Chapter 19

THE ARTIFICIAL NEURAL NETWORK
APPLIED TO SERVO CONTROL SYSTEM

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Abstract This chapter describes the basic neural network controllers. The neural controls with specialized learning architecture are introduced. The direct neural controls with the approximation of Jacobian are discussed and simulated. The adaptive control using multiple neural networks, which consists of a direct neural controller, a neural emulator and a neural tuner, is proposed. The neural emulator is used to approximate the Jacobian of plant. The linear combination of error and the error’s differential is used to approximate the back propagation error for weights update. The neural tuner is an online neural network can perform the tuning of key parameters of the linear combination.

Keywords: Direct neural controls, Servo control, Specialized learning architectures, Multiple neural networks, Neural tuner

1. Introduction

In recent years, the neural controls have been put into use in various fields owing to their capability of on line learning and adaptability. Many learning strategies for neural control were proposed and applied to some specified nonlinear control systems to overcome the unknown model and parameters variation problems. The general learning architecture and the specialized learning architecture are proposed and studied in early development of neural control [1]. The general learning architecture shown in Fig.19.1, uses neural network to learn the inverse dynamic of plant, and the well-trained network is applied to be a feed forward controller. In this case, the general procedure may not be efficient since
the network may have to learn the responses of the plant over a larger operational range than is actually necessary. One possible solution to this problem is to combine the general method with the specialized procedure. In this chapter, a direct neural controller with specialized learning architecture is introduced and applied to servo control system.

The specialized learning architecture shown in Fig. 19.2, trains the neural controller to operate properly in regions of specialization only. Training involves using the desired response as input to the network. The network is trained to find the plant input, which drives the system output to the desired command. This is accomplished by using the error between the desired and actual responses of the plant to adjust the weights of the network with a steepest descent procedure. The weights are adjusted to decrease the errors during iterations. This procedure requires knowledge of the Jacobian of the plant.

There are two strategies to facilitate the specialized learning, one is direct control shown in Fig. 19.2 and the other is indirect control shown in Fig. 19.3 [2]. In the former, the plant can be viewed as an additional but no modifiable layer of the neural network, and the dash line of Fig. 19.2 means the weights update need the knowledge of plant. The