

Research Article

Observer-Based Event-Triggered Circle Formation Control for First- and Second-Order Multiagent Systems

Peng Xu¹, Guangming Xie^{1,2,3,4}, Jin Tao^{5,2}, Minyi Xu^{1,4} and Quan Zhou⁵

¹Marine Engineering College, Dalian Maritime University, Dalian 116026, China

²State Key Laboratory of Turbulence and Complex Systems, Intelligent Biomimetic Design Lab, College of Engineering, Peking University, Beijing 100871, China

³Institute of Ocean Research, Peking University, Beijing 100871, China

⁴Peng Cheng Laboratory, Shenzhen 518000, China

⁵Department of Electrical Engineering and Automation, Aalto University, Espoo 02150, Finland

Correspondence should be addressed to Jin Tao; jin.tao@aalto.fi and Minyi Xu; xuminyi@dlmu.edu.cn

DWfW \$' EVfW TWd \$' #+- 3UWfW + <S' gSk \$' \$' -BgT fZw \$&? SdZ \$' \$'

Academic Editor: Átila Bueno

Copyright © 2020 Peng Xu et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This paper proposes an observer-based event-triggered algorithm to solve circle formation control problems for both first- and second-order multiagent systems, where the communication topology is modeled by a spanning tree-based directed graph with limited resources. In particular, the observation-based event-triggering mechanism is used to reduce the update frequency of the controller, and the triggering time depends on the norm of the state function and the trigger threshold of measurement errors. The analysis shows that sufficient conditions are established for achieving the desired circle formation, while there exists at least one agent for which the next interevent interval is strictly positive. Numerical simulations of both first- and second-order multiagent systems are also given to demonstrate the effectiveness of the proposed control laws.

1. Introduction

In recent years, many research efforts have been devoted to controlling of multiagent systems (MASs) due to both its practical potentials in a variety of applications [1–3] and theoretical challenges of physical constraints [4–6]. As a significant problem in cooperative control for MASs, formation control, aiming to guide multiple agents to form and maintain predetermined geometries, has attracted considerable interests for its extensive applications in different areas [7–10]. The main focus has been devoted to the design of a distributed formation control framework, especially concerning the robustness against both external disturbances and internal uncertainties [11, 12], as well as the increased number of agents. Moreover, for MASs subjected to aperiodic sampling and communication delays, the problem of cluster formation control was addressed in [10].

Therefore, most existing results on formation control mainly

rely on the ideal hypothesis [13–15], e.g., each agent is modeled as having unlimited communication capabilities, unlimited power, and unlimited processing capabilities, which allows arbitrary information to exchange pattern. However, as far as we know, few studies dealt with the limited capacity of communication and the power constraints of agents.

In order to save energy and bandwidth, event-triggered control methods have been presented in [16–20]. One of the most distinct characters of event-triggered control is that control actions only update when specific events occur, which lead to ease the trade-offs among actuator effort, communication, and computation. Moreover, according to the triggered methods, event-triggered control can be mainly divided into state-dependent triggering and time-dependent triggering. A simple state event-triggered schedule based on the feedback control was studied in [16]. The results lead to a guaranteed performance with a fixed sampling rate

