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ADAPTIVE FUZZY OUTPUT FEEDBACK CONTROL FOR SISO NONLINEAR SYSTEMS

Tao Wang and Shaocheng Tong

Department of Mathematics and Physics
Liaoning Institute of Technology
Jinzhou 121001, P. R. China
quwangtao_65@sina.com; jztsc@sohu.com

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Abstract. *A new indirect adaptive fuzzy output feedback control approach is developed for a class of SISO nonlinear systems. The proposed approach does not need the availability of the state variables, but by designing the state observer, the unknown states of nonlinear system can be estimated. The designing of the adaptive fuzzy output feedback controller is combined fuzzy systems and sliding mode control technique, and based on Lyapunov stability theorem, the stability of the whole closed-loop system is rigorously proved. The proposed method is applied to an inverted pendulum system and satisfactory simulation results are achieved.*

Keywords: Fuzzy adaptive control, Nonlinear systems, Fuzzy observer, Stability

1. **Introduction.** Adaptive control schemes for nonlinear systems via feedback linearization concept have been employed for decades. The ideas of feedback linearization approaches are to transform a nonlinear dynamic system into a linear system through state feedback mechanisms. With such transformations, those well-explored linear control skills can then be applied to meet the desired control specifications. Several primitive results and parameter adaptive control schemes have been reported in [1,2]. The major deficiency of those approaches is that their good performances are largely dependant on exact cancellation of nonlinear terms, or restricted to conditions that the unknown parameters of nonlinear systems are linear. If there exist uncertainties in those nonlinear terms, or the nonlinear terms are completely unknown, the performance may be awful due to non-exact cancellation. In this study, we intend to apply fuzzy modeling techniques to cope with the unknowns while employing adaptive linearization control schemes.

Since Zadeh introduced the fuzzy set theory in 1965 [3], it has received much attention from various fields and has also demonstrated good performance in various applications. One of those successful fuzzy applications is to model unknown nonlinear systems by a set of fuzzy rules. One important property of fuzzy modeling approaches is that they are universal approximator [4]. In other words, fuzzy systems can be used to model virtually any nonlinear systems within a required accuracy provided that enough rules are given. Based on the universal approximation theorem and by incorporating fuzzy systems into adaptive control schemes, the stable direct and indirect fuzzy adaptive controllers are first proposed by Wang [5,6]. Afterwards, various adaptive fuzzy control approaches for nonlinear systems have been developed [7-13].