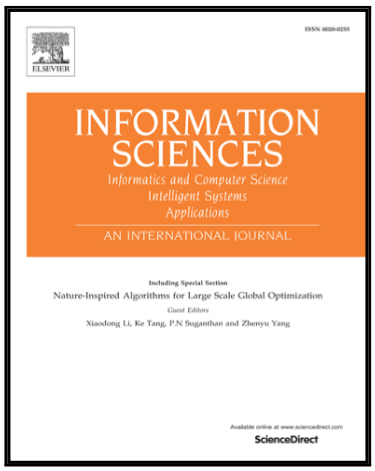

6-DOF fixed-time adaptive tracking control for spacecraft formation flying with input quantization

Ruixia Liu, Xibin Cao, Ming Liu, Yanzheng Zhu

PII: S0020-0255(18)30755-2
DOI: https://doi.org/10.1016/j.ins.2018.09.041
Reference: INS 13952

To appear in: *Information Sciences*

Received date: 17 April 2018
Revised date: 17 September 2018
Accepted date: 20 September 2018

Please cite this article as: Ruixia Liu, Xibin Cao, Ming Liu, Yanzheng Zhu, 6-DOF fixed-time adaptive tracking control for spacecraft formation flying with input quantization, *Information Sciences* (2018), doi: https://doi.org/10.1016/j.ins.2018.09.041

6-DOF fixed-time adaptive tracking control for spacecraft formation flying with input quantization

Ruixia Liu, Xibin Cao, Ming Liu, and Yanzheng Zhu

Abstract

This paper addresses fixed-time tracking control problems for spacecraft formation flying (SFF) with model uncertainties, external disturbances, and input quantization. Firstly, a coupled model based on dual quaternions is introduced to describe the six-degrees-of-freedom (6-DOF) relative motion of spacecraft formation flying. Secondly, hysteretic quantized control input is implemented to reduce the required communication rate and to avoid the oscillations caused by the logarithmic quantizer. Thirdly, a fast terminal sliding mode tracking controller with adaptive updating laws is proposed to guarantee that the resulting closed-loop system is fixed-time stable, and that the relative motion tracking errors converge to a neighborhood around the origin in a fixed time, despite the presence of model uncertainties, external disturbances, and input quantization. Finally, a simulation example is presented to show the effectiveness of the proposed control design scheme.

Index Terms

Input quantization; Adaptive control; Fixed-time control; Spacecraft formation flying;

1 Introduction

The past few decades have seen spacecraft formation flying (SFF) as a recurring research theme owing to its enhanced flexibility, efficiency, and reliability compared with traditional monolithic spacecraft systems [37], [30], [12]. It is well known that the modeling and control of orbit and attitude are two core technologies for SFF tasks. Because of the significance of modeling and control, a rich body of research results has been published regarding the modeling and control issues of spacecraft formation [20], [5], [38]. It should be noted that in the aforementioned literature, the modeling and control of orbit and attitude are often considered separately. In practice, however, the attitude control system and the orbit control system should be regarded as a single six-degrees-of-freedom (6-DOF) system, considering the strong coupling

Ruixia Liu, Xibin Cao, and Ming Liu are with Research Center of Satellite Technology, Harbin Institute of Technology, Harbin 150001, China. Ming Liu is with Key Laboratory of System Control and Information Processing, Ministry of Education of China, Shanghai, 200240, China. Yanzheng Zhu is with the School of Computing, Engineering and Mathematics, Western Sydney University, Sydney, NSW 2751, Australia. Email of Ruixia Liu: ruixialiu666@163.com. Email of Xibin Cao: xbcao@hit.edu.cn. Email of Ming Liu: mingliu23@hit.edu.cn. Email of Yanzheng Zhu: yanzhengzhu1986@gmail.com.