Influence of Assistive Brake G-Vectoring Control on Double Lane-Change Test Performance

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Maximizing emergency maneuvering performance requires a seamless transition from normal to near-limit driving while preserving a strong sense of controllability—i.e., the vehicle behaves exactly as intended by the driver. In the SDV (Software-Defined Vehicle) era, enhancing this "as-intended" continuity through software is a key approach.

This study proposes Assistive Brake GVC (AB-GVC), an ADAS-layer control that provides uniform deceleration commands to all four wheels without modifying existing ESC logic. Operating at the same layer as driver inputs, AB-GVC directly supports driver intention. Vehicle tests based on ISO 3888-2 double lane change (DLC) demonstrate that AB-GVC suppresses abrupt vehicle responses during rapid steering and increases achievable entry speed. Subjective evaluations highlight a markedly enhanced sense of controllability, with the vehicle consistently responding in an intuitive and predictable manner.

Although AB-GVC does not explicitly target physical or control limits, it reproduces effects similar to expert driver coordination, enabling a smooth approach to limit states without sudden transitions. This suggests that the essence of expert driving—maintaining controllability even near the limit—can be realized through an upstream command-based control architecture.

Fig.1 Experimental Vehicle

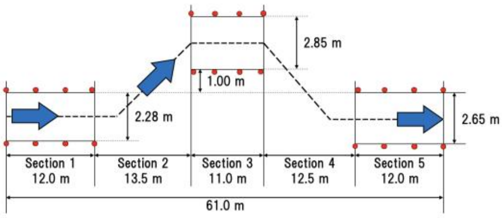

Fig.2 Elk Test Course Layout (ISO 3888-2)

Table 1 Success Rate Colormap [%]

ESC&GVC		Entry Speed [km/h] 60	65	70	75	80	85
ESC / OFF	OFF	100	100	38.5	0		
	0.11	100	83.3	50.0	55.6	0	
	0.21	100	100	71.4	45.5	26.3	
ESC / ON	OFF	100	100	100	100	29.4	
	0.11	100	100	100	100	31.3	50 (1/2)
	0.21	100	100	62.5	83.3	35.7	

During the initial steering, AB-GVC-induced deceleration generates diagonal roll, increasing rebound stroke at the inner rear wheel. This suppresses bump stroke at the same wheel during the subsequent steering, preventing bump stop contact, avoiding rapid sideslip angle growth, and suppressing transition to spin. As a result, higher entry speeds can be achieved compared to the baseline vehicle.

Near yaw reversal, a consistent relationship between roll and pitch rates is maintained, forming a linear trajectory in the p–q plane. This indicates temporary stabilization of the rotation axis, improving response predictability and reinforcing the sense of controllability.

Overall, AB-GVC enhances both limit behavior and motion consistency, providing integrated improvement in vehicle performance and driver-perceived controllability.

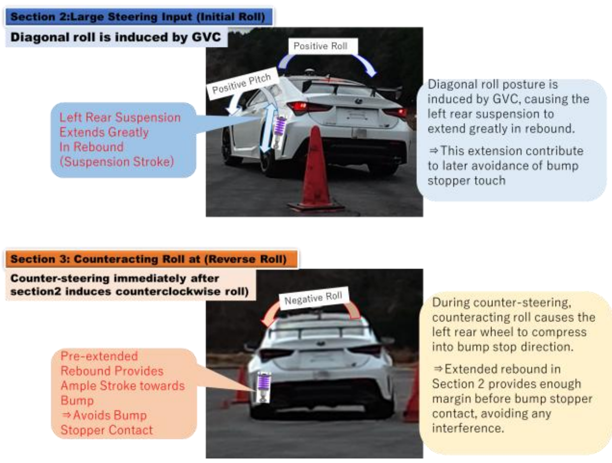

Fig.3 Roll Motion and Rear Suspension Stroke (GVC/ON)

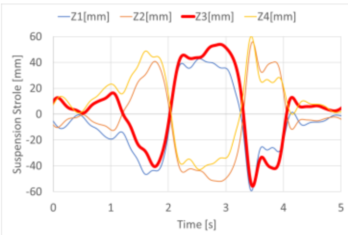

Fig.4 Suspension Stroke (GVC/OFF)

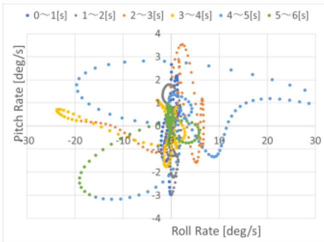

Fig.6 "p–q" diagram (GVC/OFF)

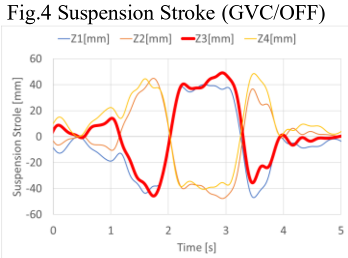

Fig.5 Suspension Stroke (GVC/ON)

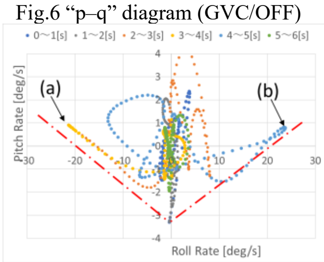

Fig.7 "p–q" diagram (GVC/ON)