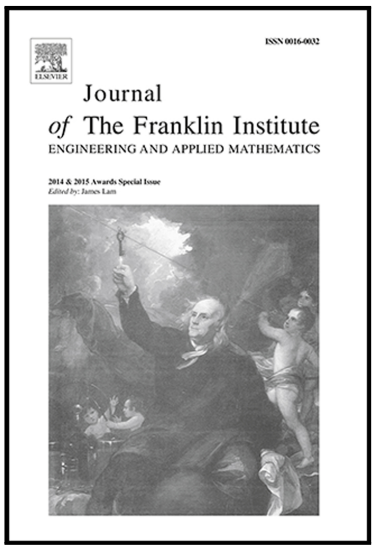

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Jinsha Li, Sanyang Liu, Junmin Li

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Adaptive iterative learning protocol design for nonlinear multi-agent systems with unknown control direction

Jinsha Li*, Sanyang Liu, Junmin Li

School of Mathematics and Statistics, Xidian University, Xi'an 710071, PR China

Abstract

This paper investigates a new adaptive iterative learning control protocol design for uncertain nonlinear multi-agent systems with unknown gain signs. Based on Nussbaum gain, adaptive iterative learning control protocols are designed for each follower agent and the adaptive laws depend on the information available from the agents in the neighbourhood. The proper protocols guarantee each follower agent track the leader perfectly on the finite time interval and the Nussbaum-type item can seek control direction adaptively. Furthermore, the formation problem is studied as an extension. Finally, simulation examples are given to demonstrate the effectiveness of the proposed method in this article.

Keywords: Multi-agent systems; Adaptive iterative learning control; Nussbaum gain; Composite energy function; Nonlinear dynamics

1. Introduction

Coordination and cooperative control of multi-agent systems has received a great amount of attentions due to its broad applications in various areas[1-7]. Consensus is a fundamental problem for cooperative control, and the basic idea of consensus control is that all agents are driven to an agreement by a consensus protocol. It is well known that Nussbaum gains can be used to tackle adaptive control with unknown control gains for nonlinear systems. In literature [8], the authors solved the adaptive consensus problem for first and second order linearly parameterized multi-agent systems with unknown identical control directions, and designed a new Nussbaum-type function to solve this consensus problem. Furthermore, the author in [9] has proposed another new kind of Nussbaum gains that can be used for adaptive consensus for multi-agent systems.

Iterative learning control has been widely used to handle the repeated tracking control and the high precision tracking performance can be achieved on the finite time interval [10]. Therefore, iterative learning control has been applied to multi-agent systems. Many literatures [11-23] have reported the consensus and formation problems for multi-agent systems by using iterative learning control. The quantized iterative learning problem of digital networks has been investigated in [17-18]. The authors designed adaptive iterative learning control protocols for coordination problem of first-order and second-order multi-agent systems in [19-20]. In [21-22], the authors investigated the cooperative learning problems for formation control of nonlinear multi-agent agents. However, the control input gain in these works is totally known. Thus, in [23], an adaptive iterative learning control scheme for high-order nonlinear multi-agent systems was studied, where the control input gain functions is not fully known. When the control input gain is fully unknown, that is to say, a control direction for multi-agent system is not known a priori, the available approaches cannot address the perfect tracking consensus problems for this kind multi-agent system. How to design the adaptive iterative learning protocol for nonlinear multi-agent systems remains an open problem for further studies.

An effective tool to handle unknown control direction is to incorporate the technique of Nussbaum-type gains into the control design. To deal with the tracking problem without a priori knowledge of the control direction, the authors

Email address: jinsha0321@163.com (Jinsha Li*)