

Information-Aware Connected-Autonomous Vehicle (IACAV) Operations in Mixed Traffic

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Background

- ❑ In an urban arterial environment, vehicles' autonomous movements in a mixed traffic situation is challenging as these autonomous vehicles need to assess their surrounding environments, including traffic, in real-time to move efficiently.
- ❑ Autonomous vehicles with an array of sensors and in-vehicle computing units are expensive, which could make them economically infeasible for broader adoption.
- ❑ Number of expensive arrays of sensors and computing units can be minimized by real-time communication with them, which would support the information-aware connected-autonomous vehicle (IACAV) movements in mixed traffic in collaboration with their sensors and computing units.

Study Purpose

The purpose of this study was to develop a strategy that would enable safe and efficient operations of connected-autonomous vehicles with the help of real-time collaborations between external data sources, and in-vehicle sensors and computing devices.

Connected-Autonomous Vehicles

What are the available sensors used in this study for IACAV?

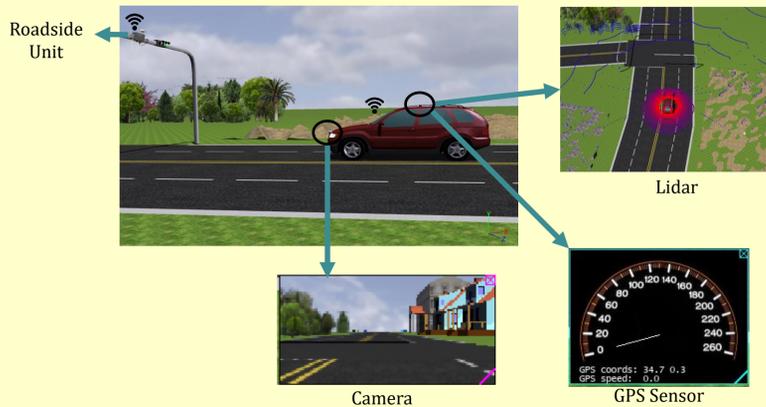


Figure: Connected autonomous vehicles generated in simulation

How will vehicle-to-infrastructure connectivity help autonomous car?

Autonomous Driving Disengagement Reasons	Google/ Waymo*	Delphi*	Will connectivity help to reduce autonomous controller disengagement?
Weather	1	-	Yes
Other road user (reckless behavior, wrong prediction or precautionary intervention)	16	58	Yes
Unwanted maneuver of the vehicle	30	-	No
Perception discrepancy	20	38	Yes
Software discrepancy	51	-	Yes
Construction zone	2	19	Yes
Emergency Vehicle	2	1	Yes
Debris on the road	2	-	No
Lane change in heavy traffic	-	62	Yes

*Collected from California DMV website https://www.dmv.ca.gov/portal/dmv/detail/vr/autonomous/disengagement_report_2016

Road Network and Test Description

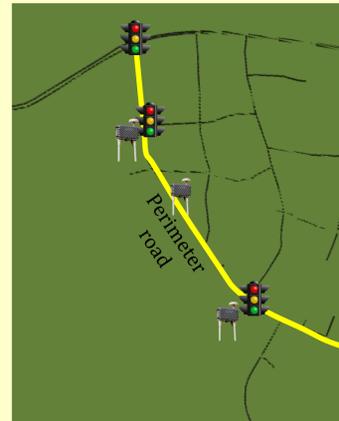


Figure: Study Corridor

Road Network

- ❑ Urban arterial
- ❑ Corridor length 0.8 mile
- ❑ Three signalized intersections
- ❑ DSRC-enabled roadside units in three intersections

