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TEATHER-LESS SPACECRAFT DEORBIT SYSTEM USING LORENTZ FORCE

Abstract

Deorbiting procedures for spacecraft are an increasing priority in low Earth orbit. New techniques are needed to ensure that satellites can be disposed of quickly and safely at the end of their lifecycle to prevent accumulation of space debris and possible collision between orbiting objects. As satellites are becoming more popular and inexpensive, there is a pressing need for innovative techniques and new deorbiting mechanisms. This paper proposes a novel deorbiting technique using the resulting Lorentz force generated by the interaction of a quickly moving charged spacecraft and the Earth's natural magnetic field to deorbit a satellite. The proposed technique accomplishes this by purposely inducing a charge to the spacecraft. The charging mechanism will be activated when the spacecraft has reached the end of its useful life. Depending on whether the spacecraft is in a prograde or retrograde orbit, the spacecraft will be charged positively, by discharging electron current using a cathode, or charging the spacecraft negatively by discharging ion current. This concept will be effective in every orbit with a significant radial Lorentz force component. It will be most effective in an equatorial orbit, with effectiveness decreasing as the satellite orbit inclination increases. We will numerically simulate the concept for various categories of orbits, including prograde and retrograde orbits of various inclinations and at various altitudes. We will present estimates of the time required to deorbit a spacecraft of the cubesat class in various orbits as well as assess the potential of applying this technique to larger satellites. Additionally, we will outline the design of the system which will charge the spacecraft, including an assessment of the added risks to the spacecraft. Finally, we will include a discussion of the decay of the induced charge bias of the spacecraft due to spacecraft-plasma interactions.