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PROPOSAL OF A NOVEL SOLAR POWER SATELLITE IN THE ATTITUDE STABILIZATION SCHEME BASED ON GRAVITY GRADIENT

Abstract

Solar power satellite (SPS) that generates electricity of several GW in space in support of Responsible Space for Sustainability, has huge weight and sizes beyond conventional space systems. So far, the Reference System by NASA was best studied for the sake of system realization, but needed too much propulsion to keep the attitude as the structure was perpendicular to the earth's gravitation. Chinese SPS with plural solar panels can solve the problem of a single-failure point of a rotary joint, but may need large propulsion. The Japanese tethered satellite with gravity-gradient stabilization can simplify the attitude control, but cannot always point solar panels to the Sun. We propose a novel structure of an SPS that utilizes the gravity-gradient stabilization scheme, and always points the solar panels to the Sun. The satellite includes a long solar panel that is supported by a long framework parallel to the direction of the earth's gravitation. The solar panel has a rotation axis perpendicular to the equatorial plane. The mechanical design of the proposed SPS is carried out. The attitude control is studied to compare the proposed system and Reference System using simplified models. The moment around the gravity center of the both systems is formulated as follows: for the proposed system: (sin K / r2) (- L/r) , for Reference System: (sin K / r2) (+ L/r), where K = G Me Mh, G is the gravitation constant, Me and 2Mh are the mass of the earth and a satellite, respectively, r is the distance between the two masses, L is the length of a structure, and is an angular perturbation. Therefore, a perturbation to satellite attitude is suppressed in the proposed system, but is increased in Reference System. Solar wind constantly hits the solar panel owing to the well-designed rotation axis in both systems. With longitudinal imbalance in structure, the proposed system tends to rotate in the equatorial plane, but Reference System to tumble on the equatorial plane. In conclusion, it was shown that the proposed SPS is beneficial to simplify the attitude control to lessen the propulsion and to eventually extend the life. Electricity can be always generated. As another advantage, if a single panel is replaced with plural panels and rotary joints, a single-failure point of a rotary joint can be solved.