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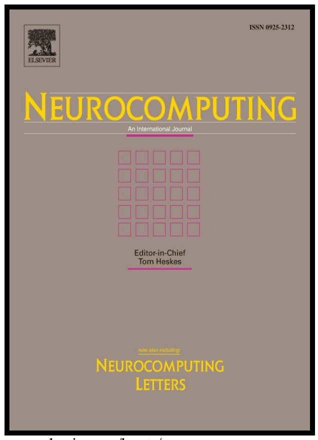

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Adaptive Neural Control for a Class of Stochastic Nonlinear Systems with Unknown Parameters, Unknown Nonlinear Functions and Stochastic Disturbances

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Abstract

In this paper, adaptive neural control (ANC) is investigated for a class of strict-feedback nonlinear stochastic systems with unknown parameters, unknown nonlinear functions and stochastic disturbances. The new controller of adaptive neural network with state feedback is presented by using a universal approximation of radial basis function neural network and backstepping. An adaptive neural network state-feedback controller is designed by constructing a suitable Lyapunov function. Adaptive bounding design technique is used to deal with the unknown nonlinear functions and unknown parameters. It is shown that, the global asymptotically stable in probability can be achieved for the closed-loop system. The simulation results are presented to demonstrate the effectiveness of the proposed control strategy in the presence of unknown parameters, unknown nonlinear functions and stochastic disturbances.

Keywords: Unknown parameters, stochastic disturbances, unknown nonlinear functions, stochastic nonlinear, adaptive neural control.

1. Introduction

In recent years, the study of the robust control system design for nonlinear systems has attracted extensive attention. Lots of significant developments have been obtained[1–12], and interesting results of adaptive nonlinear control have been ever-increasing. Adaptive backstepping as a powerful method has a large number of applied research about synthesizing controllers for lower-triangular nonlinear systems. Backstepping design technique is one of the methods to design nonlinear system by structuring intermediate laws and Lyapunov functions step by step. It has obtained a large number of successful applications in nonlinear control. Such as [13–15].

Adaptive control is an important branch of robust control. Noticeably, due to neural network control and fuzzy logic control have a good approximation ability over a compact domain, they are very suitable for handle highly uncertain and nonlinear system, and they have become an important part of adaptive control and a lot of research has been obtained, such as [16–18, 20]. In the early development stage of neural network control schemes, the control schemes that derive parameter adaptive law in off-line environments was usually used [21], which can perform well in some simple cases, but the stability, robustness and performance of nonlinear systems have few systematic analytical methods. In order to avoid the above problems, the reference [19] has obtain some adaptive neural control schemes based on Lyapunov's stability theory.

Stochastic nonlinear modelling has come to play an important role in many areas of industry, science and technology. After the success of systematic control design for deterministic nonlinear systems, how to extend this technique to the case of stochastic nonlinear systems has been an open research area [22]-[30]. Therefore, it is a challenging and meaningful issue fo the stability analysis and control design of nonlinear stochastic systems, and have attracted more and more scholars' attention in recent years. The main technical obstacle in the Lyapunov function design for stochastic nonlinear systems is that the gradient and the higher order Hessian term are involved *Itô* stochastic differentiation. In [22, 23], strict-feedback stochastic system is studied for the first time using a backstepping design. [24] tried to extend the results in [22], a class stochastic nonlinear systems with time-delay is investigated. By using the quadratic Lyapunov function, [25, 26] studied the stabilization problem of stochastic nonlinear systems. In [25], a class of stochastic nonholonomic system has investigated, and adaptive stabilization by state-feedback is resolved. For linear LTI SISO plants, [27] proposed a modified adaptive backstepping control. In [24], a class of stochastic nonlinear systems were investigated via output feedback, linearly bounded unmeasurable states are involved in nonlinear function. By an adaptive neural control (ANC) scheme, [38] studied a class of non-affine pure feedback stochastic nonlinear system. It is shown that all the signals involved are semi-globally uniformly ultimately bounded under the action of the developed controller. A simplified adaptive backstepping neural control (ABNC) strategies are proposed for a class of uncertain strict-feedback nonlinear systems in [42]. In

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