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ON-ORBIT NON-CONTACT ATTITUDE CORRECTION USING INTER-SATELLITE ELECTROMAGNETIC FORCE

Abstract

On-orbit operation is a research hotspot in recent years. Satellites with improper injection attitude may lose contact with ground as the antenna is not in the right direction, or cannot get enough energy as solar arrays are not facing the sun. In these cases, on-orbit attitude correction is an effective rescue method. However, the envisioned physical contact approaches have potential risk collision, and lack versatility since the mechanical systems are mission-specific. Inter-satellite electromagnetic force/torque, which is characterized by advantages of non-contact, no propellant consumption, no plume contamination or disturbance to optical sensors, offers a new technical approach to on-orbit attitude adjustment and presents great significance both in theory and engineering. This paper proposes a novel concept of inter-satellite electromagnetic force/torque based on-orbit attitude modification for a disabled satellite with active electromagnetic coils like magneto-torquers, and investigates the relevant dynamics and control problem. Firstly, the "one-to-one" mode, which means one operator satellite with electromagnetic coils and one "target" satellite, is analyzed with 6-DOF dynamical model considering the influence of Earth magnetic dipole. To maintain the target's orbit during the attitude correction process, the electromagnetic force should be reduced while the electromagnetic torque is working, thus special relative attitude is required. Since the attitude of the target changes, the operator needs to move around the target under inertia force to maintain the configuration. Then the coordination control of the electromagnetic torque and inertia force is investigated. However, the electromagnetic force cannot keep zero during the whole control process. To solve this problem, "two-to-one" mode (two operators and one target) is introduced. Then the relative equilibrium configuration for the three-craft formation is derived to discuss the method of attitude correction without inertia force. Concentrating on the collinear configuration of "operator-target-operator", the attitude modification performance is analyzed and evaluated. Finally, numerical simulations are conducted to validate the feasibility and validity of electromagnetic attitude correction.