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Neural Network Model Predictive Control of Nonlinear Systems Using Genetic Algorithms

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Abstract: In this paper the synthesis of the predictive controller for control of the nonlinear object is considered. It is supposed that the object model is not known. The method is based on a digital recurrent network (DRN) model of the system to be controlled, which is used for predicting the future behavior of the output variables. The cost function which minimizes the difference between the future object outputs and the desired values of the outputs is formulated. The function *ga* of the Matlab's Genetic Algorithm Optimization Toolbox is used for obtaining the optimum values of the control signals. Controller synthesis is illustrated for plants often referred to in the literature. Results of simulations show effectiveness of the proposed control system.
Keywords: model predictive control, nonlinear system, identification, digital recurrent network, genetic algorithm.

1 Introduction

The predictive controllers are based on the mathematical model of the object, which is being controlled. Nonlinear system identification and prediction is a complex task. All the processes in nature are nonlinear. In large number of processes, the nonlinearities are not prominent, so their behavior can be described by the linear model. In the linear systems theory there exist a large number of methods that can be applied for obtaining the linear model of processes. The nonlinear model must be chosen when the nonlinearity is strongly exhibited. In the identification process, the parameters of the mathematical model are being determined as such that the difference between the system response and its mathematical model is as least as possible, both in the transient regime and in stationary state. The general model of linear processes is ARX (Auto Regressive eXogenous), while for the nonlinear ones it is NARX (Nonlinear Auto Regressive eXogenous). The NARX model structure enables application of the neural networks, the fuzzy systems and the neuro-fuzzy systems for approximation of the nonlinear function.

Neural networks have been applied to the identification of nonlinear dynamical systems. The most of the works are based on multilayer feedforward neural networks with backpropagation learning algorithm. However, the conventional back-propagation algorithm has the problems of local minima and slow rate of convergence. A novel multilayer discrete-time neural network is presented for the identification of nonlinear dynamical systems, [1]. In [2] a new scheme for on-line states and parameters estimation of a large class of nonlinear systems using radial basis function neural network has been designed. A new approach to control nonlinear discrete dynamic systems, which relies on the identification of a