F2014-IVC-089

STUDY OF TORQUE VECTORING CONTROL FOR ACTIVE SAFETY IN REARWHEEL-DRIVEN VEHICLES

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KEYWORDS – Torque vectoring, torque distribution, side slip angle, vehicle stability, stability control

ABSTRACT

Torque vectoring control is the one of the recent chassis control system for vehicle active safety, and has been widely used in high-performance vehicles to obtain better traction and cornering ability. New torque vectoring control is proposed in this paper to maximize its stability control performance during the lateral manoeuvre of a vehicle. To maximize the performance, torque reduction scheme at the proper point is adopted to aid the conventional torque vectoring scheme, reducing lateral force loss at a minimum. Lateral force loss of tires causes torque vectoring effect to diminish and also decreases cornering ability, which induces an unnecessary side slip angle. Performance of proposed method is evaluated through simulation using vehicle dynamics software Carsim and Simulink, and simulation conditions are mainly focused on lateral dynamics. Proposed method is compared with conventional control scheme to validate supremacy of proposed one.

Research and /or Engineering Questions/Objective: Torque vectoring control has been mainly used in high-end racing cars to improve handling and to increase the cornering speed. This control is also implemented to recent production cars by increasing consumers' demand of vehicle safety and performance. Main advantage of torque vectoring is to prevent a vehicle's under-steer or over-steer in cornering to maintain the vehicle stability. New torque distribution algorithm with torque reduction based on tire force optimization is proposed to increase the vehicle's lateral stability.

Methodology: Upper level controller based on sliding mode control is explained first to calculate corrective yaw moment of the vehicle, by using basic sensors attached on most real production vehicles. After that, torque distribution algorithm is introduced to generate the fore-mentioned corrective yaw moment. Torque reduction scheme is also implemented to maximize torque vectoring effect, by minimizing the acceleration loss and increasing vehicle lateral stability. Proposed algorithm is designed and verified through the simulation using vehicle dynamics software Carsim and Simulink.

Results: Vehicle stability factors such as yaw rate and side-slip angle are mainly discussed throughout the simulation. Stability factors of proposed algorithm are compared with those of un-controlled and conventional control to show the increase of stability performance of proposed one. Also, the amount of torque distributed to left and right wheel, and final vehicle speed are depicted. Proposed algorithm showed better stability performance by decreased side-slip angle. Instead, final escape speed of the vehicle is slightly reduced due to the torque reduction during lateral manoeuvres. For the sake of reduced final speed, proposed algorithm showed the major improvement of vehicle lateral stability.

Limitations of this study: Unlike differential brake system such as electrical stability control (ESC), torque vectoring is operated only when the driving torque is available. Also, the vehicle states such as side-slip angle and yaw rate are assumed to be known with an acceptable accuracy.

What does the paper offer that is new in the field in comparison to other works of the author: New torque distribution with torque reduction scheme is introduced to maximize torque vectoring effect by optimizing the amount of torque of each driven wheel based on lateral and longitudinal tire force equation.

Conclusion: Optimized rear-wheel-driven torque vectoring control is proposed to improve vehicle lateral stability. Several simulations are conducted and verified that vehicle side-slip angle is reduced than conventional torque distribution scheme. Proposed algorithm showed greater stability performance especially on the acceleration condition. Furthermore, it is proved that proposed algorithm shows high compatibility with ESC.