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SECURING FUTURE EARTH-MOON COMMERCIAL SPACE TRAVELS: SIMULATION OF CAPTURE AND DE-ORBIT PHASES FOR ACTIVE DEBRIS REMOVAL IN NEAR-EARTH ORBITS

Abstract

This proposed research aims to secure future Earth-to-Moon commercial space travels starting from year 2045. To achieve this objective, the identification of objects inducing risks for the mission is a key step whose results are presented in a different paper. The study presented here focuses on the next step: active debris removal. Once the target objects and their orbital region have been identified, a removal process is proposed in order to eliminate the related risks. The current proposal consists in launching a mother satellite into the identified objects' orbital region that corresponds to 600km-800km-altitude range and 82deg/98deg inclination orbits according to the previous results. The mother satellite has a simple cubic shape equipped with six devices (boys). Each boy is released from the satellite and attached to one target object. More precisely, this study focuses on the last step of the removal, by trying to analyze and optimize the final approach, the capture, and the de-orbit phases. To optimize the efficiency of the capture phase, the angular velocity, the attitude and the shape of the target have to be considered and evaluated for a better adequacy of the boy with the object. After its release, the device hits the front side of the target, and according to the impact angle of the device on the target surface, the full adhesion of the boy to the object produces a force that modifies the attitude motion of the target object. To simulate the impact of this adhesive force, the Space Systems Dynamics Laboratory in Kyushu University has developed a complete propagator that associates an orbit propagator to an attitude motion simulator. Indeed, the attitude motion of an object is linked to its orbit motion, due to the mutual coupling effect of orbit perturbations and external torques that change the attitude. Therefore, this propagator allows performing a higher precision estimation for both orbit and attitude motions, which leads to meaningful first results concerning the configuration of the target after contact with the boy. From this estimation, it is possible to evaluate the most adequate point of release for the boy together with the best timing for the release. Then, de-orbit is operated by 10s-impulse boy's thruster burning to perform descent of the target's orbit. To stabilize this operation, this step is also simulated so as to characterize the impact of the thrust on the object's motion and the shape of the descent orbit.