SPACE DEBRIS SYMPOSIUM (A6)
Space Debris Removal Technologies (5)

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ALGORITHM FOR DETERMINATION OF FORCE TRANSMITTED BY PLUME OF ION THRUSTER TO ORBITAL OBJECT USING PHOTO CAMERA

Abstract

Recent modeling studies of the population of objects in Earth orbit have concluded that the space debris (SD) environment in certain regions is currently unstable. Space community are developing the techniques and technologies that have the potential to provide remediation of the near-Earth space environment. One of them is the direct removal of space debris, also known as active debris removal. The ion beam shepherd (IBS) is recently proposed concept for active space debris removal. The IBS is an essentially contactless actuator, which allows modifying the orbit of a SD object (a target) using the momentum transferred to the SD by the ion beam produced by electric propulsion thrusters onboard a nearby spacecraft (the Shepherd). Determination of the force transmitted to a SD object by an ion plume is one of the key problems that arise during the study of the IBS concept. Information about this force is necessary both for the successful implementation of the selected de-orbiting strategy and for relative navigation and control of the flying formation "Shepherd – target." The conventional approach to calculation of the transmitted force is based on the integration of elementary forces over the debris surface exposed to the ion beam and requires precise information about the shape, size, and attitude of the SD. However, it is quite difficult to implement this approach for IBS concept because SD have unknown mass-inertial characteristics, are uncooperative and non-communicative. A different approach is proposed in this paper for solving the problem. The approach allows to calculate the transmitted force using significantly less information about the target, namely only the contour of its central projection on an auxiliary plane. The algorithm of calculation of the transmitted force is developed including determination of the contour of the object projection and total quantity of the ion beam momentum which falls into this contour. Photo camera images are proposed to use for obtaining the target central projection. A generic algorithm of photo processing for calculating of the target contour is presented. The errors of the target contour determination due to displacement of the camera focal point with respect to the vertex of the imaginary

cone of the ion beam are investigated. An algorithm is proposed for correcting the contour errors, which are caused by the displaced photo camera. Numerical calculations illustrating the effectiveness of the approach have been carried out.