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A New Method for Forward Parallel Parking Assistance Using Rear-Wheel Steering

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Parallel parking is widely recognized as a driving task that many drivers find uncomfortable. With conventional front-wheel steering, drivers are required to perform reverse maneuvers to achieve parallel parking. The introduction of rear-wheel steering, however, makes forward parallel parking feasible and enables new forms of driver assistance. This paper proposes a forward parallel parking assistance method that applies in-phase rear-wheel steering during the initial approach phase, in contrast to conventional counter-phase rear-wheel steering, with the objective of reducing driver anxiety caused by large yaw motion.

The fundamental concept of the proposed method is illustrated in Fig. 1, which compares vehicle behavior between conventional counter-phase control and the proposed approach. Under counter-phase control, the vehicle exhibits strong yaw growth during the early approach phase, followed by a pronounced cut-back maneuver to settle parallel to the parking space. The proposed method instead applies in-phase rear-wheel steering only in the first half of the maneuver. This increases the effective turning radius during the approach, thereby suppressing yaw angle development. As the maneuver progresses, the rear-wheel steering contribution continues without reversal, effectively assisting the settling phase without the need for explicit cancellation or mode switching.

To examine the feasibility and characteristics of the proposed method, an analytical investigation based on repeated vehicle motion simulations is conducted. A minimum-length intermediate vehicle pose that must be passed to complete the maneuver efficiently is identified. Using this pose as a reference, feasible steering-start regions are derived for both the conventional and proposed methods. The comparison shows that while conventional counter-phase control allows steering initiation from tighter lateral clearances, the proposed method maintains comparable feasibility and offers advantageous regions when steering initiation is delayed, which is common in real driving scenarios.

The proposed method is further evaluated through driving tests using a test vehicle equipped with electronically controlled rear-wheel steering. Multiple steering strategies are compared, including front-wheel steering only, conventional counter-phase control, always in-phase control, and the proposed in-phase-first approach. Objective evaluation focuses on yaw behavior during the approach phase and vehicle alignment near the front boundary of the parking space. The driving test results confirm that the proposed method suppresses excessive yaw motion while achieving parking performance equivalent to the conventional counter-phase approach.

Subjective evaluations indicate that drivers perceive the proposed assistance as stable and unobtrusive, with less awareness of steering intervention compared with counter-phase control. Overall, the results demonstrate that the proposed in-phase-first rear-wheel steering strategy enables effective and natural forward parallel parking assistance, balancing parking feasibility with improved driver comfort.

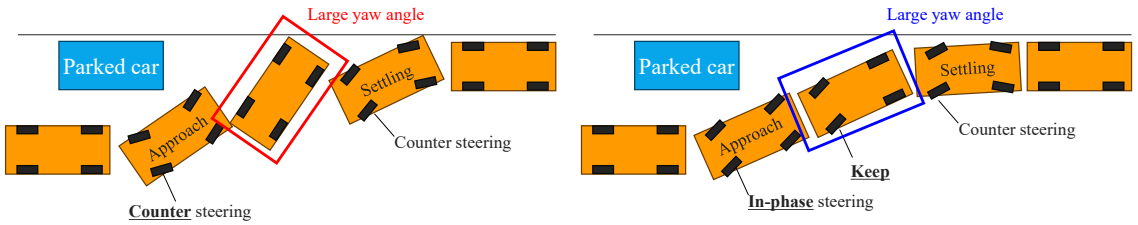

Fig. 1 Comparison of rear wheel steering methods in forward parallel parking.