ADAPTIVE NEURAL CONTROL DESIGN FOR A CLASS OF PERTURBED NONLINEAR TIME-VARYING DELAY SYSTEMS

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ABSTRACT. In this thesis, some adaptive neural control design ways are presented for a class of multi-input multi-output (MIMO) nonlinear systems in block-triangular form with disturbance input and state time-varying delay. Neural networks are employed to approximate the unknown continuous functions. By combining the use of a novel quadratic-type Lyapunov-Krasovskii functionals and adaptive NN backstepping, an adaptive neural controller is obtained, which efficiently avoids the controller singularity. The proposed control guarantees that all closed-loop signals remain bounded, while the output tracking error dynamics converges to a neighborhood of the desired trajectories. The feasibility is investigated by a simulation example.

Keywords: Adaptive neural control, Nonlinear MIMO system, Lyapunov-Krasovskii functional, Backstepping

1. Introduction. Time delays are frequently encountered in many real control systems. The existence of the time delays may be the source of instability of serious deterioration in the performance of the closed-loop systems. Meanwhile, perturbations, nonlinearity also exist in most of control systems. Thus, the problem of controlling uncertain time-delay systems has been widely considered in recent years. In [1], T. P. Zhang and S. S. Ge extended the aforementioned result to the adaptive control for a class of MIMO nonlinear state time-varying delay systems. By using Nussbaum type function and Lyapunov-Krasovskii functional, the controller with dead zone was designed. The closed-loop system was proved to be semi-globally uniformly bounded (SGUUB). In [2], the works in Z. Lin and H. Fang (2007), concerned a class of linear input delay systems. By state feedback, the input delay system was transformed into a state delay system. In [3], a class of uncertain time-varying delay system $H_\infty$ control problem is considered, and the corresponding state feedback controller using linear matrix inequalities is proposed.

Neural network control has made great progress in the past decades. Because of their inherent capability for modeling and controlling highly uncertain, nonlinear and complex systems, many neural network control schemes have been introduced to solve the control problem of time delay systems [4-10]. A class of nonlinear state-delay systems is discussed in [4]. Neural network is utilized to estimate the unknown function. By backstepping method, a delay-independent controller is designed. The closed-loop system is proved to be globally uniformly ultimately bounded (GUUB). In [5], a control scheme combined with backstepping, radius basis function (RBF) neural networks and adaptive control is proposed for the stabilization of nonlinear system with input and state delay. By using state transformation the original system is converted to the system without input delay.