

Evaluation of Vehicle Dynamic Performance on Snowy Roads Using a Driving Simulator and Its Application to the Development Process

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This study developed an environment for evaluating vehicle dynamics on snowy roads before real-vehicle testing to identify vehicle and control behavior and issue causes, thereby shifting testing from issue identification to validation of predefined hypotheses and countermeasures.

Increasing vehicle, powertrain, and control-system complexity, variable environmental conditions, and difficulty in measuring tire forces and road-tire friction make repeatable evaluation challenging and require considerable expertise to relate subjective evaluations to physical quantities and control states.

A driving simulator was integrated with vehicle, tire, road, and production-intent control models. An actual proving-ground course and measured studless winter tire characteristics enabled repeatable comparisons. Driver inputs, vehicle states, tire forces, and control states were synchronized in a 3D visualization to support collaborative issue analysis.

The method was applied to an ESC specification study for a four-wheel-drive vehicle. Despite absolute-value differences, lateral-acceleration and yaw-rate trends were broadly consistent between simulation and vehicle tests. The analysis identified issue causes, hypotheses, countermeasures, and verification items. The yaw-rate stabilization trend after modification was also consistent with vehicle-test results.

The method can shift vehicle testing from issue identification to validation of predefined hypotheses and countermeasures. Future work will address continuous model updates and quality assurance for multi-model integration.

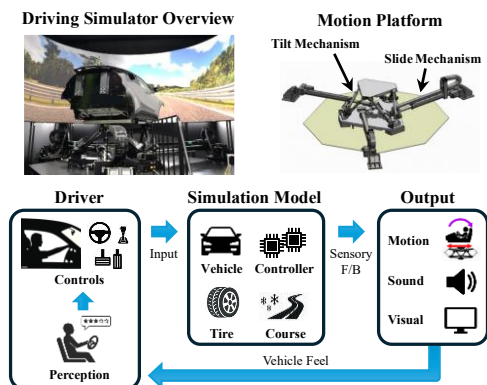


Fig.1 Proposed DS-based evaluation environment



Fig.2 Playback visualization method

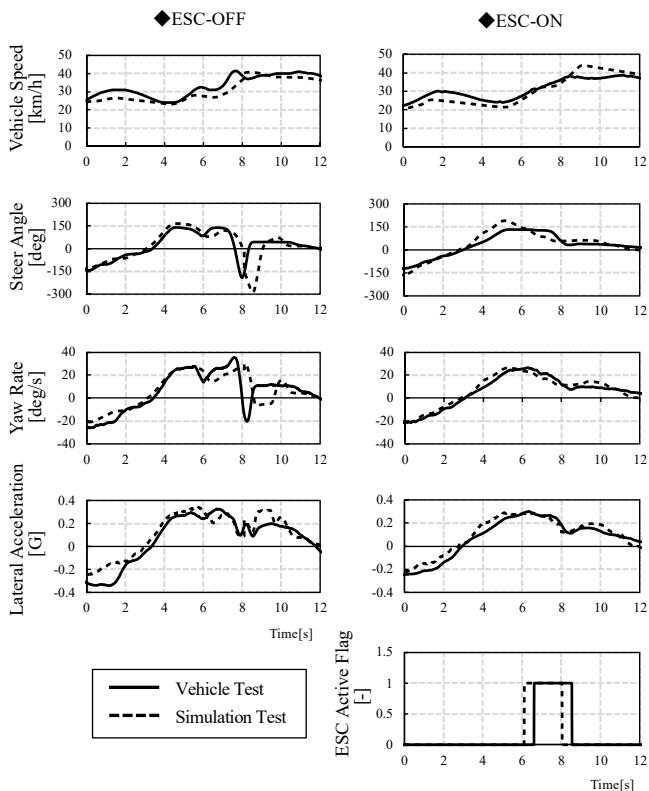


Fig.3 Comparison between simulation and real-vehicle testing