Paper ID: 3804

ASTRODYNAMICS SYMPOSIUM (C1)
Orbital Dynamics (2) (10)

Author: Mr. Brian Kaplinger
Iowa State University, United States

Prof. Bong Wie
United States

ORBITAL DISPERSION SIMULATION OF NEAR-EARTH OBJECTS DEFLECTION/FRAGMENTATION BY NUCLEAR EXPLOSIONS

Abstract

A hovering gravity tractor (GT) in a static equilibrium standoff position requires canted thrusters to avoid plume impingement on the target asteroid surface. Consequently, McInnes [1] has investigated a GT spacecraft flying in a displaced non-Keplerian orbit (also often called a halo orbit) for a possible fuel-efficient way of towing asteroids. However, a GT in a displaced orbit will require a much heavier spacecraft (about 2.8 times heavier than a single hovering GT) if its x-axis location is the same as the standoff distance of a hovering GT. Or it will need to be placed much closer to the target asteroid (at about 59% of the standoff distance of a hovering GT) if it has the same mass as a hovering GT. Despite such drawbacks, a displaced orbit simply allows many GTs for towing a target asteroid. In [2], a system of multiple gravity tractors (MGTs) flying in halo orbits near a target asteroid is proposed as a viable near-term option for deflecting a certain class of near-Earth asteroids such as asteroid 99942 Apophis or other highly porous, rubble-pile asteroids. A system of orbiting MGTs has many advantages over a single hovering gravity tractor. They include: its larger total ΔV capability, multi-spacecraft redundancy, and mission design flexibility with smaller satellites equipped with lower-risk propulsion systems. In this paper, we further explore the practical feasibility of such MGTs by investigating the halo orbit insertion and stationkeeping control problems of MGTs near a very irregular shaped asteroid. A vision-based guidance and navigation system provides an autonomous rendezvous with a target asteroid and insert a gravity tractor at a given position with a given velocity to initiate its orbiting phase. This paper presents the preliminary GNC design and simulation results for multiple gravity tractors near a very irregular shaped asteroid.

[1] McInnes, C. R., "Near Earth Object Orbit Modification Using Gravitational Coupling," Journal of Guidance, Control, and Dynamics, Vol. 30, No. 3, 2007.

[2] Wie, B., "Dynamics and Control of Gravity Tractor Spacecraft for Asteroid Deflection," Journal of Guidance, Control, and Dynamics, Vol. 31, No. 5, 2008.