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Haiyang Li, Jingyang Li, Fanghua Jiang

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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*

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## 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

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\*Corresponding author

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

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