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Finite-time formation control for first-order multi-agent systems with region constraints

Key words: Finite-time formation; Multi-agent system; Asymptotic convergence; Set constraint; Lyapunov theorem

Corresponding author: Zhengquan YAN
E-mail: zquanyang@zjut.edu.cn
https://orcid.org/0000-0003-0406-6640

Motivation

1. In practical applications, we need to consider some constraints and timeliness, such as the need to implement a formation into a specific area within a specific time.

2. We design a controller which controls all the agents to enter the desired region and to track a desired shape in finite time.

3. For the desired region, the previous studies often obtain a leader-following formation controller. In contrast, our algorithm does not depend on the leader. It has good robustness.

Main idea

1. A novel control algorithm is proposed using local information and interaction.

2. If the communication graph is undirected and connected and the desired framework is rigid, it is proved that the controller can be used to solve the formation problem with a target area.

Method

Based on the rigorous undirected network topology, it is shown that all the agents would enter the global desired area and reach formation in finite time.

Major results

1. Under Assumptions 1 and 2, if $\beta > N$, for the first-order MAS (1) with algorithm (5), all the agents can realize the asymptotic convergence of the formation shape in finite time and $\boldsymbol{x}_i(t) \in \Omega$ in finite time.

$$\dot{\boldsymbol{x}}_i(t) = \boldsymbol{u}_i(t), \tag{1}$$

$$\begin{aligned} \boldsymbol{u}_i(t) = &- \sum_{j \in N_i} a_{ij} \mathrm{sgn}(\boldsymbol{x}_i(t) - \boldsymbol{x}_j(t) - \boldsymbol{\gamma}_{ij}^*) \\ &- \beta \mathrm{sgn}(\boldsymbol{x}_i(t) - P_\Omega(\boldsymbol{x}_i(t))). \end{aligned} \tag{5}$$

Major results (Cont'd)

2. Simulation process of a 92-agent target formation shape

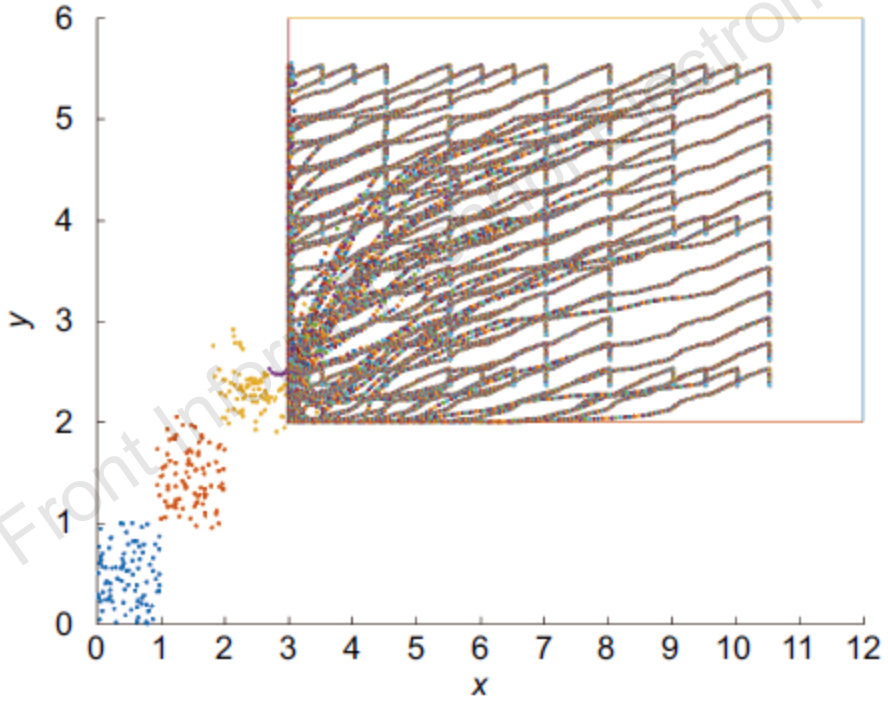

Fig. 4 Simulation process of a 92-agent target formation shape

Major results (Cont'd)

3. Final configuration of 92 agents

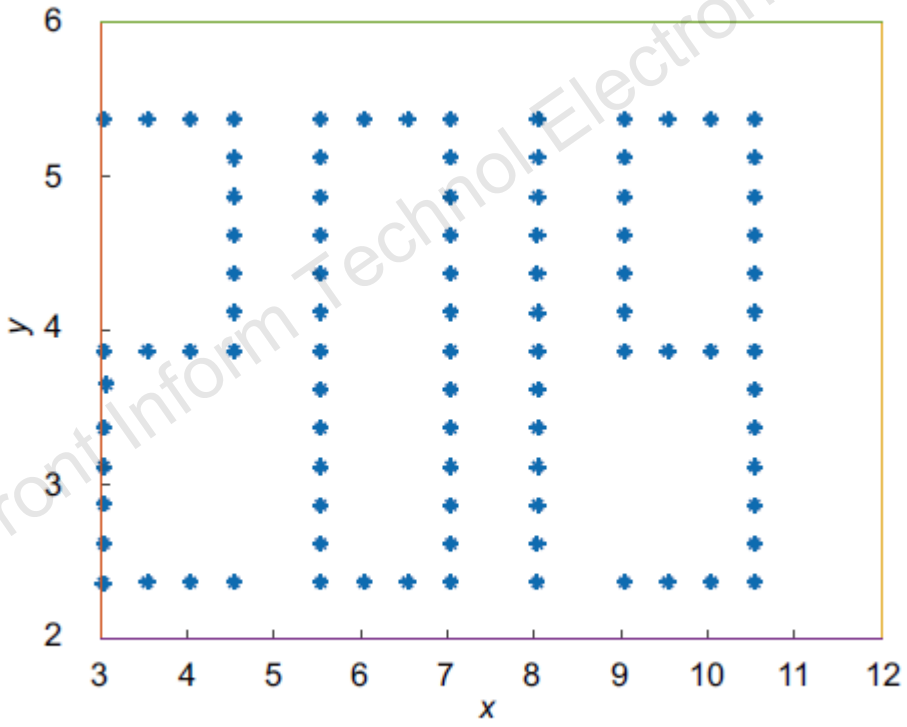

Fig. 5 Final configuration of 92 agents

Conclusions

1. A formation controller has been proposed by the convex set and local information among the agents.

2. Based on the rigorous undirected network topology, it is shown that all the agents would enter the global desired area and reach formation in finite time.

3. The results have been illustrated by simulation.

Zhengquan YANG received his BS degree in mathematics from the Institute of mathematics, Qufu Normal University, Qufu, China, in 2003, and his PhD in Operational Research and Control Theory from Nankai University, Tianjin, China, in 2009. He is working at the Civil Aviation University of China. His main research interests include synchronization of complex networks and flocking of multi-agents.

Prof. Zengqiang CHEN was born in 1964. He received his BS degree in mathematics, his MS and PhD degrees in control theory and control engineering from Nankai University, Tianjin, China, in 1987, 1990, and 1997, respectively. He is working at Nankai University and is currently a professor in the Department of Automation. His main research interests include nonlinear control, chaos system, and adaptive control. He has authored more than 80 journal papers.