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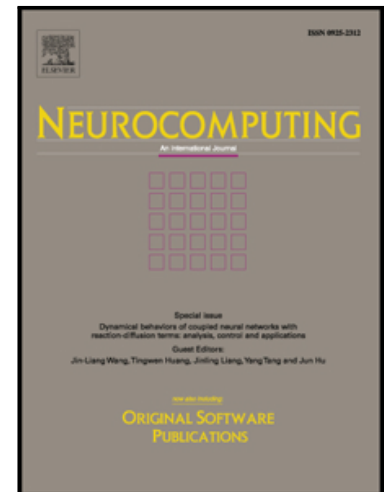
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Stable Robust Adaptive Radial Basis Emotional Neurocontrol for a Class of Uncertain Nonlinear Systems

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Abstract

Various models of emotional learning in mammalian brain have inspired a number of cognitive control and decision-making paradigms to date. These architectures are promising in terms of their learning ability and low computation, but they generally lack rigorous analysis of stability and mathematical proof of performance. In order to remedy this weakness, this paper proposes a modified thalamus using a radial basis emotional neural network (RBENN) structure. Lyapunov analysis is then used to derive laws of adaptation within the context of an indirect adaptive robust control architecture. Accordingly, the stability of the proposed adaptive robust radial basis emotional neuro controller (ARBENC) is proved for a class of uncertain nonlinear systems. The proposed architecture is then applied to two nonlinear systems with partially unknown dynamics with or without disturbances and noisy conditions. In comparison with competing radial basis function neural, fuzzy, and emotional controllers, ARBENC exhibits fast learning while keeping a simple structure, leading to improved error performance and less overall computational time. These numeric results are consistent with earlier reports on emotion-based approaches, the main advantage here is ARBENC's amenity to theoretical analysis and proof of stability.

Keywords: Brain emotional learning; Adaptive control; Nonlinear control; Lyapunov stability theory; Neural networks.

1. Introduction

It is believed that most of human decisions are made, at best, with only bounded rationality. Emotion, in contrast to logical thinking, has in fact a profound effect on human behavior and consequently on his survival, particularly when there is either insufficient time or information for the rational mind to reason and act appropriately. The recent success of various intelligent and cognitive architectures such as fuzzy logic and neural networks only raise the expectation that emotion-based computational frameworks may exhibit similar outstanding results. In fact, a considerable number of numerical and simulation results have already been reported for such emotion-based computational machines. But the development of rigorous and mathematical analysis of such emotional machines is still at its early stages.

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