ROBUST ADAPTIVE SLIDING MODE CONTROLLER
FOR SEMI-ACTIVE VEHICLE SUSPENSION SYSTEM

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ABSTRACT. For the tracking control problem of vehicle suspension, a robust design method of adaptive sliding mode control is derived in this paper. The influence of parameter uncertainties and external disturbances on the system performance can be reduced and system robustness can be improved. The adaptive sliding mode controller is designed so that the practical system can track the state of the reference model. The asymptotically stability of the adaptive sliding mode control system is proved based on the Lyapunov stability theory. Numerical simulations demonstrate the effectiveness of the proposed adaptive sliding mode control for semi-active vehicle suspension.

Keywords: Adaptive sliding mode control, Vehicle suspension, Reference model, Lyapunov stability

1. Introduction. The performance of vehicle suspension is typically evaluated by its handling safety and riding comfort. The current vehicles can only offer a compromise between these two properties by providing spring and damping coefficients with fixed rates. Among them, semi-active suspension control systems have wide application prospects in the future. Compared with active suspension system, the advantages of the semi-active suspension system are simple, economical, safe and a small power demand. Therefore, semi-active suspension system has been researched for a long time.

A variety of control algorithms have been proposed for semi-active suspension. From skyhook, LQG and fuzzy control strategies have been studied. Karnopp et al. [1] first proposed a skyhook control algorithm for a vehicle suspension system and demonstrated that this system can improve performance over a passive system when applied to a single-degree-of-freedom system. Dyke et al. [2] applied a clipped-optimal control strategy (LQG) based on acceleration feedback. The performance of LQG or LQR controllers is dependent upon the choice of weighting matrices for the vector of regulated responses and control forces. Fang and Chen [3] applied a fuzzy control strategy to a 4-DOF vehicle model and developed a useful control strategy.

As we know, vehicle is a complicated vibration system which needs to be simplified in order to build its dynamic model. However, simplified model is not exact. Otherwise, the variation in load, the nonlinear of spring and damper, the wear of tires as well as the pressure variation in tires could generate parameters variations in systems and cause model uncertainties. In order to reach a high robustness against model parameter uncertainty and road disturbance, robust control schemes should be adopted. Various robust control