Paper ID: 66269
student

19th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Interactive Presentations - 19th IAA SYMPOSIUM ON SPACE DEBRIS (IP)

Author: Mr. Ruochen Yang
Northwestern Polytechnical University;National Key Laboratory of Aerospace Flight Dynamics, China, 1753769464@qq.com

PROXIMITY MANEUVER AND DETUMBLING METHOD FOR NON-COOPERATIVE TARGET BASED ON MICROSATELLITES

Abstract

With the development of technology of aerospace field, the demand for on orbit services and space debris removal continues to increase. Close proximity and nondestructive capture of non-cooperative targets are important and has promising application prospect. The existing on-orbit service methods are mainly based on tracking platforms and robotic arms, Which are suitable for scenarios of non-tumbling targets and low-speed tumbling targets. The traditional methods are Suboptimal for capturing high-speed tumbling non-cooperative targets without damage. The paper focuses on the non-damaging capture of high-speed tumbling non-cooperative targets with microsatellite assemblies, and the following work has been carried out:

Based on the dual quaternion, spacecraft attitude and orbit integrated relative motion and dynamic model of the chaser and the target is established.

And with this particular model, a two stage approaching control method is designed to synchronize the center of mass of the chaser and the target and tumbling motion of them. Considering the target has a high tumbling speed and the mass distribution of it is unknown, a mass distribution estimation sliding mode control law based on dual quaternion is designed.

With the effect of the deviation of the control force and torque, the observation error of relative motion between the chaser and the target and the perturbation of orbit considered, simulation shows the relative attitude error described with the quaternion is within 10-3 and the relative position error is within 10-2m.

Based on the motion state after the proximity operation, two target capturing methods are designed and compared. The friction method or adhesion method eliminates the relative position error and relative attitude error and completes the precise synchronization of the motion of the tracker and the target. Analysis shows that the friction contact method is suitable for tumbling targets with a large angular velocity difference, and the adhesive contact is suitable for rotating targets with a small angular velocity difference.

To successfully detumbling the target under limited communication of micro satellites, the distributed thrust distribution algorithm of the micro satellite assembly taking over the target motion control is designed. The thrust distribution problem of the multi-microsatellite is transformed into a distributed thrust distribution problem, and through the coordination of multiple groups of micro satellites, the attitude of the target is under control.

Keywords: Microsatellites, Non-cooperative Target, Proximity Maneuver, Sliding Mode Control, Distributed Optimization