Research Fact Sheet

UMEC
URBAN MOBILITY & EQUITY CENTER

Research project: Development of Multimodal Traffic Signal Control

What's the issue?

Traffic congestion affects traveler mobility and also impacts air quality, which negatively affects public health. One way to reduce congestion is to use advanced traffic signal controllers, which integrate connected vehicles (vehicles that can communicate wirelessly with infrastructure and each other) and transit and freight signal priority to maximize traffic flows in real-time. For example, a traffic light could remain green to accommodate a large truck, which takes longer to stop and start, as it approaches and passes through an intersection.

What did the research discover?

This research developed a DNB (decentralized Nash bargaining) controller—a novel, real-time, adaptive, multimodal decentralized traffic signal controller that integrates connected vehicles—using a Nash bargaining game-theoretic framework by optimizing total queue length. The DNB controller optimizes the signal timings at each signalized intersection by modeling each phase as a player in a game, where players cooperate to reach a mutually agreeable outcome. This framework has a flexible phasing sequence and free cycle length, and can adapt to changes in traffic demand. Researchers implemented and evaluated the controller using the INTEGRATION microscopic traffic assignment and simulation software. They tested it on an isolated intersection and found that it reduced backups (or queue length, in technical terms) at the intersection by 58% to 77%. Emissions were reduced by 6% to 17%. When tested on an arterial network, the controller reduced delays by 36% to 67%, with a decrease in emissions ranging from 6% to 13%. The controller also was tested for Los Angeles—a city known for traffic congestion—where it reduced delays, stop times, travel times, and emissions. Integrating transit signal priority in the developed DNB controller on an isolated intersection resulted in improvements in the average vehicle travel time of 77.5%, average passenger travel time of 76.8%, average total delay of 56.6%, and average emissions of 17.6%. In addition, the results of integrating freight signal priority in the developed controller on an isolated intersection showed improvements in average vehicle travel time of 78.8%, average total delay of 50%, fuel consumption of 13.3%, and emissions of 16%. The results demonstrate that the proposed decentralized DNB controller produces major improvements over other state-of-the-art centralized and decentralized controllers.

How can I implement this?

Decentralized systems are scalable and easy to expand by inserting new controllers into the system. Additionally, decentralized systems are often inexpensive to establish and operate, as there is no essential need for a reliable and direct communication network between a central computer and the local controllers in the field. The flows can be measured using stationary sensors (e.g., loop detectors or through video image processor detection obtained from closed circuit television [CCTV] cameras). Queue length estimates can be obtained using CCTV cameras or via GPS-equipped vehicles that communicate with the traffic signal controller. As such, the proposed controller is technology agnostic.

Learn more:

The full report is available at
https://www.morgan.edu/school_of_engineering/research_centers/urban_mobility_and_equity_center/research/completed_research/traffic_control.html

The Urban Mobility & Equity Center is a federally funded research consortium led by Morgan State University and includes the University of Maryland and Virginia Tech. www.morgan.edu/umec