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ROBUST ADAPTIVE FUZZY TRACKING CONTROL WITH TWO ERRORS OF UNCERTAIN NONLINEAR SYSTEMS

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Abstract. *This paper aims to develop robust adaptive fuzzy control techniques to improve tracking performance, where both the tracking error and the modeling error are utilized to adjust system parameters. A hybrid adaptive control scheme including a H_∞ compensator is proposed which makes the tracking performance faster and more reliable. Performance analysis is given by using Lyapunov theory. In our proposed hybrid control scheme, the adaptive fuzzy controller serves as a master controller and contributes to a rough tuning of tracking control, and the H_∞ compensation term turns to refine the tuning course. Simulations are carried out to illustrate controller design steps and performance evaluation aspects in detail. Results indicate that the effect of both fuzzy modeling errors and external disturbances on tracking errors can be attenuated by our proposed robust adaptive control techniques. Furthermore, it is observed that a superior tracking performance can be achieved with guaranteed closed-loop system stability.*
Keywords: Robust intelligent systems, Adaptive fuzzy control, H_∞ compensation

1. **Introduction.** Adaptive control techniques are composed of systems identification methods and controllers design based on the models identified using input-output data. Over the past few decades, there has been significant research on adaptive control schemes for linear and nonlinear systems [1-3]. Many practical applications have shown the power and value of adaptive control techniques. However, conventional adaptive control theory was developed based on mathematical models and parameter estimation algorithms. Therefore, it is hard to perform tracking control tasks while dynamics demonstrate larger uncertainties and strong nonlinearities. A remarkable characteristic of the existing adaptive control technique is that system design does not take advantage of the use of domain knowledge from operators or workers. Recently, some progress on fusion technology has been reported in the literature. It has been widely recognized that integration of structured information and numerical data helps greatly in intelligent control systems design and performance improvement. In particular, an adaptive version of fuzzy systems has received considerable attentions to deal with problems of complex industrial process modeling and control.

The number of successful applications of fuzzy control techniques in engineering practice has increased tremendously over the last decade since the pioneering work published by Zadeh [4] and Mamdani [5]. It is very impressive that many commercial products using