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ARTEMIS: A COMPLETE MISSION ARCHITECTURE TO BRIDGE THE GAP BETWEEN HUMANITY AND NEAR-EARTH ASTEROIDS

Abstract

Asteroid retrieval missions have recently attracted increasing interest from the community and could provide opportunities for scientific exploration, resource utilisation and even the development of planetary defence strategies. This paper summarises the results of a 6-month MSc group project at Cranfield

University (developed by a team of 14 Astronautics & Space Engineering students). An overall system design is proposed for a technology demonstrator mission to move a near-Earth asteroid into an easily accessible location where it could be further explored by future missions. The target final orbit is a halo M1 orbit around the Lagrange point (L2) on the Sun-Earth system. ARTEMIS (Asteroid Retrieval Technology Mission) abides by ESA's constraints for a Large (L) mission call: realised in only one launch with Ariane 64, an operational duration of less than 15 years and a cost at completion of at most 1100 M euros.

The proposed mission combines the design of optimal trajectories, employs advanced solar electric propulsion and introduces a befitting level of spacecraft autonomy. The target is the 2006RH120 asteroid, with an approximate diameter of 6.5 m and mass of roughly 350 tons. To refine existing data, the ARROW CubeSat mission is to be launched a year prior to the main mission to probe the asteroid via a fly-by. ARROW will provide valuable information, such as the asteroid's spin rate, rotational axis and better mass estimate, increasing the overall chance of mission success. The main mission will then capture and secure the asteroid using a mechanism of arm-like booms with xenon-filled vectran "bags". To allow for proper adaptability to the asteroid's shape and mass distribution, as well as to preserve the asteroid unaltered, the mechanism is fully contained in multi-layer insulator fabric that encapsulates the asteroid.

The paper concludes that such a mission is feasible, and summarises the design process of the final overall mission architecture. It also examines the practicality of the suggested design for future missions such as space debris removal or its ability to retrieve celestial bodies with variable mass and shape. Proper adaptation of the design could allow for retrieval of smaller objects (and of larger objects as well, if Ariane's size constraint is bypassed). The future implementation of this mission may further the understanding of the origin of the solar system and act as a catalyst to a new celestial body exploitation industry.