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SYNTHESIS OF THE OPTIMAL CONTROL OF SPACECRAFT WITH AIR-BREATHING ELECTRIC PROPULSION IN ORBITS WITH ULTRA-LOW PERIGEE IN VIEW OF DEPENDENCE OF THE ENGINE EFFICIENCY ON ANGLE OF ATTACK

Abstract

Last years the interest in using ultra low Earth orbits with a perigee altitude of 150-200 km is significantly intensified. One of the efficient ways to compensate the aerodynamic drag at these altitudes is the installation of air-breathing electric propulsion (ABEP), using ambient atmosphere gases as a propellant.

Problems of long-term existence of spacecraft (SC) in orbits with ultra-low perigee and changing the orbital parameters by means of ABEP are considered. The ABEP efficiency depends essentially on an angle of attack due to varying the gas flow through the air intake and descending the relative gas concentration in the ionization chamber.

The optimal control is determined by solving the problem on the conditional maximum of the local (at the current point) impact of the perturbing acceleration on the functional, assuming the perturbations' smallness compared to gravity. In comparison with previous investigations the essential factor of dependency of ABEP thrust efficiency on the angle of attack is taken in account.

An approximate synthesis of the optimal ABEP thrust vector and SC orientation is obtained. The analytical results are confirmed by the mathematical simulation of SC flight with ABEP in view of significant variations of ionosphere density and composition due to solar activity and inhomogeneity of the gravitational field.