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FPGA-BASED ROBUST ADAPTIVE CONTROL OF BLDC MOTORS USING FUZZY CEREBELLAR MODAL ARTICULATION CONTROLLER

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Abstract. *A novel fuzzy cerebellar-model-articulation-controller (CMAC), which is a generalization of a fuzzy neural-network, is developed in this study. Moreover, this paper proposes a robust adaptive control (RAC) system for brushless DC (BLDC) motors using a fuzzy CMAC (FCMAC). The proposed RAC system is composed of an FCMAC and a robust controller. The FCMAC is developed to serve as the main controller and the robust controller is designed to attenuate the effect of the approximation error between the FCMAC and an ideal controller. The developed RAC system is implemented in a field programmable gate array (FPGA) chip to control a BLDC motor in a real-time mode. Using an FPGA to implement an FCMAC for real-time control systems is also a novel approach. For comparison, an adaptive CMAC-based supervisory control, a robust adaptive fuzzy control and the proposed RAC are employed to control a BLDC motor. The experimental results verify that the proposed RAC can achieve better tracking performance than the other control methods.*

Keywords: Adaptive control, Robust control, Fuzzy system, Cerebellar model articulation controller, Brushless DC motor, Field programmable gate array

1. **Introduction.** According to the approximation property of neural network (NN), the NN-based adaptive controllers have been developed to compensate for the effects of nonlinearities and system uncertainties [1-4]. In order to obtain fast learning property and good generalization ability, cerebellar model articulation controller (CMAC) has been proposed [5-7]. CMAC is classified as a non-fully connected perceptron-like associative memory network with overlapping receptive fields, and it intends to resolve the fast size-growing problem in the currently available types of neural networks (NNs). It has already been validated that CMAC can approximate a nonlinear function over a domain of interest to any desired accuracy. There has recently been considerable interest in exploring the applications of CMAC to deal with the uncertainty and nonlinearity of control systems [6,8]. It has been shown, in some cases, that CMAC-based control systems can achieve better control performance than NN-based control systems [9,10]. Moreover, to accommodate the fuzziness of input data, the structure of CMAC with input fuzzification