Robust Design of CAV-Dedicated Lanes Considering CAV Demand Uncertainty and Lane Reallocation Policy

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Abstract

The reduced headways between connected and automated vehicles (CAVs) provide an opportunity to address the growing traffic congestion and its environmental impacts in urban areas. A CAV-dedicated lane concept is suggested for the transition period with a mixed fleet of CAVs and human-driven vehicles (HDVs). This study develops a schedule for optimally deploying CAV-dedicated lanes in a transportation network over a long horizon. This study captures the uncertainty in the forecast of potential CAV market size, i.e., consumers' willingness to purchase CAVs, to derive the optimal CAV-dedicated lane deployment plan. This problem is formulated as a bi-level model. The upper level uses a robust optimization technique that identifies the links and number of CAV-dedicated lanes to minimize the worst-case total emissions cost. The analysis also accounts for the relatively smaller CAV lane widths compared to HDVs due to the small lateral wander of CAV tire tracks across pavement cross-sections. Therefore, this study also considers lane reallocation policies that capture the prospect of reducing CAV-dedicated lane widths and thereby increasing the number of lanes at wide highway sections. At the lower level, equilibrium and demand diffusion models capture the travelers' route and vehicle type choices (CAV/HDV). This model is solved using an active-set algorithm. The computational experiments, applied to a

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small network, indicate that the impact of uncertainty in consumers' willingness to purchase CAVs on total emissions costs can be reduced by deploying CAV-dedicated lanes. It is also shown that the lane reallocation policy can provide more than a 6% reduction in vehicular emissions costs by reducing lane width to 8 ft.