FPGA-based real-time implementation of an adaptive RCMAC control system

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Abstract

The main advantage of the recurrent cerebellar model articulation controller (RCMAC) is its rapid learning rate compared to other neural networks. This paper proposes an adaptive RCMAC control system for a brushless DC (BLDC) motor. The proposed control scheme is composed of an RCMAC controller and a compensation controller. The RCMAC controller is used to mimic an ideal controller, and the compensation controller is designed to compensate for the approximation error between the ideal controller and the RCMAC controller. The Lyapunov stability theory is utilized to derive the parameter tuning algorithm, so that the uniformly ultimately bound stability of the closed-loop system can be achieved. As compared with standard adaptive controller, the proposed control scheme does not require persistent excitation condition. Then, the developed adaptive RCMAC control system is implemented on a field programmable gate array (FPGA) chip for controlling a brushless DC motor. Experimental results reveal that the proposed adaptive RCMAC control system can achieve favorable tracking performance. Since the developed adaptive RCMAC control system uses a hyperbolic tangent function to compensate for the approximation error, there is no chattering phenomenon in the control effort. Thus, the proposed control system is more suitable for real-time practical control applications.

Keyword：BLDC; FPGA implementation; RCMAC; adaptive control; Lyapunov function; neural control; uniformly ultimately bound stability