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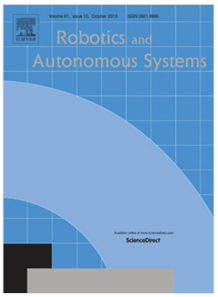

A decentralized cooperative control scheme for a distributed space transportation system

Yunhe Meng, Qifeng Chen, Ahmed Rahmani

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A Decentralized Cooperative Control Scheme for a Distributed Space Transportation System

YunheMeng[1]
National University of Defense Technology, Changsha, Hunan 410073, China

Qifeng Chen[2]
Central South University, Changsha, Hunan 410083, China

and
Ahmed Rahmani[3]
Ecole Centrale de Lille, Villeneuve d'Ascq, Lille 59650, France

***Abstract*—In this paper, a new concept for a distributed space transportation system is proposed and a corresponding decentralized cooperative control scheme is investigated. First, for a leaderless team of homogeneous space robots transporting a large object in orbit, a systematic control architecture that includes information flow is developed. Second, based on relative orbit dynamics, a rendezvous guidance law and a rigid formation control law are designed, and the necessary communication topology for the space robot team is discussed. Third, to guarantee the consensus of the motion of the large object with the robot team, both orbital maneuver control and attitude control for the large object are studied. Emphasis is placed not on the attitude control law but on the force distribution problem, for which an algorithm exploiting a special property of trigonometric functions is proposed to transfer the necessary attitude control torque to the distributed forces. To support the above control method, an estimation of the motion of the formation center contributed by each robot in a decentralized manner is developed using a Kalman filter. Fourth, the robustness of the system to the failure of one robot is analyzed, and four effective typical fault response modes are proposed. Finally, numerical simulations validated the performance, robustness and practicability of the developed control scheme.**

Index Terms—**Distributed Space Transportation System; Decentralized Attitude Determination; Force Distribution Algorithm; Rendezvous Guidance; Formation Control.**

I. INTRODUCTION

A. *Motivation*

MULTI-robot cooperative systems have been of interest to researchers for a long time because of their wide range of applications. On-orbit assembly is becoming an increasingly interesting field of application for systems of multiple space robots[1]. Large space structures (LSSs) are crucial facilities in space; they include space stations, space power stations, space docks, space telescopes, and so on. All such structures are physically large and expensive and cannot be launched from the surface of the Earth in a single piece or in their operational configuration. Instead, an LSS must be launched in several parts, and these modules must

[1]Associateprofessor, College of Aerospace Scienceand Engineering, National University of Defense Technology, Changsha 410073, China(e-mail:mengyunhe@nudt.edu.cn).
[2]Professor,School of Aeronautics and Astronautics, Central SouthUniversity, Changsha 410083, China(e-mail:chenqifeng@csu.edu.cn).
[3]Professor, CRIStAL, UMR CNRS 9189,Ecole Centrale de Lille, Villeneuve d'Ascq, 59650, France(ahmed.rahmani@centralelille.fr).