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LanE-change Path Planning of Autonomous Driving Using Model-Based Optimization, Deep Reinforcement Learning and 5G Vehicle-to-Vehicle Communications

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Abstract : Lane-change path planning is a crucial and yet complex task in autonomous driving. The traditional path planning approach based on a system of carefully-crafted rules to cover various driving scenarios becomes unwieldy as more and more rules are added to deal with exceptions and corner cases. This paper proposes to divide the entire path planning to two stages. In the first stage the ego vehicle travels longitudinally in the source lane to reach a safe state. In the second stage the ego vehicle makes lateral lane-change maneuver to the target lane. The paper derives the safe state conditions based on lateral lane-change maneuver calculation to ensure collision free in the second stage. To determine the acceleration sequence that minimizes the time to reach a safe state in the first stage, the paper proposes three schemes, namely, kinetic model based optimization, deep reinforcement learning, and 5G vehicle-to-vehicle (V2V) communications. The paper investigates these schemes via simulation. The model-based optimization is sensitive to the model assumptions. The deep reinforcement learning is more flexible in handling scenarios beyond the model assumed by the optimization. The 5G V2V eliminates uncertainty in predicting future behaviors of surrounding vehicles by sharing driving intents and enabling cooperative driving.

Keywords : lane change, path planning, autonomous driving, deep reinforcement learning, 5G, V2V communications, connected vehicles
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