Technology Transfer Final Report

STRIDE Project D

Evaluation of Advanced Vehicle and Communication Technologies through Traffic Microsimulation

Pruthvi Manjunatha

July 2021

1. Project Overview

Researchers at UFTI leading a STRIDE Center project in collaboration with the Georgia Institute of Technology (GaTech) have developed a robust microsimulation extension in VISSIM. The extension allows for the development and refinement of advanced transportation management strategies and evaluation procedures for the presence of connected and autonomous vehicles (CAVs). Simply put, the researchers have developed simulation extensions to test "what if" scenarios related to CAVs.

Our main objective is not to develop an AV or CV model or "what if" scenarios, it is to develop a platform or a framework so that these scenarios can be tested. Our work is building a tool to test and design for the new reality of having AV/CVs alongside conventional vehicles on the road.

This project considers both mobility and environmental impacts. The goals of the project are accomplished using the VISSIM microsimulator. The UF research focused on traffic simulation while the GaTech team focused on emissions.

The framework the research team created is a simulation extension with CAV functionality, which includes integrated emissions modeling. Practitioners can use this framework to evaluate transportation management strategies using emerging technologies.

2. Research Goal

The goal of this project was to develop a robust microscopic simulation extension to allow the evaluation of traffic operational quality considering the presence of CAVs. This was accomplished by the following:

1. Evaluating the microscopic simulator VISSIM's ability to simulate CAVs
2. Developing a comprehensive simulation extension to represent CAVs in VISSIM
3. Integrating emissions modeling to calculate real-time energy and emission estimates
4. Assessing traffic operational and environmental performance measures for various CAV levels

3. Findings

In this project, the researchers evaluated the capability of microsimulator VISSIM to model CAVs and concluded that internal modeling provides limited access to vehicle/driver behavior parameters and cannot model connectivity. Externally, COM Application Interface Programming (API) and External Driver Model (EDM) in VISSIM have powerful features to enable CAV modeling. Researchers used these features and developed a simulation extension with CAV functionality. This extension was integrated with emissions modeling.

Researchers tested this extension by implementing an existing AV model (Talebpour and Mahamassani, 2016) and CV model (PTV, 2016), and simulating various penetration levels of CAVs. The results showed net improvement in traffic operational measures.

However, emissions did not follow the same trend. While increasing AV penetration rates resulted in emissions reductions, increasing CV and CAV penetration rates resulted in higher emissions. A deeper analysis into the root cause for these trends showed that while VISSIM's CV logic seeks to maximize the likelihood of vehicle arrival-on-green, the algorithm likely results in oscillation of the second-by-second speeds leading to overall higher emissions.

4. Performance Metrics

Metric	# Completed
OUTPUTS	
Product(s): Number of new or improved tools, technologies, products, methods, practices, and processes created or improved	1
Technical Report: Number of client-based technical reports published	STRIDE Final Report
OUTCOMES	
Body of Knowledge: Number of trainings for transportation professionals	2
Professionals Trained: Number of professionals participating in trainings *(Students NOT included)*	200+
IMPACTS	
Stakeholders: Number of stakeholders you met with to encourage adoption or implementation of product(s)	200+
Adoption/Implementation: Number of incidences outputs of research have been implemented or adopted	

5. Product

A simulation extension with CAV functionality, which includes integrated emissions modeling. Practitioners can use this framework to evaluate transportation management strategies using emerging technologies.

6. Who benefits/will benefit from your product(s)?

The CAV research community would be the early adopters of the products from this research with an eventual end goal of DOTs and public agencies benefitting from this research.

8. Body of Knowledge & Professionals Trained

1. PTV Annual User Group Meeting. Presentation Title: Autonomous and Connected Vehicle Operational Performance Evaluation Using PTV VISSIM (11/12/2020)
Presented by Dr. Pruthvi Manjunatha, Dr. Michael Hunter and Dr. Lily Elefteriadou
PTV is a software company, with VISSIM as its main product. VISSIM is one of the most widely used microsimulation software.
100+ people attended

2. TRB Workshop on Simulation and CAV modeling. Presentation Title: Evaluation of the Operational Effects of Autonomous and Connected Vehicles through Microsimulation (11/18/2020)
Presented by Dr. Pruthvi Manjunatha, Dr. Michael Hunter and Dr. Lily Elefteriadou
http://onlinepubs.trb.org/onlinepubs/Conferences/2020/TrafficSimCAV/TrafficSimProgram.pdf
100+ people attended

9. Stakeholder Engagement

The two meetings above engage two key stakeholders-

Research community in the field of traffic simulation and traffic simulation user group.

10. Adoption/Implementation

The CAV research community would be the early adopters of the products from this research with an eventual end goal of DOTs and public agencies benefitting from this research.

11. Broader Impacts

Adoption of simulation extension developed in this project would enable wide-scale assessment of impact of CAVs on traffic congestion and emissions.