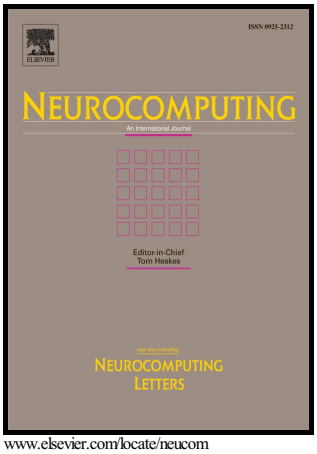

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Distributed Adaptive Fault-Tolerant Control of Pure-Feedback Nonlinear Multi-Agent Systems With Actuator Failures

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Abstract

In this paper, we are concerned with the output tracking consensus matter for a class of pure-feedback nonlinear multi-agent systems (MASs) with actuator failures comprising loss of effectiveness and bias. Taking advantage of relative information from individual agents and their neighbors, a distributed adaptive fault-tolerant control strategy is proposed recursively by the approximation property of neural networks (NNs), backstepping methods, dynamic surface control (DSC) methodology and algebraic graph theory. The distinct features of this control approach are that it is not of requirement of prior information of individual agents with the help of approximation property, and the online update parameters are the norms of NNs weight vectors instead of weight vectors themselves. Also, it reduces the computational burden considerably by introducing the DSC approach. The stability of the resulting closed-loop system is rigorously investigated and it is proven that the consensus tracking errors of the MASs under directed communication topology converge to a small adjustable neighborhood around the origin in spite of actuator failures. Two simulation examples, both practical and numerical ones, are presented to verify the effective of the proposed approach.

Keywords: Distributed Control, Multi-agent Systems, Neural Networks, Fault-Tolerant Control, Dynamic Surface Control

1. Introduction

Over the past decade, tremendous interests have been aroused about the cooperative control of multi-agent systems (MASs) due to their widespread applications in military and civil affairs, such as multi-mobile robots, spacecraft systems, sensor networks [1]–[5]. Cooperative control methods of linear MASs were reported in [6]–[8] and distributed output regulation problems for linear MASs were addressed in Hong *et al.* [9], Chopra and Spong [10]. Further extensions of these work were carried out by Kim *et al.* [11] to the heterogeneous uncertain cases and by Li *et al.* [12] to the heterogeneous linear discrete-time ones. Since numerous of practical applications are with nonlinear behavior inherently, it has attracted considerable attention to this topic. By introducing internal models, Su and Huang converted the cooperative global robust output regulation issue into a global stabilization problem and reported distributed schemes for second-order heterogeneous nonlinear uncertain MASs [13], nonlinear uncertain MASs with unknown leader [14], minimum phase nonlinear uncertain MASs [15]. In [16], a consensus control strategy was developed for network-connected nonlinear systems whose subsystems were heterogeneous with non-sector-bounded nonlinearities. Shen *et al.* and Wang *et al.* investigated distributed consensus tracking control schemes for nonlinear strict-feedback MASs [17] and strict-feedback MASs with unknown control gains [18], respectively. Wang *et al.* tried to apply their theory

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