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OUTPUT FEEDBACK TRACKING CONTROL FOR A CLASS OF MIMO NONLINEAR MINIMUM PHASE SYSTEMS BASED ON RBF NEURAL NETWORKS

Shao-Jie Zhang and Shou-Song Hu

College of Automation Engineering
Nanjing University of Aeronautics and Astronautics
29 Yudao Street, Nanjing, Jiangsu 210016, P. R. China
zhangsj@nuaa.edu.cn

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Abstract. *An adaptive neural feedback tracking control scheme is presented for a class of multi-input multi-output nonlinear minimum phase systems with uncertainties and external disturbances. Gaussian basis RBF neural networks are used to approximate the plant unknown nonlinearities, and a high-gain observer is used to estimate the states which can not be measured. The proposed controller can guarantee that the closed-loop system is stable, all the states are bounded and the tracking errors are uniformly ultimately bounded. Simulation results demonstrate the effectiveness of the proposed method.*
Keywords: MIMO nonlinear minimum phase systems, Adaptive neural control, Output feedback, RBF neural networks, High-gain observer

1. **Introduction.** In recent years, the analytical study of adaptive control for nonlinear systems has received much attention, see [1-5] and references therein. Due to their universal approximation, learning, and adaptation abilities, neural networks (NN) are widely used in nonlinear control systems, see references [4, 6-16, 20-22]. Typically, neural networks are used to approximate models for the unknown system nonlinearities. Adaptive neural controllers for single-input single-output (SISO) nonlinear systems were studied in [6, 7, 10-12], but owing to input and output coupling, most of the techniques developed for SISO systems cannot be directly extended to multi-input multi-output (MIMO) systems. Gao and Er [13] developed an adaptive fuzzy neural controller for a class of MIMO nonlinear systems, in which a key assumption is that the nonlinear systems are full relative degree. Adaptive neural feedback control schemes for two classes of systems in block-triangular forms were presented in [14], the controllers require that all the states of the plants are measurable, but the states or part of the states are immeasurable for many plants in control engineering. In [15], an output feedback controller using single-hidden-layer neural networks was proposed for a class of MIMO nonlinear systems, yet the analytical models of the systems were required. All these conditions are too restrictive to be obtained in practical applications.

In this paper, an adaptive neural control scheme based on RBF neural networks is proposed for a MIMO uncertain minimum phase system represented by an input-output model. In such a system, unknown nonlinearities are included and the measurability of all states is not required. Firstly, we augment integrators at the input side of the plant, and represent the extended system by a state space model, RBF neural networks are used to approximate the system's unknown nonlinearities. Secondly, a high-gain observer is used to estimate the states of the extended system, and then a robust adaptive tracking controller is presented against the uncertainties and disturbances of the plant.