Paper ID: 57775
oral

18th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Post Mission Disposal and Space Debris Removal (2) (6)

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

ANALYSIS OF THE SPACE DEBRIS OBJECTS NOZZLE CAPTURE DYNAMIC PROCESSED BY A TELESCOPIC ROBOTIC ARM

Abstract

Space debris removal from near-Earth orbits has become one of the widely discussed issues of space exploration today. Deorbiting large-sized space debris objects (SDO) seems to be the most effective way to deal with technogenic pollution of space, since these objects are potential sources of fragments, which may trigger Kessler's effect. According to ballistic calculations, the most energy-efficient approach is to deorbit a group of 10-15 SDOs with the similar orbital inclinations in the course of one mission. The report discusses a disposal spacecraft for the upper stages of Zenit-type launch vehicles with a mass of about 9000 kg from orbits with a semi-major axis of about 7000 km and an eccentricity of about 0.003. The spacecraft has a two-stage configuration: the base spacecraft (BSC) is equipped with small thruster de-orbiting kits (TDK). The BSC is used to fly between the SDOs, rendezvous in orbit, capture the object, install the TDK onto it, orientate and stabilize the SDO before undocking. The TDK is to be installed into the of the main engine nozzle using the BSC "ammo magazine" configuration. TDK is designed to provide SDO deceleration impulse. To capture debris main engine nozzle one docking robotic arm with two telescopic links is used. This allows the maximum similarity to the "probe-and-drogue" docking assembly, where the robotic arm with several degrees of freedom acts as a probe, and the SDO engine nozzle acts as a drogue. The advantage of this configuration is the expanded range of docking initial conditions, since the telescopic arm allows capturing a non-cooperating object rotating at an angular speed of about 10..15 degrees / sec. The report presents the results of MSC ADAMS numerical simulation of the nozzle critical section capture dynamic processed by a telescopic robotic arm. It is shown that, the location of the capture point on the longitudinal axis of the SDO, and using the robotic arm, mounted along the longitudinal axis of the spacecraft, eliminates the eccentricities of the constraint forces and lead to reduction of dynamic loads and disturbing moments. The use of a long robotic arm makes it possible to effectively reduce the angular velocity of the SDO rotation, since the resulting BSC-SDO assembly has a significant moment of inertia. The simulation results enabled determining the rational parameters of stiffness and damping of shock absorbers required for effective damping of BSC-SDO assembly oscillations.