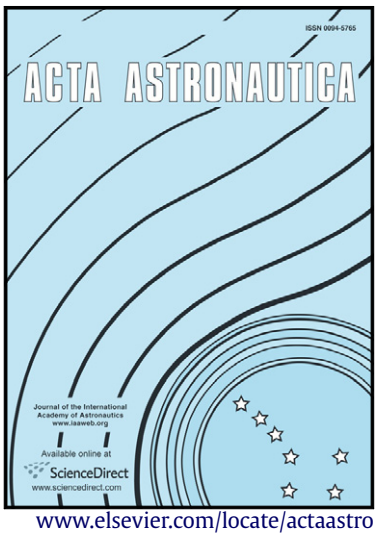

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Guanghui Sun, Z.H. Zhu

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Fractional Order Tension Control for Stable and Fast Tethered Satellite Retrieval

Guanghui Sun[1,2] and **Z. H. Zhu**[1]*

[1]School of Astronautics, Harbin Institute of Technology

92 Xidazhi St., Harbin, Heilongjiang, 150001, China

[2] Department of Earth and Space Science and Engineering, York University

4700 Keele Street, Toronto, Ontario, M3J 1P3, Canada

* Corresponding Author: Email: gzhu@yorku.ca. Tel: +1 416 7362100 x 77729.

Abstract

The retrieval of a tethered satellite system is intrinsically unstable. This paper develops a new control strategy to retrieve the tethered satellite system stably and quickly using the fractional order control theory. The governing equation of the tethered satellite system and classic linear feedback tension control law were first reviewed and examined as a benchmark. Then, a new fractional order tension control law has been to avoid the tethered satellite winds around the main satellite near the end of retrieval by existing integer order tension control laws. The newly proposed control law has been discretized and implemented by the Laplace transform and Tustin operator. Unlike the existing integer order control laws, which are based on the feedback of current state and memoryless, the fractional order control law has the memory of previous states and thus controls the tether retrieval more smoothly while maintaining the retrieving speed. The effectiveness and advantage of the new fractional order tension control law is demonstrated numerically by comparing with its integer order counterpart. The results show that the new control law not only retrieves the subsatellite without winding around the main satellite, but also provides a better control performance with smaller in-plane libration angles.

Keywords: Tethered satellite; Retrieval; Fractional order; Tension control; Dynamics

1. INTRODUCTION

The past decades have witnessed 26 tethered satellite missions [1] due to its great potential in space exploration, microgravity and upper atmospheric studies, electrodynamic propulsion and

* Corresponding Author: Email: gzhu@yorku.ca. Tel: +1 416 7362100 x 77729.