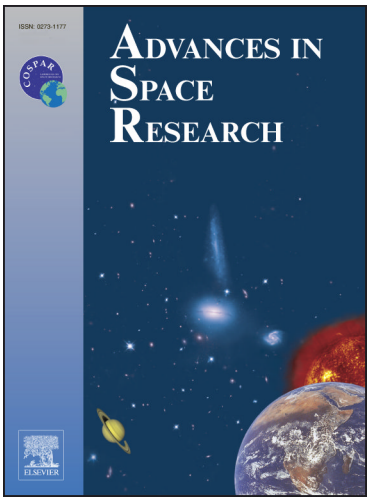

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Dynamics and Control for Contactless Interaction between Spacecraft and Tumbling Debris

Haiyang Li, Jingyang Li, Fanghua Jiang*

School of Aerospace Engineering, Tsinghua University, Beijing 100084, China

Abstract

Tumbling debris has become a great threat to orbit activities. Contactless interaction is a novel concept for active debris removal, through which the tumbling debris no longer rotates freely but is under control. The contactless interaction method aims to de-tumble the debris and then maintain desired relative states between the spacecraft and debris. The spacecraft is simultaneously stabilized through three-axis attitude control, which makes the de-tumbling and capture operation much safer, more effective and accurate. The dynamics and control for the contactless interaction have been little studied in the past years. This paper considers a generic dynamics and control problem for contactless interaction between a spacecraft and debris. A translational and rotational dynamics model of contactless interaction is proposed and the 6-DOF equations are established. The contactless interaction control law is designed with the backstepping method, and the spacecraft three-axis control law is designed with the PD control. Simulation results show that the angular momentum is transferred from the debris to the spacecraft and the debris is thus de-tumbled. The desired relative states are achieved efficiently. Significantly, the spacecraft and debris no longer rotate in the inertial frame and, hence, the safety and accuracy for capture operation are guaranteed.

Keywords: contactless interaction; tumbling debris; active debris removal; backstepping control

*Corresponding author

Email addresses: lihy15@mails.tsinghua.edu.cn (Haiyang Li), lijingyang.thu@hotmail.com (Jingyang Li), jiangfh@tsinghua.edu.cn (Fanghua Jiang)