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Improving Urban Mobility: Analyzing Impacts of Connected and Automated Vehicles on Traffic and Emissions

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Abstract : In most cities in the world, traffic has increased strongly over the last decades, causing high levels of congestion and deteriorating inner-city air quality. This study analyzes the impact of connected and automated vehicles (CAVs) on traffic performance and greenhouse gas (GHG) emissions under different CAV penetration rates in mixed fleet environments of CAVs and driver-operated vehicles (DOVs) and under three different traffic demand levels. Utilizing meso-scale traffic simulations of the City of Ottawa, Canada, the research evaluates the traffic performance of three distinct CAV driving behaviors—Cautious, Normal, and Aggressive—at penetration rates of 25%, 50%, 75%, and 100%, across three different traffic demand levels. The study employs advanced correlation models to estimate GHG emissions. The results reveal that Aggressive and Normal CAVs generally reduce traffic congestion and GHG emissions, with their benefits being more pronounced at higher penetration rates (50% to 100%) and elevated traffic demand levels. On the other hand, Cautious CAVs exhibit an increase in both traffic congestion and GHG emissions. However, results also show deteriorated traffic flow conditions when introducing 25% penetration rates of any type of CAVs. Aggressive CAVs outperform all other driving at improving traffic flow conditions and reducing GHG emissions. The findings of this study highlight the crucial role CAVs can play in enhancing urban traffic performance and mitigating the adverse impact of transportation on the environment. This research advocates for the adoption of effective CAV-related policies by regulatory bodies to optimize traffic flow and reduce GHG emissions. By providing insights into the impact of CAVs, this study aims to inform strategic decision-making and stimulate the development of sustainable urban mobility solutions.

Keywords : connected and automated vehicles, congestion, GHG emissions, mixed fleet environment, traffic performance, traffic simulations
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