

A Control Method for Enhancing Vehicle Handling and Stability via Driving and Braking Force Distribution Based on Vehicle Sideslip Angular Velocity

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Conventional yaw-rate-feedback control improves vehicle handling by enabling yaw motion to respond more faithfully to driver steering inputs. However, under excessive steering inputs, the resulting increase in vehicle sideslip may degrade vehicle stability. To achieve a higher level of both vehicle handling and stability, a driving and braking force distribution control method based on vehicle sideslip angular velocity is proposed. The proposed control adds a restoring yaw moment based on vehicle sideslip angular velocity to conventional yaw-rate-feedback control, thereby constraining the sideslip angular velocity within the control area during excessive sideslip behavior. The restoring yaw moment is modulated by K_{sp} , which remains zero below a predefined threshold and increases continuously as excessive sideslip approaches its upper limit (Fig.1). As a result, excessive sideslip behavior is suppressed while minimizing interference with the driver's intended cornering operation, enabling simultaneous improvement of vehicle handling and stability (Fig.2)

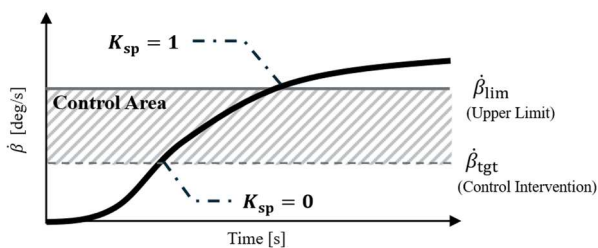


Fig.1 Characteristics of K_{sp}

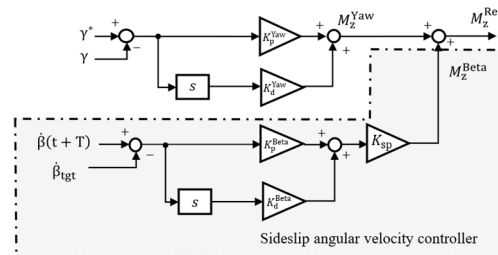


Fig.2 Block diagram of the proposed controller

Vehicle tests were conducted on a dirt surface under excessive steering inputs to verify that the proposed control method can constrain the sideslip angular velocity within the control area. Compared with conventional control, the proposed control enabled earlier intervention of the restoring yaw moment and constrained the sideslip angular velocity within the control area, thereby suppressing excessive sideslip behavior (Fig.3,4). The effectiveness of the proposed control was evaluated through closed-course tests on dirt and snow test courses. Improved correlation between the target and measured yaw rates was observed on both surfaces, indicating enhanced vehicle handling (Fig.5). Furthermore, the interquartile range (IQR) of vehicle sideslip angular velocity decreased on both surfaces, demonstrating enhanced vehicle stability (Fig.6). These results demonstrate that the proposed control achieves a higher level of both vehicle handling and stability under low-friction driving conditions.

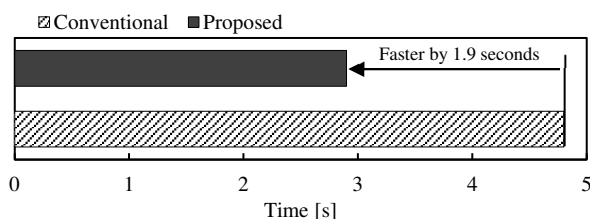


Fig.3 Restoring yaw moment request initiation time

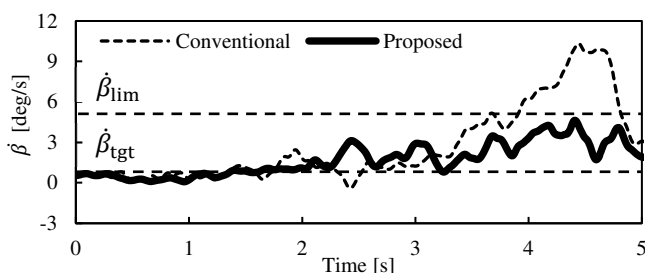


Fig.4 Vehicle sideslip angular velocity and control range

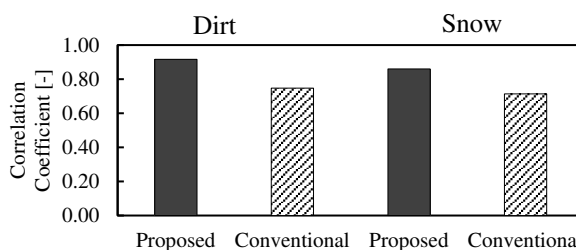


Fig.5 Correlation between Target and Measured yaw rate

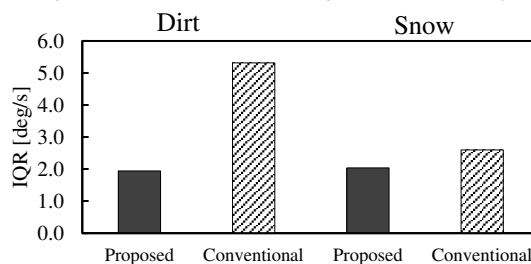


Fig.6 IQR of vehicle sideslip angular velocity