

Improving Traffic Flow with Autonomous/Connected Vehicles: A Macroscopic Fundamental Diagram Approach

(STRIDE Project O2)

PROJECT OVERVIEW

With the development of automation and connectivity technology, there will be more connected and autonomous vehicles (CAVs) entering the road network. Before all of the existing human-driven vehicles (HVs) are replaced by CAVs, there will be a long transition period where CAVs and HVs are mixed on the roadway. Equipped with vehicle-to-vehicle communication capability, CAVs are expected to improve the road capacity due to smaller reaction times and headways. However, in mixed traffic, the movement of human-driven vehicles is uncertain and unmanageable, which will severely hinder the communication between CAVs. Managing the operation of CAVs in mixed traffic is a struggle. Additionally, the arrival of CAVs also has the potential to increase vehicle travel demand by improving road capacity or reducing travel and parking costs. However, the extent to which travel demand will increase is still uncertain. This uncertainty makes it challenging to determine how to modify existing road networks to improve traffic flow/throughput.

RESEARCH GOALS

The researchers proposed the following:

1. A lane-changing algorithm to guide CAV platoons to bypass the slower HVs;
2. An analytical methodology to examine how the urban street capacity would evolve with the penetration of CAVs; and
3. Implementation of the concept of macroscopic fundamental diagram (MFD) to identify design solutions to the transportation network that would improve traffic flow/throughput.

FINDINGS

Simulation results indicated that the proposed lane-changing algorithm provided significant performance improvements to the mixed traffic flow in terms of outflow and travel time for both CAVs and HVs. Experiments using a macroscopic fundamental diagram (MFD) model found that as CAV penetration rates increased, the urban street capacity may increase or decrease depending upon the reaction time settings. Through simulations, an MFD-based method was shown to yield robust network design solutions that can increase the capacity by deciding which roads should be built when traffic demand is random.

PRODUCTS & IMPACTS

- 1) The **Cooperative Bypassing Algorithm** can help CAVs move efficiently in a mixed traffic environment.
- 2) The **Mixed Corridor Capacity Methodology** can help vehicle industries determine the reaction time settings of CAVs.
- 3) The **Transportation Network Design Methodology** can improve future road capacity by proposing where to build new roads.

WHO BENEFITS?

- State Departments of Transportation
- Vehicle industries interested in CAVs
- City planners

RESEARCH TEAM

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PRODUCT DESCRIPTIONS

1) Cooperative Bypassing Algorithm

Departments of Transportation and the vehicle industry can use the developed algorithm to control the autonomous and connected vehicles in a mixed traffic environment. The algorithm is described in [“Cooperative Bypassing Algorithm for Connected and Autonomous Vehicles in Mixed Traffic.”](#)

2) Mixed Corridor Capacity Methodology

The vehicle industry can use the proposed methodology to determine the reaction time of autonomous vehicles. Departments of Transportation using the methodology can determine the penetration rate of autonomous vehicles. The methodology is described in [“Analytical Approximation for Macroscopic Fundamental Diagram of Urban Corridor with Mixed Human and Connected and Autonomous Traffic.”](#)

3) Transportation Network Design Methodology

When new roads need to be built to ease traffic congestion, city planners can use the proposed method to determine which links should be built. The methodology is described in [“Macroscopic Fundamental Diagram Based Discrete Transportation Network Design.”](#)

For more information on Project O2 (Macroscopic Fundamental Diagram Approach to Traffic Flow with Autonomous /Connected Vehicles), visit the [STRIDE Project page](#).

About STRIDE

The Southeastern Transportation Research, Innovation, Development & Education Center (STRIDE) is the 2016 Region 4 (Southeast) U.S. Department of Transportation University Transportation Center headquartered at the University of Florida Transportation Institute (UFTI).

