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A robust training algorithm of discrete-time MIMO RNN and application in fault tolerant control of robotic system. (English) Zbl 1327.93288

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Summary: In this paper, a novel robust training algorithm of multi-input multi-output recurrent neural network and its application in the fault tolerant control of a robotic system are investigated. The proposed scheme optimizes the gradient type training on basis of three new adaptive parameters, namely, dead-zone learning rate, hybrid learning rate, and normalization factor. The adaptive dead-zone learning rate is employed to improve the steady state response. The normalization factor is used to maximize the gradient depth in the training, so as to improve the transient response. The hybrid learning rate switches the training between the back-propagation and the real-time recurrent learning mode, such that the training is robust stable. The weight convergence and L_2 stability of the algorithm are proved via Lyapunov function and the Cluett's law, respectively. Based upon the theoretical results, we carry out simulation studies of a two-link robot arm position tracking control system. A computed torque controller is designed to provide a specified closed-loop performance in a fault-free condition, and then the RNN compensator and the robust training algorithm are employed to recover the performance in case that fault occurs. Comparisons are given to demonstrate the advantages of the control method and the proposed training algorithm.

MSC:

93C85 Automated systems (robots, etc.) in control theory
93C55 Discrete-time control/observation systems

Keywords:

adaptive training; weight convergence; Lyapunov function; L_2 stability; Cluett's law; fault tolerant control

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