ABSTRACT

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Autonomous vehicles are emerging as a disruptive technology expected to vastly change the current transportation system. Studies have shown the potential benefits of AVs in safety, mobility, and energy efficiency. As a system of vehicles, AVs are expected to increase travel demand due to the ease of making trips and provision of mobility to people with travel-limiting disabilities. The increase in travel demand, and the consequent congestion, may be offset by the increase in the transportation network capacity due to the reduced operational headways between AVs. However, the capacity benefits are only expected when AVs fully saturate the market, as operating at low headways with HDVs may be unsafe. Thus, in order to promote AV ownership due to their inherent benefits while also capturing the capacity benefits of an AV-only traffic stream, many researchers prescribe the conversion of traditional lanes for AV-exclusive use. In the AV-exclusive lanes, the vehicles can operate at reduced headways and at higher speeds, sharply increasing throughput. However, the metric frequently used for AV-exclusive lane deployment in the literature is the total system travel time. While deploying AV-exclusive lanes to minimize total system travel time may appear to be beneficial, doing so neglects important elements for sustainable development, namely, environmental protection and social equity. Taking away traditional lanes for AV-exclusive use causes congestion for HDVs, thereby increasing vehicular emissions. Further, the systemic improvements are made by benefitting AVs at the cost of HDVs, which raises questions about equity. Thus, this thesis presents a sustainable AV-exclusive lane deployment strategy through solving a multicriteria bi-level optimization problem with strong constraints to manage inequity. Mathematically, the problem is a discrete network design problem and is an NP-hard problem. Because it is difficult to solve the problem, this thesis combines the active set method with heuristic conditionalities to improve computational efficiency. Using the framework from this thesis, the transportation agency can adopt sustainable AV-exclusive lane deployment strategies which provides reduced risk of remedial action in the future.