Abstract

Over recent years, Connected Autonomous Vehicles (CAVs) have been a trending research area due to their promising benefits and advanced technology. A large array of studies have shown that CAVs can improve traffic efficiency and safety in mixed traffic modes. The researchers in this domain have proposed several traffic management techniques utilizing the potential of CAVs to increase highway capacity, and reduce travel time, road accidents, and fuel consumption. A dedicated lane for CAVs is one of the proposed techniques. However, the dedicated lane is a relatively new area, and thus the research based on the impact of the dedicated lane on traffic mode with both CAVs and HDVs is limited. Recent studies in this domain have utilized mixed traffic modes with different distributions of CAVs and HDVs, and varying numbers of dedicated lanes. The majority of these studies have shown that at a higher CAV penetration rate, the dedicated lane technique improves traffic efficiency. However, the impact of the dedicated lane on a realistic highway network with real-time traffic flow is unclear.

This study aims to analyze the expected impact of dedicated lanes on traffic efficiency on a realistic motorway network with a real-time traffic data. For this purpose, the performance of several dedicated lane strategies have been studied for varied CAV penetration rates and traffic volumes. The significance of the deployment of dedicated lanes from both the left side and right side of the motorway has also been studied.

The simulation experiments in this study are designed based on position of dedicated lane, number of dedicated lanes, CAV penetration rates, several traffic scenarios with both validation and realistic highway network. The experiments are highly resource- and time-consuming, and also generate large amount of data. The results show that the assignment of dedicated lanes shows improvement in traffic efficiency. For saturated flow, one dedicated lane shows improvement in trip duration for CAV MPR 70% to 90%. For congested flow, one dedicated lane shows improvement in traffic efficiency for CAV MPR 30% to 70% and two dedicated lanes for CAV MPR 70% to 90%. No impact was observed during the free-flow traffic scenario. We also find that optimal position and location of the dedicated lane are highly dependent on the complexity of the highway network. Based on the simulation experiments, a rule-based adaptive approach to dynamically assign the dedicated lane. The performance of this approach is evaluated with 24 hour real traffic data with all other lane strategies implemented in this work.