

Distributed Constrained Consensus of Multi-Agent Systems with Uncertainties and Disturbances under Switching Directed Graphs

Hao Luan, Jie Mei, *Member, IEEE*, Han Yu, and Guangfu Ma

Abstract

This paper provides a distributed leaderless consensus control framework for nonlinear multi-agent systems with time-varying asymmetric state constraints, uncertainties, and disturbances under switching directed graphs. In such a framework, original constrained states of agents are first transformed into free states in a transformed state space. To deal with directed graphs, we drive agents towards consensus in the transformed space by leveraging a model reference control scheme, and it is sufficient that the original states reach consensus strictly subject to the time-varying constraints under mild assumptions. A single-layer neural network with weights adapted online is used to approximate the uncertainties in agent dynamics. For the external disturbances and reconstruction errors in the approximation, we introduce a robust term with an adaptive gain for compensation. Distributed consensus algorithms are proposed, respectively, for multi-agent systems with first- or second-order dynamics. We prove convergence to consensus via Lyapunov analysis and study the proposed algorithms' performance using numerical simulations. The theoretical and numerical studies, taken together, demonstrate the effectiveness of the proposed control framework and algorithms in the presence of disturbances and uncertainties.

Index Terms

Multi-agent systems, leaderless consensus, state constraints, switching directed graphs, distributed control.

©2021 IEEE. Personal use of this material is permitted. Permission from IEEE must be obtained for all other uses, in any current or future media, including reprinting/republishing this material for advertising or promotional purposes, creating new collective works, for resale or redistribution to servers or lists, or reuse of any copyrighted component of this work in other works.

This work has been submitted to the IEEE for possible publication. Copyright may be transferred without notice, after which this version may no longer be accessible.

This research was supported in part by the National Natural Science Foundation of China (62073098, U1913209) and the Shenzhen Basic Research Program(JCYJ20200109113210134).

The authors are with the School of Mechanical Engineering and Automation, Harbin Institute of Technology, Shenzhen, Guangdong, 518055, China.