Attitude and Orbit Coupled Tumbling Space Debris Tracking Control

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As the number of the space debris increases, the collision probability between the spacecraft in services and the space debris has reached a critical level that attracts the attentions of researchers globally. In reality, there have been several accidents of this kind. It is not too late to investigate the technology of actively removing space debris now.

Close-proximity tracking of a space debris is a prerequisite for capturing the object. It is also an important technology in Rendezvous & Docking missions. Very few of current publications investigates the tracking of a tumbling space debris. This problem is the topic of this paper. As illustrated in Fig. 1, the objective is to keep the tracking spacecraft stay at a certain distance above a specific face of the space debris. In this way, the spacecraft is able to detect the specific face in detail and to capture the space debris by contacting the specific physically utilizing a manipulator or other devices.

Close-proximity tracking of a tumbling space debris challenges in that the attitude motion of the space debris requires the spacecraft to track the specific face by attitude and orbit coupled motion. The complexity of the tumbling motion also increases the difficulty of the tracking control. The expected motion of the tracking spacecraft is determined by the space debris' orbital and attitude status. Formation flying equations and the quaternions are utilized to describe the center of mass motion and the attitude motion respectively. A Lyapunov based nonlinear controller is developed to fulfill the tracking mission. Numerical simulations demonstrate the effectiveness of the tracking control.

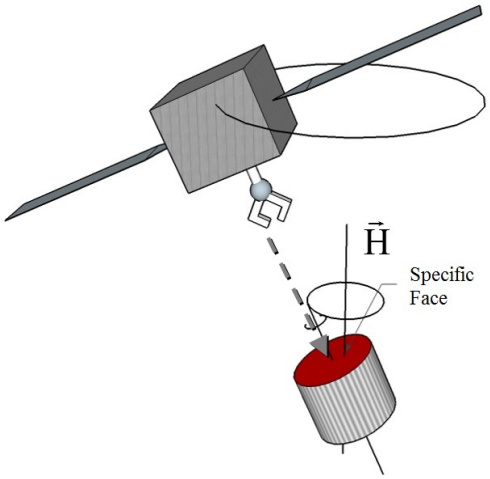

Fig. 1. Scenario of the close-proximity tracking of a rotating space debris.

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