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APPROACHES TO MODEL AND CONTROL NONLINEAR SYSTEMS BY RBF NEURAL NETWORKS

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Abstract. *Many systems in reality exhibit nonlinear characteristics and in most cases they cannot be treated satisfactorily using linearized approaches over the full operating range. In this paper, an approximate modeling approach is introduced to overcome the mismatch between the linear/linearized model and the real nonlinear plant by treating the nonlinear system as a linear uncertain system that consists of a linear part and an uncertain part, for which a radial basis function neural network is employed to approximate, and a nonlinear control scheme is proposed using a linear feedback PD (proportional-derivative) controller to work concurrently with a nonlinear radical basis function neural network controller (RBFNNC). The PD controller, designed for the linear part, is used to improve the transient response while maintaining the stability of the system, and the RBFNNC, designed from fuzzy if-then rules with functional equivalence to a fuzzy inference system, is employed to compensate for the system nonlinearity/uncertainty and reduce the steady state error. The proposed modeling approach or control scheme can incorporate prior knowledge in its framework and provide a more transparent insight than the neural black-box approach. The simulation results reveal that the proposed modeling and control scheme for nonlinear systems is effective.*

Keywords: Nonlinear system, Uncertain system, Modeling, Control, Neural network, Radical basis function, Approximation, Linearization

1. Introduction.

Most systems in reality are nonlinear to some extent. But there are no powerful traditional approaches available to tackle nonlinear modeling and control. Many researches have successfully demonstrated that neural networks provide a good means of modeling complex nonlinear systems [1-3], but most of those efforts have been put on developing black-box models that simply map inputs onto outputs.

As it is very difficult to solve nonlinear problems in modeling and control, researchers have tried to solve the nonlinear problems by linearization within a small operating regime. One typical approach is the linear approximating approach by Taylor series expansion. However, there will often be a limited range of operating conditions in which the linearized model is a good approximation of the nonlinear system.

Due to the shortcomings of linearization, there are considerable incentives for developing more effective modeling and control strategies that incorporate knowledge of the nonlinear characteristics. As approximating the sophisticated nonlinear relationships, neural networks (NNs), especially multilayer feedforward neural networks (FNNs), have been