Model-Free Safe Adaptive Synchronization Control of Nonlinear Multi-Agent Systems

Huijuan Li
School of Marine Electrical Engineering
Dalian Maritime University
Dalian, China
lihuijua@126.com

Nan Gu
School of Marine Electrical Engineering
Dalian Maritime University
Dalian, China
gu@dlmu.edu.cn

Dan Wang
School of Marine Electrical Engineering
Dalian Maritime University
Dalian, China
dwangdl@gmail.com

Zhouhua Peng*
School of Marine Electrical Engineering
Dalian Maritime University
Dalian, China
zhpeng@dlmu.edu.cn

***Abstract*—This paper investigates the model-free safe adaptive synchronization problem for high-order nonlinear multi-agent systems with completely unknown internal uncertainties, unknown external disturbances, and unknown control input gains. A safe adaptive synchronization controller is proposed based on a finite-time data-driven fuzzy predictor and an input-to-state safe control barrier function (ISSs-CBF). Specifically, by utilizing the integral of historical data, a finite-time data-driven fuzzy predictor is designed to estimate the unknown model parameters and ensure the convergence of the estimation without requiring persistent excitation. Based on this estimated information, a safe adaptive synchronization controller is proposed, which allows the tasks of leader-following synchronization and safety to be represented separately but can be implemented jointly. The closed-loop control system is proven to be input-to-state stable via Lyapunov theory. Moreover, the multi-agent systems are proven to be input-to-state safe. Simulation results validate the effectiveness of the proposed model-free safe adaptive synchronization control method for high-order nonlinear multi-agent systems with a fully unknown dynamic model.**

***Index Terms*—High-order nonlinear multi-agent systems, synchronized control, finite-time fuzzy predictor, input-to-state safe control barrier function.**