

## ADAPTIVE FUZZY TRACKING CONTROL FOR UNKNOWN NONLINEAR SYSTEMS

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**ABSTRACT.** *In this paper, an adaptive fuzzy controller (AFC) for a certain class of unknown nonlinear systems is proposed. The proposed approach employs a fuzzy system to approximate the unknown functions in designing the adaptive controller and an observer is designed to generate an error signal for the adaptive law. The free parameters of the AFC can be tuned on line based on the Lyapunov synthesis approach. The overall adaptive scheme guarantees the global stability of the resulting closed-loop system in the sense that all signals involved are uniformly and ultimately bounded. The design methodology is illustrated by application to the problem of balancing of an inverted pendulum on a cart.*

**Keywords:** Adaptive control, Takagi-Sugeno fuzzy, Lyapunov theory, Nonlinear systems

**1. Introduction.** Adaptive control of uncertain nonlinear systems has received increasing attention and many significant developments have been achieved. Recently, several stable adaptive fuzzy control schemes have been introduced based on fuzzy logic systems [1-4].

Most of adaptive controllers involve certain types of function approximation such as neural networks (NNs) and fuzzy logic systems (FLSs) in their learning mechanism. On the other hand, robust control scheme focuses on compensating uncertainties by the use of high-gain feedback. Recently, many adaptive NN and FLS controllers have been presented for various control applications, and the closed-loop stability can be guaranteed [5,6]. One of the advantages of the fuzzy based control is that linguistic information can be directly incorporated into the controller, and the details of mathematical model in the systems are not needed. According to the universal approximation theorem [7], any nonlinear function over a compact set can be approximated by a fuzzy logic system [8,9] with arbitrary accuracy. Adaptive fuzzy control has been applied successfully in many nonlinear control problems and theoretical analysis [10-13] shows that it can guarantees the system stability in Lyapunov sense. However, most of these control methods assumed that the information of the nonlinear system states is completely available by measurement and these adaptive fuzzy control methods cannot be applied to general nonlinear systems in which some of the system states are not available for measurement [10,14].

In this paper, we propose a method for designing an adaptive observer with observer for the control of a certain class of unknown nonlinear dynamical systems, in which only