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SPACE DEBRIS SYMPOSIUM (A6)
Modeling and Risk Analysis (2)

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SUCCESS RATE AND EFFECT OF USING ELECTRODYNAMIC TETHER SYSTEM FOR DE-ORBIT LEO SPACECRAFT

Abstract

The near-Earth orbit debris population will continue to increase in the future due to ongoing space activities, on-orbit explosions, and accidental collisions among resident space debris. In actual, on February 10 at approximately 1656 GMT, the Iridium 33 an Cosmos 2251 communications satellites collided over northern Siberia. The space debris is a hazard not only of future, but also at the moment. For the measurement against debris, commonly mitigation measures, such as limiting post mission orbital lifetimes of satellites to less than 25 years, are adopted. This measurement will slow down the population growth, but will be insufficient to stabilize the environment. To better limit the growth of the future debris population, the remediation option, actively removing existing large and massive objects from orbit, needs to be considered. In Japan, JAXA has proposed an active debris removal using electro-dynamic tether to reduce large space debris in the low-Earth orbit. The electro-dynamic tether system can generate propulsion usingjust gravity gradient and earth magnetic field. However, tether satellite system must solve two big matters in order to execute the mission success. A tether strand is thin but long enough to have a large area so that it is vulnerable to small particles. This vulnerability might be one of the weakest points of a tether system against orbital debris. In order to overcome the weak point of vulnerability, a double tether system, in which two tether strands are tied together at even intervals to form equally spaced loops, has been suggested as one of the promising candidates. This paper provides a mathematical approach to estimate the survival probability of a double tether system and then apply the approach to evaluate the mission success rate of the active debris removal using electro-dynamic tether that JAXA has proposed. There are two parameters to measure the double tether's performance, number of loops and clearance between tethers. This mathematical approach can be concluded the countermeasure to get enough success rate can be obtained. The other weak point is that the tether satellite has a fear to entangle the other operational spacecraft, because strand is long for the enough propellant using Lorentz force. In order to carry out tether system, to research the effect of system against the other operational spacecraft must be simulated. This paper provides a simulation of tether satellite's impact probability to the other spacecraft and aims to propose the measurement for mission success.