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MECHANISM AND STRATEGY DESIGN OF EDDY CURRENT METHOD FOR ACTIVE DESPINNING OF SPACE DEBRIS

Abstract

Space debris is one of the big challenges that space engineers have encountered in recent years. Without proper methods to actively remove space debris, not only would the limited space resources be wasted, but also the remaining space debris could possibly cause damage to functioning spacecrafts on orbit. As most of space debris would have certain spin or nutation rate, which would cause difficulty in direct mechanical capture, despinning of space debris is routinely considered to be a prerequisite to remove space debris.

The eddy current torque, with its feature of no contact and multi-DOF controllability, is one of the potential approaches to despin space debris. The eddy current is produced in a conductor exposed to changing magnetic fields due to relative motion of the field source and the conductor, or due to time-varying fields. This paper is a preliminary study of the mechanism and strategy design of eddy current despinning method, with external magnet fields produced by an actuator to a target of space debris. First, we examined the simplified expression of eddy current torque, based on the spherical shell target model, to analyze the capability and feature of electromagnetic eddy current method to targets with various spin or nutation speeds. Second, we analyzed the eddy current force, which is a combination of a repulsion force and a lateral force during despinning process, and investigated its influence on despinning effectiveness. Third, we focused on the strategy design of eddy current despinning method, by analyzing the relative configuration of the actuator and the target and establishing corresponding attitude dynamics and 6-DOF dynamics. In the meantime, we have conducted case study simulations of a defunct cubesat target using Finite Element Method, and obtained the eddy current distribution and the resulted eddy current torque, to compare with the analysis result from the simplified model. Last but not least, we have designed the ground test platform to verify the simulation and analysis results, and to further testify the feasibility of the eddy current active despinning method in the future.