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PROPOSED DESIGN OF A MICROSPACE MISSION FOR NEAR-EARTH ASTEROID MINING SURVEY AND TRACKING

Abstract

Terrestrial mining is a multistage process, which mitigates risk and cost by beginning with systematic prospecting in the search for prime locations. Asteroid mining can follow a similar approach, using dedicated prospecting missions to evaluate the presence of volatiles and rare-Earth metals in potential targets. Furthermore, there is a need to provide high-fidelity orbit determination of near-Earth asteroids for Earth collision hazard assessment, the importance of which was underlined by the February 2013 Chelyabinsk incident. Accurate asteroid characterization and tracking objectives are best realized with in-situ measurements performed by probes stationed at asteroids of interest. Traditional deep-space missions to each of dozens of target candidates would be a prohibitively expensive endeavor, however, by following a microspace design approach, a cost-effective asteroid rendezvous mission becomes feasible. Preliminary analysis shows that a microsatellite mission is capable of targeting these near-Earth asteroids. The conceptual framework discussed herein provides a low-cost, low-risk alternative to traditional deep-space programs that would be capable of determining key characteristics of target asteroids whilst providing accurate tracking for Earth collision hazard assessment.

In this proposed design, two identical Microsatellite for Asteroid Tracking and Surveyance (MATS) probes would be carried on a solar sail mothership and jettisoned at individual target asteroids. The mothership design is proposed to use existing solar sail technology while the probe design leverages the successful heritage of UTIAS/SFL's Generic Nanosatellite Bus, such that low cost and rapid development is achievable. Each MATS probe will begin to evaluate various properties of the asteroid on arrival, including mass, size, shape, and spin rate. For this purpose, each probe carries narrow and wide field of view imagers, a LIDAR system, and a propulsion system, as mass estimates are made via sequential and controlled fly-bys of the target asteroid. A discussion is provided on the operations and capabilities of

the payload suite onboard each probe. This paper also highlights the major challenges experienced when adapting the microspace approach to suit a deep-space mission, with focus on the systematic conflicts between communications, power, structures, and thermal subsystems. This preliminary concept shows a feasible approach for deep space missions by following a microspace design, and proposes that an organization with sufficient interest could realize asteroid prospecting at a low cost.