Adaptive Neural Control of Vehicle Yaw Stability with Active Steering System using Extreme Learning Machine

Abstract-Active front steering (AFS) can enhance the vehicle yaw stability, which is essential to road safety. However, the intelligent control of vehicle yaw rate is very challenging due to 1) the unmodeled nonlinearity and uncertainties in vehicle dynamics; 2) timely response in control scheme. These two issues can be *simultaneously* alleviated through an emerging machine learning approach, extreme learning machine (ELM), for its high model generalization and fast computational speed. However, typical ELM cannot be directly applied to adaptive control applications. For this reason, a new ELM-based adaptive neural control method is proposed, which is equipped with a newly designed adaptation law based on the theorem of Lyapunov stability. To test the performance of the proposed control method, simulations were carried out using a validated vehicle model. The simulation results show that, compared to conventional backpropagation neural network based controller, the proposed ELM-based adaptive controller can reduce the response time and attenuate oscillatory steering in the case of cornering maneuver under fast variant vehicle speed. The results also demonstrate that the proposed ELM-based adaptive controller outperforms the state-of-the-art fuzzy logic controller in multiple aspects including tracking nominal vehicle yaw rate, desired sideslip angle and intended path. Overall, this kind of machine learning-based adaptive control method is promising to vehicle yaw stability control.