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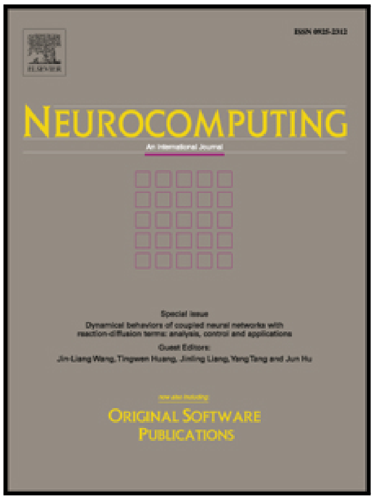

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Distributed Formation Tracking of Multi-Robot Systems with Nonholonomic Constraint via Event-Triggered Approach

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Abstract

This paper investigates the distributed formation tracking problem of multi-robot systems with nonholonomic constraint via event-triggered approach. A variable transformation is firstly given to convert the formation tracking problem into the consensus-like issue. Then a novel type of distributed event-triggered control strategy is proposed under fixed topology and switching topology, which can guarantee multi-robot systems to produce desired geometric configuration from arbitrary initial positions and orientations for each robot, while the centroid of formation can follow one dynamic reference trajectory. Moreover, the novel event-triggering conditions under fixed topology and switching topology, which only need intermittent interaction between neighboring robots, are designed to assist the execution of distributed controllers. Based on the designed event-triggering conditions, the robot systems can effectively reduce the communication cost, energy consumption and mechanical wear, especially when the quantity of robots is huge. Finally, the effectiveness of theoretical results is illustrated by some numerical examples.

Keywords: Multi-robot systems, event-triggered control, nonholonomic constraint, distributed coordination, formation tracking, non-smooth analysis

1. Introduction

Over the past two decades, cooperative control issues of multi-robot systems with nonholonomic constraint have attracted compelling attention due to broad civilian and military applications, such as intelligent transportation systems, source seeking [1, 2], plume tracking [3], manipulators coordination [4, 5], surveillance, military deterrence, multi-sensor/actuator networks, and so forth [6, 7]. An essential topic in the cooperative control of multi-robot systems is the formation tracking problem, which requires that all the robots produce a desired geometric configuration from arbitrary initial positions and orientations while the centroid of formation follows one dynamic reference trajectory. In order to achieve formation tracking task, there already exists a variety of methods such as leader-follower approach, behavior-based approach, artificial potential approach, virtual structure approach, consensus-based approach [8–10]. In general, current control frameworks can be categorized roughly as two categories: centralized and distributed, from the view of communication and computation. It is worth noting that most of above control methods belong to the centralized control framework. Different with the centralized manner, distributed control owns inherent superiority with higher robustness, flexibility, maintainability and economical efficiency. It is specially suitable for the control task of large amount of robot networks under limitative communication cost and computing capability. As aforementioned, the consensus-based formation tracking control method with distributed nature is a promising direction for the multiple robots control in the future [11–15].

Except for above aspects, the communication is also a key factor in the coordination behavior. Along with increasing quantity of robots, the burden of information channel with limited communication bandwidth and rate will

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