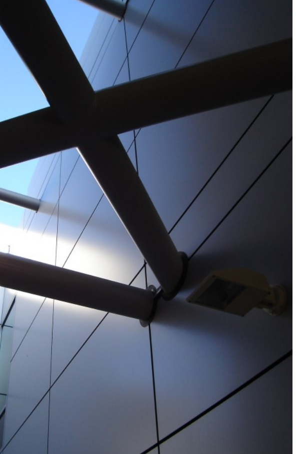

MECHANICAL ENGINEERING
DISSERTATION DEFENSE

The Department of Mechanical Engineering presents:

The Ph.D. Dissertation Defense of

Ziran Wang

Wednesday, May 29, 2019,
3:30PM in Winston Chung Hall 205/206

Developing agent-based distributed cooperative vehicle-infrastructure systems in the connected and automated vehicle environment

Doctor of Philosophy, Graduate Program in Mechanical Engineering
University of California, Riverside, June 2019
Dr. Matthew J. Barth, Chairperson

Rapid development of our transportation systems has brought much convenience in daily life, while also introduces various issues related to safety, mobility and environmental sustainability. To address those issues in the transportation systems, connected and automated vehicle (CAV) technology has achieved significant development during the last decade. With CAV technology, the level of connectivity and automation of vehicles can be greatly improved, which allows equipped vehicles to not only drive partially or fully automatically using information from on-board sensors, but also behave cooperatively through vehicle-to-everything (V2X) communications.

In this dissertation research, agent-based distributed cooperative vehicle-infrastructure systems have been developed to evaluate CAV applications from safety, mobility and environmental sustainability perspectives qualitatively and quantitatively. Specifically, the proposed systems are divided into two major categories: The first one is only based on vehicle-to-vehicle (V2V) communication among CAVs, while the second one is based on both V2V and infrastructure-to-vehicle (I2V) communication.

Specifically, three different cooperative automation applications are studied, including cooperative adaptive cruise control (CACC), cooperative eco-driving at signalized intersections, and cooperative merging at highway on-ramps. Different agent-based motion control algorithms of CAVs are proposed, including distributed consensus control algorithm, online feedforward/feedback control algorithm, and optimal control algorithm. All proposed applications are qualitatively and quantitatively evaluated by numerical simulations and/or microscopic traffic simulations, showing their benefits of avoiding collisions, increasing traffic flow, decreasing travel time, and/or decreasing energy consumption and pollutant emissions. Field implementations with real vehicles traveling in the real-world traffic environment are also conducted to evaluate the effectiveness of the proposed algorithms.

Additionally, studies of aforementioned cooperative automation applications are also conducted in the game engine, which provides a simulation environment with more realistic vehicle models and road networks. Human-in-the-loop simulations are conducted on the driving simulator platform, and a learning-based approach is further developed to model the human factor.