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ROBUST ADAPTIVE FUZZY CONTROL FOR A CLASS OF NONLINEAR INTERCONNECTED SYSTEMS

Qiang Kang, Wei Wang and Yanjun Liu

Research Center of Information and Control
Dalian University of Technology
Dalian 116024, P. R. China
wangwei@dlut.edu.cn

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Abstract. *In this paper, a robust adaptive fuzzy control algorithm is proposed for a class of nonlinear multiple-input-multiple-output (MIMO) systems with unknown interconnected functions. In the controller design, the robust control terms are used to compensate the approximation errors, which can improve robustness of the systems. The developed control algorithm overcomes the singularity problem of nonlinear MIMO systems. Using Lyapunov method, it is shown that the proposed algorithm ensures that all the signals in the closed-loop system are bounded. A simulation example is given to show the effectiveness of the proposed techniques.*
Keywords: Adaptive fuzzy control, Unknown interconnected function, Nonlinear systems

1. **Introduction.** Recently, the fuzzy control theorem has been applied in various fields [2-5,12]. By means of the approximation property of the fuzzy systems, some stable adaptive fuzzy control schemes are proposed in [2] for SISO nonlinear systems with uncertainties. In [3-5], some adaptive fuzzy contorl approaches are obtained for MIMO nonlinear systems with uncertainties. However, unknown nonlinear functions are required to satisfy the matching conditions in [2-5], such restrictions are removed in [6-11]. Several adaptive control schemes are proposed to stabilize the resulting closed-loop systems for SISO strict feedback systems [6-9]. For the MIMO nonlinear sytems in the strict-feedback form, two adaptive control schemes developed in [10,12] guarantee that all the signals in the closed-loop system are bounded and the systems output asymptotically track a reference signal. One limitation of the results obtained in [10,12] is that the gain matrices must be known. Thus, these two approaches are not applicable to the situation with unknown gain matrices. An adaptive neural network design approach was presented for uncertain MIMO nonlinear systems to guarantee the uniform boundedness of all the signals in the closed-loop systems, which was avoided perfectly controller singularity problems in [11]. Although gain coefficient matrices of such systems are unknown nonlinear functions, the results are obtained based on the assumption that the only unknown terms are the function of part state variables of other subsystems such that each subsystem satisfies the triangular structure. However, the assumption can not be satisfied in some cases.

In this paper, a robust adaptive fuzzy control algorithm is proposed for a class of uncertain nonlinear systems, which are composed of n subsystems with unknown interconnected functions. Some adaptive control schemes are proposed in [3,13]. However, the considered interconnected function only appears in the last equation of each subsystem. Compared with these results in [3,13], the main properties of the model considered in this paper are the following: 1) the uncertainties in this paper are not required to satisfy