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CONTACTLESS ON-ORBIT RESCUE SCHEME FOR SATELLITE WITH UNIAXIAL CONSTANT MAGNETIC MOMENT USING ELECTROMAGNETIC FORMATION

Abstract

With the increasing requirements of on-orbit rescue for disabled spacecraft, it is of great significance to conduct proximity operation or deorbit the target to ensure an effective follow-up operation. Considering that the magnetorquer is a widely used attitude control system for on-orbit satellite because of its low cost, low energy, small weight, and simple hardware requirement, generally it can still offer constant magnetic moment despite the magnetorquer out of control. If we could find a way to control the disabled satellite by affecting the working magnetorquer, that would represent a promising aspect for on-orbit rescue. Enlightened by the spacecraft electromagnetic formation flight technology, we put forward a novel concept of mixed electromagnetic formation, which actuates both the contactless inter-satellite electromagnetic force and traditional thruster to enable multiple electromagnetic spacecraft coordination with the disabled targets satellite. Considering the fact that the electromagnetic formation maintains a fixed geometry and behaves as a single rigid body in orbit through invariant shape with constant magnetic moments, it is feasible to conduct the whole mixed electromagnetic formation on-orbit maneuver or other operations if the mixed formation is stabilized in an invariant shape. In addition, due to the internal force nature of the electromagnetic force, the total inertial linear and rotational momentum of the electromagnetic formation cannot be changed, and the center of mass does not maneuver at any time. Thus the traditional thrusters are assumed to amount on each electromagnetic satellite to conduct the formation maneuver control. With above consideration in mind, in order to conduct the contactless on-orbit rescue for satellite with uniaxial constant magnetic moment, we need to investigate the shape design and stability control of the invariant shape for mixed electromagnetic formation, which are the key elements for such mixed formation design and control. Naturally, the original invariant shapes are designed under some special conditions about the formation spatial geometry and the magnetic moments of each electromagnetic satellite. However, for the new mixed formation the magnetic moment of the disabled satellite is given, whether a proper invariant shape with constant actuation exist and whether the invariant shape is stable remains crucial issues to the follow-up operations. Finally, numerical simulation is presented to verify the feasibility and validity of the proposed contactless on-orbit rescue scheme.