

Study on the Process of Detumbling Space Target by Laser

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Abstract : The active removal of space debris and asteroid defense are important issues in human space activities. Both of them need a detumbling process, for almost all space debris and asteroid are in a rotating state, and it's hard and dangerous to capture or remove a target with a relatively high tumbling rate. So it's necessary to find a method to reduce the angular rate first. The laser ablation method is an efficient way to tackle this detumbling problem, for it's a contactless technique and can work at a safe distance. In existing research, a laser rotational control strategy based on the estimation of the instantaneous angular velocity of the target has been presented. But their calculation of control torque produced by a laser, which is very important in detumbling operation, is not accurate enough, for the method they used is only suitable for the plane or regularly shaped target, and they did not consider the influence of irregular shape and the size of the spot. In this paper, based on the triangulation reconstruction of the target surface, we propose a new method to calculate the impulse of the irregularly shaped target under both the covered irradiation and spot irradiation of the laser and verify its accuracy by theoretical formula calculation and impulse measurement experiment. Then we use it to study the process of detumbling cylinder and asteroid by laser. The result shows that the new method is universally practical and has high precision; it will take more than 13.9 hours to stop the rotation of Bennu with $1E+05kJ$ laser pulse energy; the speed of the detumbling process depends on the distance between the spot and the centroid of the target, which can be found an optimal value in every particular case.

Keywords : detumbling, laser ablation drive, space target, space debris remove

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