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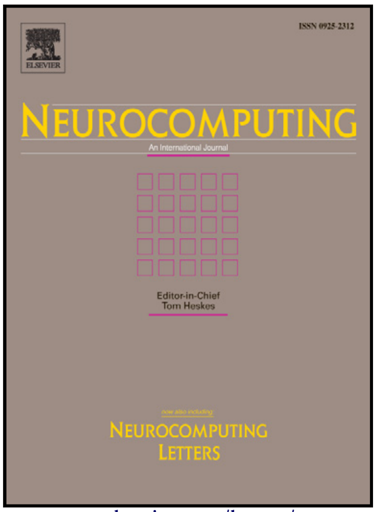

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Neural adaptive control for uncertain nonlinear system with input saturation: state transformation based output feedback[1]

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Abstract

This paper presents neural adaptive control methods for a class of nonlinear systems in the presence of actuator saturation. Backstepping technique is widely used for the control of nonlinear systems. By introducing alternative state variables and implementing state transformation, the system can be reformulated as output feedback of a canonical system, which ensures that the controllers can be developed without backstepping methodology. To reduce the influence caused by actuator saturation, an effective auxiliary system is constructed to prevent the stability of closed loop system from being destroyed. Radial basis function (RBF) neural networks (NNs) are used in the online learning of the unknown dynamics. High-order sliding mode (HOSM) observer is used in the output feedback case of the achieved canonical system. Ultimate and transient tracking errors can be adjusted arbitrarily small by choosing proper design parameters in an explicit way with input saturation in effect. Simulation results are presented to verify the effectiveness of proposed schemes.

Keywords: Neural adaptive control, Actuator saturation, Sliding-mode observer, Nonlinear system

1. Introduction

Recent decades have witnessed great advance and development of adaptive control methods for nonlinear systems in theoretical studies and practical applications [1] [2] [3] [4] [5] [6] [7], and multifarious controllers have been developed using advanced techniques (e.g., inversion control [8], sliding mode control [9], backstepping [10][11][12], and so on). Among various control methods, adaptive backstepping control has been acknowledged as a powerful methodology and widely used in nonlinear control field [13]. To eliminate the difficulty and challenge caused by unknown nonlinear dynamics, approximation-based control methods have been used [14][15], where either neural networks or fuzzy logic systems act as the function approximators. The merits of above-mentioned approximation-based control are that the assumption of *linear in unknown parameters* can be removed, and the adaptive laws of

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