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Author: Dr. Vera Mayorova
Bauman Moscow State Technical University, Russian Federation, victoria.mayorova@gmail.com

Dr. Georgy Shcheglov
Bauman Moscow State Technical University, Russian Federation, h15r@yandex.ru
Mr. Mihail Stognii
Bauman Moscow State Technical University, Russian Federation, mihael199617@yandex.ru

SIMULATION OF THE DYNAMICS OF LARGE SPACE DEBRIS OBJECT GRIPPING BY ONE FLEXIBLE TELESCOPIC ROBOTIC ARM

Abstract

Removing space debris from Earth orbits is one of the important challenges facing the international space community today. One effective way to solve this problem, namely to eliminate the potential source of space debris fragments that can trigger the Kessler effect, is to deorbit large-sized space debris objects (SDO) using an active spacecraft. The presented work is a continuation of research aimed at the development of a spacecraft for the removal of a series of objects from LEO, such as the second stages of Zenit launch vehicles with a mass of about 9,000 kg and the following orbital parameters: inclination - about 71 degrees, semi-major axis - about 7,000 km and eccentricity - about 0.003. In previous papers, the ballistic scheme, the principle of operation of the spacecraft, as well as its structural and layout scheme were considered in detail. The maximum mass of a spacecraft equipped with 12 thruster de-orbiting kits is about 15600 kg. The results of modeling the process of capturing the SDO by the nozzle of the rocket engine using one telescopic robotic arm of the spacecraft were also obtained. This made it possible, in the first approximation, to select the design parameters of the robotic arm: stiffness and damping of shock absorbers in the joints as well as the length of the robotic arm, which was about 13 m. This work is devoted to the consideration of an improved model of robot arm, taking into account more details of the dynamic scheme and flexibility of its parts. The dynamic simulation of the object gripping process, were performed in the MSC ADAMS program. Obtained results, allowed to select the design parameters of the robot arm links, to specify the values of the damping system parameters, as well as to assess the performance of the whole system "spacecraft - space debris object" in general during the transient mode of oscillations of two massive elements, connected by a relatively lightweight and flexible beam. As a result of simulation the range of allowable initial angular velocities of the SDO at which its safe capture is possible is also determined.