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CHOICE OF DESIGN PARAMETERS OF A CUBESAT 6U FOR PROVIDING THREE-AXIS PASSIVE STABILIZATION

Abstract

In this work, a study of angular motion dynamics for CubeSat 6U nanosatellites relative to the center of mass when moving in a low circular orbit under the influence of aerodynamic and gravitational moments was carried out in a probabilistic statement. Unlike the CubeSat 1U-3U NS, the CubeSat 6U NS has three different linear dimensions, and, consequently, the expression for the aerodynamic angular acceleration is also different. In addition, most CubeSat 1U-3U NS are dynamically symmetric or have small differences in transverse moments of inertia, while CubeSat 6U NS are dynamically asymmetric, which can be used to provide passive three-axis stabilization. A classification of three-axis passive stabilization systems for CubeSat 6U nanosatellites flying in a circular is proposed: aerodynamic-gravitational, gravitational and gravitational-aerodynamic. Altitude ranges for each type of passive stabilization are identified, due to the predominant influence of a certain type of external force moments. Analytical expressions of the maximum angle values distribution functions are obtained for a nanosatellite axes deviation from the required directions for uniform distribution and Rayleigh distribution of component values of the initial angular velocity vector. Formulas are derived and nomograms are plotted for selecting the design parameters (static stability margin, moments of inertia) which ensure the required attitude with the specified probability in circular orbits. Verification calculations based on the spatial model of the nanosatellite's motion have confirmed the validity of the proposed solutions. The results obtained can be useful for developers of CubeSat 6U type nanosatellites, since the choice of design parameters makes it possible to ensure the required orientation of the nanosatellite while minimizing energy costs for its maintenance after quenching the acquired initial kinetic moment after separation. This work was accomplished in the framework of Project no. 0777-2020-0018, which provided financial support to the winners of the competition among scientific laboratories of educational institutions under the auspices of the Ministry of Education and Science of Russia.