Paper ID: 56003
student

Space Transportation (6)
Space Transportation (1) (1)

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SPACECRAFT WITH HELIOROTOR SOLAR SAIL FOR INTERPLANETARY FLIGHTS

Abstract

This project presents the work of a student team, developing a nanosatellite, capable of independently changing its trajectory from geocentric to interplanetary using the solar sail, conduct research and transmit data to Earth. The satellite classified as a CubeSat 6U spacecraft with two solar sail blades, extended by centrifugal forces. One side of the sail is light reflecting and the other is light absorbing. The spacecraft does not have a movable hinge at the joint of the sail with the hull, therefore, in the process of controlling the thrust vector according to the method, orienting one or the other side of the sail towards the Sun, the whole structure turns over. The unwinding of the apparatus around the axis of rotation is carried out using two jet engines of the type resistojet. The advantage of this method is that it saves the life and size of the battery and the working fluid of the jet engine during its operation, as well as the fact that jet engines do not affect the deployable sail design. For the flight using a solar sail from the Earth's orbit to the take-off trajectory, are used control laws and trajectories, where the direction of the force vector coincides with the trajectory plane, on witch gravitating center is located on. However, such flight paths are rather difficult to implement using the reorientation method. That is the reason why in this project it was proposed to fly with this type of solar sail along a trajectory, whose orbit is perpendicular to the direction of the sun's rays and does not coincide with the attracting center. For half of the orbital period in such an orbit, the vessel orientates the sail with its reflecting side to the Sun, and the other half - the light absorbing side. As a result, the orbit is not only shifted relative to the attracting center, but also rotated. Orbital motion is an analogue of parametric oscillations and such a system can enter a resonance state. Numerical and needed time calculations were made for a flight with reference circular geocentric orbit until the radius vector reaches a value that coincides with the distance between the Earth and the Moon at different solar sail sizes. The calculations took into consideration the annual motion of the Earth around the Sun, as well as the attraction of the Moon.