Test Scenarios

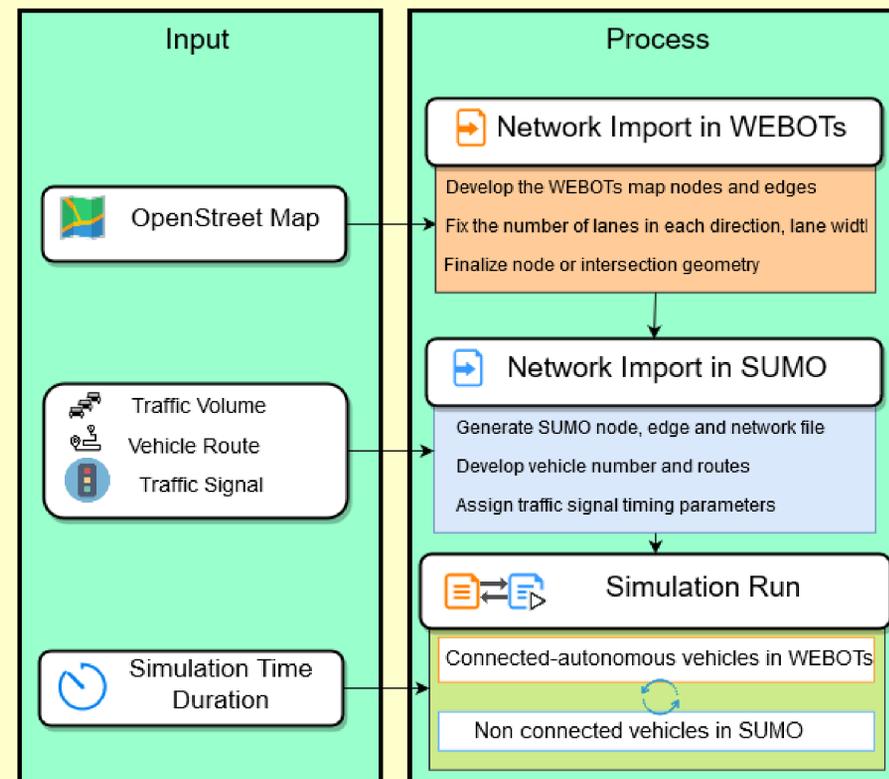
Field test:

To evaluate the Dedicated Short Range Communication coverage in test network

Simulation test:

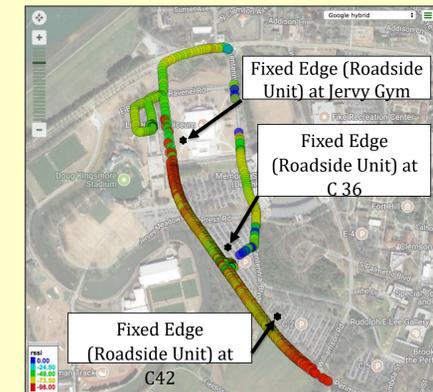
- ❑ To evaluate the performance of Dedicated Short Range Communication for mobility application
- ❑ To evaluate the efficacy of external data from traffic signal controller for safe connected-vehicle operation
 - ❑ Without Vehicle-to-infrastructure connectivity
 - ❑ Without Vehicle-to-infrastructure connectivity

Research Method

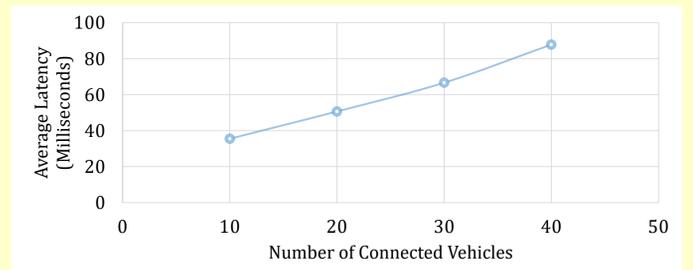


Analysis of the Experiments

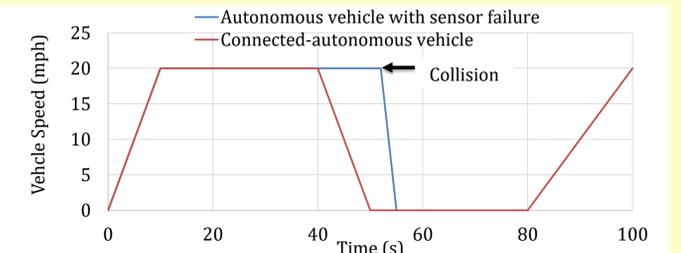
Is existing DSRC coverage sufficient for IACAV operations in Perimeter road?



How does DSRC perform with increasing connected vehicles?



How does an IACAV operate with traffic signal information?



Conclusions and Future Research Directions

- ❑ Webots-SUMO platform provides unique capabilities to evaluate connected-autonomous vehicles in a simulated real-world roadway traffic network.
- ❑ Information-aware connected autonomous vehicle operation is safer than sensor-dependent autonomous vehicle movement, as IACAV reduces sensor data uncertainty, lag of sensor data filtering or sudden failures of sensors.
- ❑ Future research will focus on evaluating IACAV operations during diverse traffic conditions, such as during traffic incidents and evacuation.
- ❑ More research should be conducted to study the reliability of wireless connectivity to support IACAV during diverse environmental conditions, and with increasing number of IACAVs.