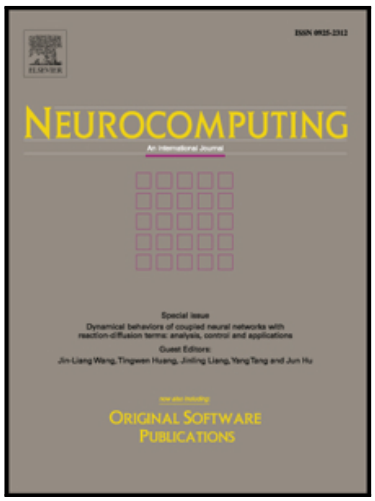

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Self-Learning Interval Type-2 Fuzzy Neural Network Controllers for Trajectory Control of a Delta Parallel Robot

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Abstract

This paper presents a self-learning interval type-2 fuzzy neural network (SLIT2FNN) control scheme for trajectory tracking problem of a Delta robot. This intelligent control scheme is computationally efficient and can be easily applied to existing equipment. The controller has a parallel structure, which combines an interval type-2 fuzzy neural network (IT2FNN) controller and a traditional Proportional-Derivative (PD) controller. We use the PD controller to compensate the transient performance, and use the IT2FNN to learn the dynamic characteristics of the system. A novel arrangement of trapezoidal interval type-2 fuzzy membership functions (IT2MF) is proposed, the arrangement enables the adaptation laws to have an analytical form. A learning algorithm based on sliding mode control (SMC) theory is proposed for the parameter training of the IT2FNN system. The control algorithm learns from the feedback error online and tunes the parameters of the IT2FNN, and will become the main source of the control signal after several learning iterations. Unlike model-based control, this control method has no requirement of prior information and constraint conditions from the robot plant. Lyapunov stability method is employed to prove asymptotic stability of the proposed approach. The structure of the SLIT2FNN and the operations in each layer are introduced in detail. The performance and robustness of the proposed controller is demonstrated on the Delta robot trajectory tracking problems in the presence of structured and unstructured uncertainties. Simulation results illustrate that the proposed SLIT2FNN control approach produces higher trajectory tracking accuracy and more robust to uncertainties as compared to its counterparts.

Key words: Interval type-2 fuzzy logic systems, neural network, intelligent control, Delta parallel robot, self-learning algorithm.