ABSTRACT

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The main goal of this dissertation is to apply intelligent techniques to adaptive controllers, in order to improve their performance. These techniques are applied to three cases. In the first case, it was developed an artificial neural network that is able to suppress high-frequency oscillations in the output of an extremum seeking control system. High-frequency oscillation degrades the control performance in pratical applications. The artificial neural network used is a multilayer perceptron with one input, one hidden layer and one output. For the training, only a small sample of the extremum seeking output signal is utilized. In the second case, a genetic algorithm (GA) is applied to initialize the parameters of a model reference adaptive control (MRAC), by reducing the previous knowledge required for the implementation of this kind of controller in the trajectory tracking problem. First, the GA is used to find the best control parameters for single-input-single-output (SISO) systems, so that the transient of the output responses are significantly reduced without needing to increase the control signal amplitudes. Second, multi-input-multi-output (MIMO) plants were taken into account, where the GA is able to find the control direction signs of the high-frequency gain (HFG) matrix, so that the global stability/convergence of the multivariable MRAC controller is guaranteed. This prior knowledgent is fundamental to the operation of the multivarible adaptive controller in real-world scenarios, which depending on the application is impossible to be known a priori. The results of the latter case are compared with a method of monitoring functions, also developed in this work, where the benefits of using the GA for the closed-loop system are evident as the number of inputs and outputs increases. The last contribution applies monitoring functions with adaptive binary control, of the BMRAC type, to solve the problem of high frequency gain matrix with leading principal minors of unknown signs, responsible to define the control direction. The proposed method is developed to multi-input-multi-output (MIMO) systems of relative degree one, since the design of BMRAC controllers even when the signs of the HFG matrix are known are very challenging, due to the large number of restrictions required and prior knowledge. All methods exhibited good performance results, showing their efficiency and, therefore, opening new possibilities to new studies.

Keywords: extremum seeking; adaptive control; artificial neural network; genetic algorithm; monitoring functions.