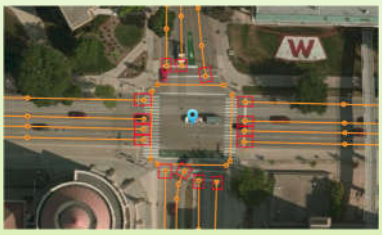
Developing an Open-Source Multi-Agent Simulation Environment for Connected Autonomous Vehicles

This research seeks to create a simulation environment where connected autonomous vehicles can be tested, evaluated, and developed such that their autonomous behavior can be understood and improved. Discussed in this project is a simulation framework that leverages high-fidelity dynamics and sensing simulation from Chrono [1] in a multi-agent environment called Synchrono. This multi-agent environment allows for multiple vehicles to participate in a coherent simulated scenario.



Synchrono multi-agent simulation framework allows multiple vehicles to be simulated in the same environment and scenario. Each vehicle can leverage Chrono for high-fidelity physics and sensor simulation.

Virtual Environment and V2X Communication



The Synchrono simulation framework can leverage real-world DSRC messages and allow V2X communication within the simulated environment.

A three-dimensional virtual environment based on the real world is used as an environment for autonomous vehicle simulation (courtesy of Continental Mapping [2]).

"Simulating dynamics, sensing, and communication within a multi-agent framework to test and evaluate connected autonomous vehicles."

Along with the multi-agent framework, this project allows for vehicle-to-vehicle (V2V) and vehicle-to-anything (V2X) communication within the simulation to understand and study the effect of connectivity in various scenarios. Collaboration with Continental Mapping has been ongoing to demonstrate the ability to generate and use in simulation a virtual environment that is generated from the real world. The virtual environment is used to inform the dynamics, sensing, and communication simulation. This project shadows a City of Madison pilot project to test connected autonomous vehicles and understand the impact and role of connected infrastructure in controlling the traffic of connected roadways.

Outcomes

- We produced an open-source software infrastructure called Synchrono, which is used in conjunction with another open-source software infrastructure called Chrono.
- Synchrono will be used in conjunction with a City of Madison pilot project that seeks to understand how V2X communication comes into play in controlling the traffic of the future.
- The University of Wisconsin-Madison Formula Team is using Synchrono in preparation for their first participation in the 2020 edition of the Formula Student Germany Driverless.
- Several presentations have been given that highlighted this SAFER-SIM project. Specifically, the PIs/students working on Synchrono reported on this project at Northwestern University, University of Wisconsin-Stout, Clemson University, Mississippi State University, Georgia Tech, MIT, University of California Berkeley, Jet Propulsion Lab, Disney Research, and University of California San Diego.
- We are in the process of using this project to generate a two-hour module that will be taught in eight weeks in conjunction with a residential summer camp for underrepresented high-school students interested in STEM activities.

Impacts

It is too early to judge what the long-term impact of this project is. However, Synchrono or a simulation platform like it can make a difference in the deployment of autonomous vehicles and their adoption by the public at large. Specifically, the technology pursued under this SAFER-SIM project does the following:

- Plays a role in reducing the number of crashes from implemented policy, practice, regulation, rulemaking, or legislation. These policies, regulations, etc. can be informed by statistical data that can be generated using a tool such as Synchrono.
- Can help researchers improve traffic flow owing to the scalable nature of the infrastructure developed, which in theory can simulate thousands of vehicles if deployed on a supercomputer infrastructure. As a byproduct, traffic congestion alleviation and improved flow are poised to have a positive environmental impact as well.

References

[1] A. Tasora, R. Serban, H. Mazhar, A. Pazouki, D. Melanz, J. Fleischmann, M. Taylor, H. Sugiyama, and D. Negrut, "Chrono: An open source multi-physics dynamics engine," in High Performance Computing in Science and Engineering – Lecture Notes in Computer Science (T. Kozubek, ed.), pp. 19–49, Springer, 2016.

[2] Continental Mapping. https://www.continentalmapping.com/. Accessed: 2019-04-19

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