

Influence of Coupling Engagement Level in an Electronic AWD System on Planar and Vertical Vehicle Dynamics

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In all-wheel drive (AWD) vehicles equipped with an electronically controlled coupling, front-rear torque distribution is achieved through longitudinal differential limiting, which influences not only planar motion but also sprung-mass behavior. While previous studies have mainly focused on vehicle performance in high lateral acceleration regions, the effects in low-to-medium lateral acceleration regions, where mass-produced vehicles are frequently operated, have not been sufficiently clarified, particularly from the viewpoint of driver operation.

In this study, the influence of coupling engagement level on both planar motion and sprung-mass behavior is systematically analyzed using a full-vehicle simulation model. The results show that increasing rear torque distribution can reduce yaw response during the initial steering phase due to increased yaw restoring moment generated by differential locking and tire self-aligning torque characteristics.

Based on these findings, a coupling control strategy coordinated with G-Vectoring Control (GVC) is proposed, as shown in Figure 1. By suppressing the increase in coupling torque during turn-in and increasing it in the steady-state cornering phase, the proposed control improves yaw response without sacrificing vehicle stability (Figure 2).

Furthermore, driver-in-the-loop experiments using a τ_L -based evaluation method reveal that the proposed control enhances driver steering margin and subjective handling performance (Figure 3). The results demonstrate that coordinated control of torque distribution and vehicle dynamics is effective in achieving both responsiveness and stability in AWD vehicles.

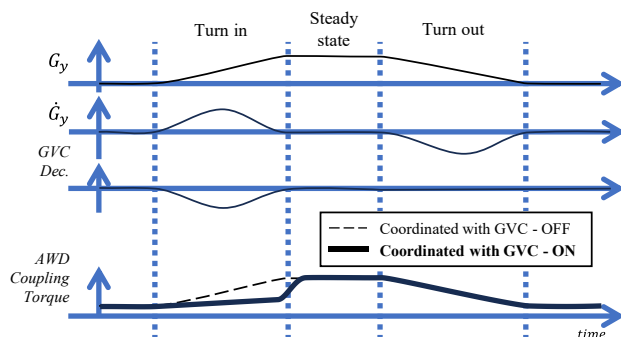


Fig.1 Coupling Control Coordinated with GVC

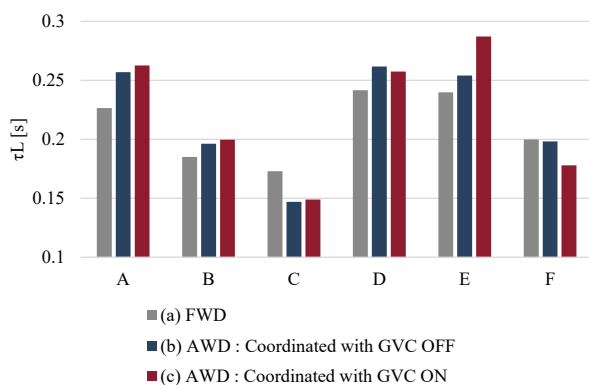


Fig.3 Identified τ_L for each Subject

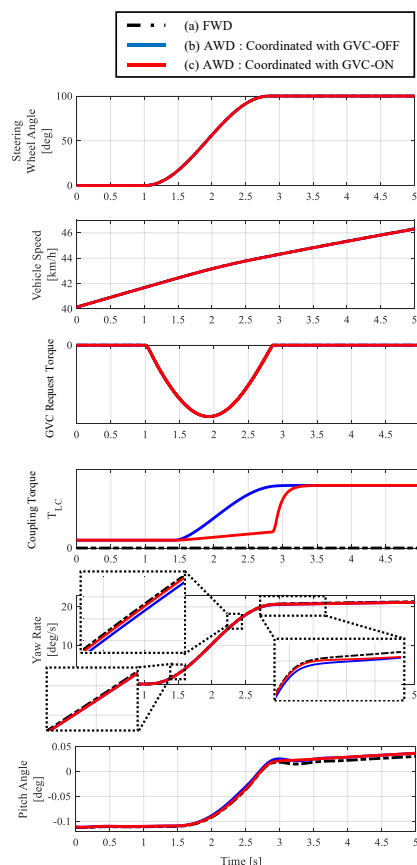


Fig.2 Time Series data of Simulation