The Astani Department of Civil & Environmental Engineering presents

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Computational Frameworks for Transportation Systems with E-Hailing Services and Network Controls

Contemporary transportation systems are featured with two notable developments, namely the emergence of Transportation Network Companies (TNCs) such as Uber, Lyft and DiDi providing e-hailing services, and the instrumentation of urban transportation infrastructure with sensing and actuation mechanisms. These new developments provide both challenges and opportunities for government to make intelligent operations and transportation policy design. In order to promote a more efficient, more convenient and greener transportation system, we develop novel computational frameworks for both. Specifically, in order to incorporate e-hailing services, we propose a general economic equilibrium model, which provides the foundation for formal studies on the impact of e-hailing services on individuals' mobility choices, the utilization of public transit, network congestion and the environment. Consisting of three interacting sub-models, namely the TNC choice module, the customer choice module and the waiting time module, the equilibrium model belongs to a Nash equilibrium problem of the generalized type. We manage to show the existence of an equilibrium under certain assumptions. On the other hand, in order to utilize the sensing and actuation capabilities, we consider a finite horizon optimal control problems, where the dynamics is described by the continuous time Cell Transmission Model. We propose a distributed algorithm by adapting ADMM (*alternating direction method of multipliers*) in a way to utilize sparsities in networks. The algorithm achieves fast computation by allocating the computational burden over multiple processors and is shown to converge to an optimal solution under minor conditions. Overall, these two computational frameworks are combined to provide an effective solution to efficient operations of modern transportation systems with the emergent mobility services and control capabilities.