

Vehicle Dynamics Performance Prediction by Integrating a Driving Simulator and Brake HILS

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This study proposes an integrated evaluation environment that connects a driving simulator with a brake hardware-in-the-loop simulation (HILS) bench to predict vehicle dynamics performance before a prototype vehicle is available. The target case is traction control (TRC) behavior during acceleration on a split- μ road, where stability and acceleration can cause conflict.

The driving simulator calculates the vehicle and powertrain models, while the brake HILS uses production-level brake electronic control units and actuators. Driver input, cooperative control signals, vehicle information, and brake pressure are exchanged in real time. To connect the brake ECU without masking the original software logic, wheel-speed model outputs are translated into sensor-equivalent pulse signals, including direction and very-low-speed behavior.

Two TRC specifications were compared under a standing-start acceleration test on a left-right split- μ road. Spec A limits the left-right driving-force difference more strongly and represents a stability-oriented setting. Spec B relaxes this limit and represents an acceleration-oriented setting. The comparison uses yaw-rate peak, corrective steering area, and 10 m acceleration time as representative performance indices.

Spec A showed lower vehicle deviation and lower corrective steering demand than Spec B, indicating that it is easier to secure stability. Spec B increased vehicle speed more rapidly and shortened acceleration time, but the result confirmed a trade-off between stability and acceleration performance.

The integrated environment enables early comparison of control-specification effects that have conventionally been checked in vehicle tests. By reproducing realistic brake-control behavior and including driver operation, the approach can support earlier trade-off analysis and may reduce rework in later development. Future work will verify correlation with vehicle-test results and expand the applicable evaluation range.

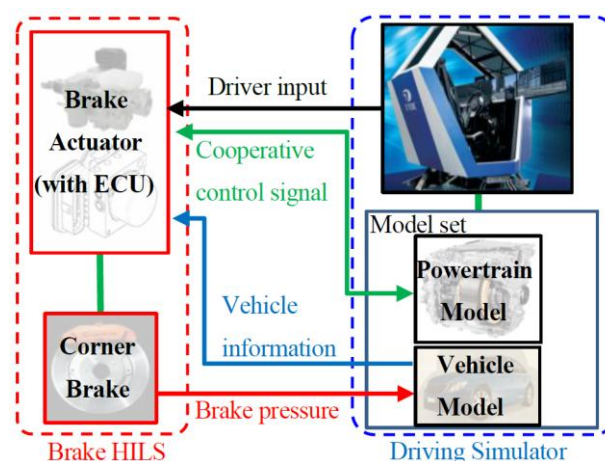


Fig. 1 Integrated Driving Simulator-Brake HILS Environment

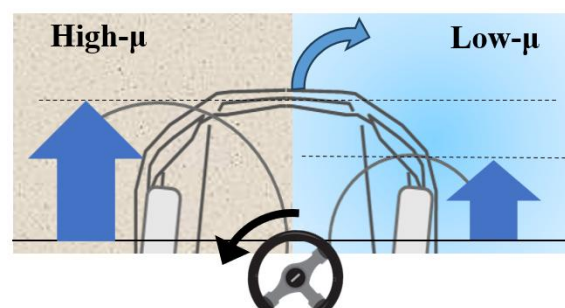


Fig.2 Split- μ acceleration condition

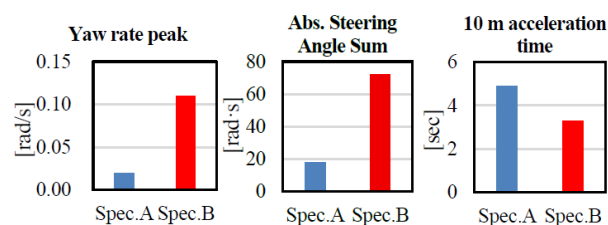


Fig.3 Results of split- μ acceleration