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ENEA: CHARACTERIZATION OF NEAR EARTH OBJECTS THROUGH THE DEVELOPMENT OF AN ASTEROID HOPPING MISSION

Abstract

The Exploration of Near Earth Asteroids (ENEA) is a space mission concept developed by a team of eleven MSc students from Politecnico di Milano over five months. ENEA aims to approach three Near Earth Asteroids (NEAs), of particular interest to better understand the Solar System's formation and evolution. Specifically, it intends to determine the gravel size and surface composition of 2006HZ51 and 2004QD14 during flybys and map small-scale features, and the internal structure of 2000SG344, by rendezvous. The latter is a potentially hazardous asteroid as it ranks fourth on ESA's risk list for Earth collisions, making it a great candidate for a more in-depth study. The targeted asteroids vary significantly, with diameters ranging from only 40m to 400m and orbit with eccentricities and inclinations from 0.06 to 0.45 and 0.11deg to 12.4deg, respectively, presenting unique challenges for mission analysis design. Starting from state-of-the-art research and statistical studies, a trade-off between different architectures was performed to limit the available solutions regarding the number of spacecraft and propulsion. Given the characteristics of the small objects under study, a thorough analysis of the payloads was performed to comprehend their effect on the mission design. Using the concurrent engineering methodology, with each student in charge of one subsystem, the mission development was addressed in an iterative process to enforce subsystem interaction and cooperation. A common design model, guided by mission objectives and requirements, led to the proposal of a singular spacecraft. ENEA would begin with the first interplanetary leg to reach 2006HZ51; the spacecraft would then enter the second transfer leg to 2004QD14. The two NEAs would be flown by while scientific data is retrieved. After the third interplanetary transfer, two years after launch, the spacecraft would rendezvous with 2000SG344. The last and smallest NEA would be studied in two stages: in the first one, the spacecraft would map the surface of the target ranging from 100km to 500m of distance from it, while in the second one, it would perform a radio science experiment on a quiescent terminator orbit at 120m of altitude. Lastly, the spacecraft would be set to crash into 2000SG344 or proceed to a graveyard orbit in compliance with Planetary Protection Guidelines. The

paper presents the subsystem specifications, mission architecture, criticalities and technology needed to improve the mission concept. Despite the stringent constraints and high uncertainties, the ENEA design has proven to produce feasible results in achieving the scientific requirements.