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USING ADAPTIVE RECURRENT NEURAL NETWORKS FOR CHAOS CONTROL

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Abstract. This paper proposes a new adaptive control scheme, based on a dynamic neural network, for trajectory tracking of unknown nonlinear plants. The main components of this scheme include a neural identifier and a control law, which together guarantee the desired trajectory tracking performance. Stability of the tracking error is analyzed by using the Lyapunov function method and the inverse optimal control approach. The scheme is tested by simulations on examples of complex dynamical systems: chaos stabilization and synchronization.

Keywords. Dynamic neural networks, chaos synchronization, inverse optimal design, adaptive control, Lyapunov function, stability.

1 Introduction

Motivated by the seminal paper [1], there exists continuously increasing interest in applying neural networks to identification and control of nonlinear systems. Most of these applications use feedforward structures [2], [3]. Recently, dynamic neural networks are being developed, which allow more efficient modeling of the underlying dynamical systems [4]. Two representative books [5], [6] have reviewed the application of dynamic neural networks for nonlinear system identification and control. In particular, [5] uses off-line learning, while [6] analyzes adaptive identification and control by means of on-line learning, where stability of the closed-loop system is established based on the Lyapunov function method. In [6], the trajectory tracking problem is reduced to a linear model following problem, with application to DC electric motors.

On the other hand, control methods applicable to general nonlinear systems have also been extensively developed since the early 1980's, for example based on the differential geometry theory [7]. Recently, the passivity approach has generated some increasing interest for synthesizing control of general nonlinear systems [8]. An important problem in this approach is how to achieve robust nonlinear control in the presence of unmodelled dynamics