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ADAPTIVE FUZZY BACKSTEPPING POSITION TRACKING CONTROL FOR A PERMANENT MAGNET SYNCHRONOUS MOTOR

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Abstract. *The position tracking control problem of permanent magnet synchronous motors with parameter uncertainties and load torque disturbance is addressed. Fuzzy logic systems are used to approximate nonlinearities and adaptive backstepping technique is employed to construct controllers. The proposed adaptive fuzzy controllers guarantee that the tracking error converges to a small neighborhood of the origin. Compared with the conventional backstepping method, the proposed fuzzy controllers' structure is very simple and easy to be implemented in practice. The simulation results illustrate the effectiveness of the proposed results.*

Keywords: Nonlinear system, Fuzzy control, Adaptive control, Permanent magnet synchronous motor, Uncertainty, Backstepping

1. Introduction.

Modern electrical drives based on Permanent magnet synchronous motors (PMSM) are of great interest for industrial applications due to their high speed, high efficiency, high power density and large torque to inertia ratio. However, the performance of the PMSM is very sensitive to external load disturbances and parameter variations in the plant because their dynamic model is usually multivariable, coupled and highly nonlinear. All these factors make it a challenging problem to control the PMSM to get perfect dynamic performance in the real application.

In order to overcome this problem, some advanced control techniques, such as H_∞ control [1,2], sliding mode control [3-5], feedback linearization control [6], adaptive control [5,7], backstepping principles [8-11], fuzzy logic control [12-17] and so on, are applied to the speed or position control of PMSM. Hsien et al. [1] proposed an H_∞ design to ensure robust speed tracking for PMSM. An adaptive control scheme with a pre-specified H_∞ property was proposed for the tracking control of PMSM drives by Lee [2]. The key of the H_∞ control is to synthesize a feedback law that renders the closed-loop system to satisfy a prescribed H_∞-norm constraint which representing desired stability or tracking requirements. But in order to ensure robustness under large uncertainty perturbations, the H_∞ design usually brings a solution with high control gain, employing this approach not feasible in practical application. In [4], Wai et al. developed a sliding-mode controller for pm synchronous servo motor drives. Theoretically, the sliding motion is smooth if the switching frequency of a system is infinite. However, the switching frequency of a system is finite in practice, thus chattering comes out along the sliding surface [3,5]. A robust speed control of PMSM using boundary layer integral sliding mode control technique was presented by Baik et al. [18] to reduce the chattering phenomenon but this would cause the steady-state error. Elmas and Ustun [19] introduced a hybrid controller consisting of a parallel connected sliding mode controller and a neurofuzzy controller for the speed