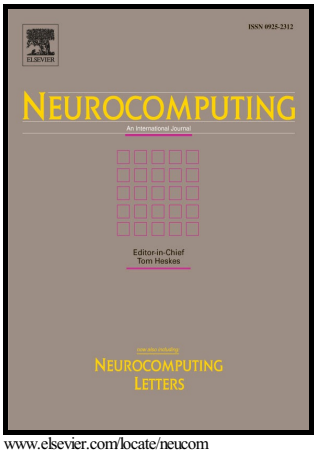

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Robust Output-feedback Based Vehicle Lateral Motion Control Considering Network-induced Delay and Tire Force Saturation

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Abstract

This paper presents a robust H_∞ output-feedback vehicle lateral motion control strategy considering network-induced delay and tire force saturation. The unavoidable time delay in the in-vehicle networks degrades the control performance, and even deteriorates the system stability. In addition, the tire lateral force suffers saturation phenomenon, which also deteriorates the control effect in extreme driving conditions. To handle the network-induced control delay and tire force saturation, a robust H_∞ controller is presented to regulate the vehicle lateral motion. An output-feedback control schema, which does not need the vehicle lateral velocity, is designed to achieve the desired control performance and reduce the cost of control system. The tire cornering stiffness uncertainty and external disturbances are also considered in the controller design to improve the robustness of the proposed controller. The comparative simulation results based on Carsim-Simulink joint simulation verify the effectiveness and robustness of the proposed control strategy.

Keywords: Control delay, vehicle dynamics, saturation, output-feedback, robust control.

1. Introduction

Advanced technologies such as active front steering (AFS), antilock brake system (ABS), and direct yaw-moment control (DYC) have been utilized to improve the vehicle safety and handling increasingly[1][2][3]. To better improve the performance of the aforementioned technologies, numerous control strategies have also been presented in engineering field, such as fuzzy control [4], sliding mode control (SMC) [5], data-driven control [6], learning control [7], adaptive robust control [8], and convex programming [9][10]. However, while enjoying the convenience of these advanced technologies, the vehicle system is becoming much more complicated. In addition, to ensure the performance of each subsystems, the information among all the subsystems, controllers, sensors, and actuators should be transmitted timely. Due to the heavy tasks on information exchange and signal transmission among all the vehicle components, the in-vehicle networks such as controller area network (CAN) have attached more and more attentions in modern vehicles[11][12]. It is noteworthy that the in-vehicle networks are always working under severe environment, i.e. the varying temperature, the unreliable performance of the hardware, the limited bandwidth of the networks and the

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