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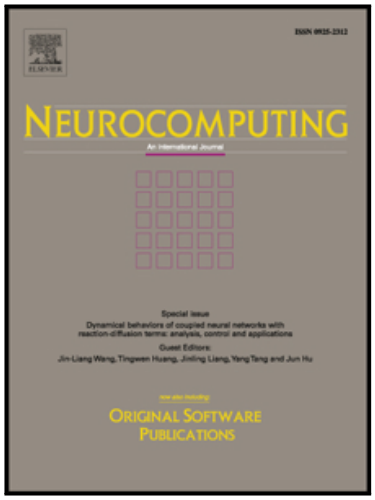

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Distributed Fixed-Time Formation Tracking of Multi-Robot Systems with Nonholonomic Constraints

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Abstract

This paper addresses the fixed-time formation tracking problem of multi-robot systems with nonholonomic constraints. A new type of distributed nonlinear controller for each robot is designed. Some corresponding sufficient conditions are derived by using algebraic graph theory, matrix analysis and fixed-time stability theory. In addition, an upper bound of the settling time for the multi-robot systems is also explicitly given. It is shown that the obtained upper bound of settling time is regardless of initial errors of systems, which implies that it can facilitate the pre-design of the convergence time off-line. Numerical example is provided to illustrate the effectiveness of the present theoretical results.

Keywords: Multi-robot systems, nonholonomic constraints, distributed control, formation tracking, fixed-time stability.

1. Introduction

Over the pass two decades, the distributed control mechanism has become a hot topic that received great attention in broad areas. This technique has gradually infiltrated into distributed computation, ground/aerial/underwater multiple vehicles cooperative control, attitude calibration of satellites, formation stabilization and maneuver of aircrafts, cooperative source searching, disaster surveillance and rescue and multi-sensor information fusion. For detailed instance, authors in [1] studied the distributed kinematic control of multiple redundant manipulators via recurrent neural networks. Furthermore, reference [2] investigated the distributed cooperative control of manipulators with a game-theoretic perspective. Reference [3] proposed the first distributed protocol to deal with winner-take-all problem in networks via Lyapunov theory. And reference [4] studied the hunting problem of multi-robot systems by a distributed approach. In addition, distributed filter under directed switching topologies via consensus theory are proposed and analyzed in [5]. Thus, when we naturally introduce distributed control perspective to the decision and control of a group of autonomous robots, traditionally centralized control mechanism gradually paled. Based on the characteristics of distributed control approach, each robot with built-in micro distributed controller only needs to interact with its neighbors or the leader, and the collective formation behaviors will be produced to finally complete the complex task.

Also, the formation tracking problem for the distributed multi-robot systems have been considered widely in various communities due to its broad applications against single mobile robot, except for the cases referred above, it is very suitable for the forest fire monitoring and huge component transport, etc. Employing distributed control mechanism to solve the formation tracking problem of multi-robot systems with nonholonomics constraints is a promising direction recently. For this point, there have existed numerous interesting results, the partial results can be found

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