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ADAPTIVE FUZZY CONTROLLER FOR A CLASS OF NONLINEAR SYSTEMS

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Abstract. *In this paper, we propose an adaptive fuzzy controller for a class of nonlinear system with disturbance, in an effort to (1) utilize knowledge about the system to be controlled as much as possible; (2) stably tune all parameters involved in the whole system; (3) guarantee the system stability and let the tracking error between system state and its reference model state shrink to arbitrarily small magnitude by choosing appropriate control parameters. Simulations performed on a simple nonlinear system illustrate the approach and theoretical analysis.*
Keywords: Fuzzy control, Fuzzy approximator, Lyapunov synthesis approach, System stability, Adaptive law

1. **Introduction.** Over the last decade or more, beside the traditional adaptive control and sliding model control techniques [2]-[5], neural control [6]-[10], fuzzy control [11] have been appearing strongly capable in a large number of research and industrial applications. The motivation is often that they provide an alternative to the traditional modeling and design of control systems where system knowledge and dynamic models in the traditional sense are uncertain and time varying. A key element of this success has been the merger of adaptive system theory with approximation theory [6][12], where the unknown plants are approximated by parameterized approximators. Actually as shown in [6][22], no matter either fuzzy rules or neural networks, the parameterized approximations are finally expressed as a series of radial functions (RBF) expansion due to its excellent approximation properties. Especially, in fuzzy control such an approximation is described as the human-being-oriented form (*i.e.,* if-then rules) obtained by either learning or some experienced experts if any. This means that a prior knowledge about plant and its control process is possibly involved in the if-then rules. This is the major reasons why fuzzy control has been so popular on both theoretical and practical grounds since the 1980s. However, some researchers who stick to the traditional control system, where clearly proven system stability is the first task to be considered, cast a skeptical look sometimes at the system due to the lack of formal synthesis technique that can guarantee system stability among other basic requirements for control system. This is why a large amount of research has focused on fuzzy control systems with a keyword of "system stability" since earlier 1990's (e.g. [12]-[24] and references therein). In such a fuzzy control system, the Lyapunov synthesis approach is used to construct a stable controller, and to deal with unknown plant in