Neural Network Enhancement of Closed-Loop Controllers for Ill-Modeled Systems with Unknown Nonlinearities

by

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(ABSTRACT)

The nonlinearities of a nonlinear system can degrade the performance of a closed-loop system. In order to improve the performance of the closed-loop system, an adaptive technique, using a neural network, was developed. A neural network is placed in series between the output of the fixed-gain controller and the input into the plant. The weights are initialized to values that result in a unity gain across the neural network, which is referred to as a "feed-through neural network." The initial unity gain causes the output of the neural network to be equal to the input of neural network at the beginning of the convergence process. The result is that the closed-loop system's performance with the neural network is, initially, equal to the closed-loop system's performance without the neural network.

As the weights of the neural network converge, the performance of the system improves. However, the back propagation algorithm was developed to update the weights of the feed-forward neural network in the open loop. Although the back propagation algorithm converged the weights in the closed loop, it worked very slowly. Two new update algorithms were developed for converging the weights of the neural network inside the closed-loop. The first algorithm was developed to make the convergence process independent of the plants dynamics and to correct for the effects of the closed loop. The second algorithm does not eliminate the effects of the plant's dynamics, but still does correct for the effects of the closed loop. Both algorithms are effective in converging the weights much faster than the back propagation algorithm. All of the update algorithms have been shown to work effectively on stable and unstable nonlinear plants.

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Table of Contents

List of Figures

List of Tables