Ain-Shams University

Faculty of Engineering

Computer and Systems Engineering Department

Adaptive Control using Neural Networks

A thesis submitted in partial fulfillment

of the requirements of the degree of

Master of Science in Electrical Engineering

(Computer and control)

By

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STATEMENT

The dissertation is submitted to the faculty of Engineering Ain Shams University for degree of master of science in Electrical Engineering (Computer and systems division).

The work included in this thesis was carried out by the author in the department of computer and control, Faculty of Engineering, Ain Shams University, from 1991 to 1995.

No part of this thesis has been submitted for a degree or a qualification to any other university or institution.

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Abstract

In this thesis we have made a survey for the existing neural network learning algorithms and we give the advantages and disadvantages of each one. Also we suggest to use a learning algorithm for training neural network which overcomes the problems with the current available neural network learning algorithms; this is the random optimization algorithm. We use the teacher forcing concept to modify neural network learning algorithms to increase the training speed and enhance the generalization accuracy.

The structure of neural network, its complexity has been studied. Guide rules for the selection of; initial weights, network parameters (number of layers and number of hidden nodes), training data and data preprocessing are presented.

System identification using neural networks is an important item in neural network applications. We describe the available neural network configurations for system identification and the different methods to implement the dynamics within the neural networks. Prediction of the system output for k-step ahead is also described using neural networks. Finally a simulation problem is carried out to show the power of neural network models for system identification and prediction.

In this thesis we consider the generalized predictive control approach as a reference of comparison. We have also carried out simulation for this approach. A complete survey of the different available neural network configurations to control a dynamical systems and the problems associated with each one are given with simulation for each, using the same example. Also we give a configuration where the neural network replaces the predictor in the control structure profiting of its high performance in prediction.

A comparative study between the performance of the generalized predictive control of linear systems and the neural network controllers, is carried out. We conclude that using the neural networks in the predictive control configuration gives satisfactory results. Neural networks prove that it can be a powerful method to build a generalized adaptive controller.

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