CAREER: ***Integrated Online Coordinated Routing and Decentralized Control for Connected Vehicle Systems***

-- Lili Du

Traffic congestion jeopardizes the function of urban transportation systems and has a growing negative effect on the health of urban economies. It also increases air pollution with numerous negative health impacts on our citizenry. A promising solution to alleviating traffic congestion is to establish coordinated driving mechanisms. This is enabled by recent connected or even autonomous vehicle technologies and advanced onboard computing facilities. However, engineers who design such mechanisms are still lacking scientific knowledge and effective tools that can be proven as efficient and reliable for use by the general public. The goal of this Faculty Early Career Development (CAREER) program award is to develop innovative approaches to the coordination of connected vehicle drivers' online route choices. This will be done by exploiting emerging information and computing technologies equipped in connected transportation infrastructure. The proposed approaches will improve transportation system mobility, safety, and environmental sustainability without sacrificing the interests of the individual vehicles. This research will deepen our understanding of the competition among vehicles on limited traffic resources. It should also reveal the impacts of the decisions of individual vehicles on traffic congestion, and offer a new paradigm of real-time traffic control.

The specific research objectives of this CAREER project are: (a) developing coordinated mechanisms for drivers' route choices to mitigate over-competition; (b) engineering collective effects of drivers' decisions to improve system-level performance; and (c) implementing the coordinated routing mechanisms and decentralized traffic control in an online environment. If successful, this project will lead to: (1) game-theory based modeling, analysis, and design techniques for coordinated routing mechanisms; (2) innovative methods for integrating decentralized control into individual routing decisions via intentional information perturbation techniques; and (3) better understanding of convergence, efficiency and robustness of distributed algorithms for decentralized congestion control. The proposed approaches include: (a) using game theory, optimization, and traffic dynamics to design and analyze coordination mechanisms; (b) using equilibrium analysis, price of anarchy, bounded rationality, and decentralized control for the study of collective effects; and (c) developing distributed algorithms for implementation and carrying out a theoretical analysis of these algorithms. This project will involve underrepresented K-12 students, undergraduate and graduate college students in numerous research tasks, and disseminate research findings through multiple channels, such as national/international workshops and conferences, as well as journal publications.