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NANOSATELLITE FORMATION FLYING TO ENHANCE SCIENCE IN BINARY ASTEROID ENVIRONMENT

Abstract

Nano satellites are becoming more and more attractive even in planetary exploration. They have evident limitations in accomplishing interplanetary transfers by their own, but they add flexibility to the operational mission if they are thought to be the opportunity to distribute sensors in different locations as soon as the main platform arrives at the target planet. A fleet of nanosatellites, equipped either with identical or different scientific payloads can be released at the end of the interplanetary transfer to support the main probe science data collection or to add more environmental data retrieval, making the mission enhanced. Moreover, they can be released to get through harsh and dangerous environments –such as planetary ejecta and aggressive atmosphere – as scouts, preserving the safety of the main vehicle while acquiring scientifically interesting data the collection of which with a single classic size probe, would have required a largely expensive design, testing and qualification to ensure any catastrophic risk mitigation. Nano satellite delivery mitigates the risk with numerosity and flexibility. In this perspective the paper presents the study run on a nanosatellite fleet delivery around the Dydimos binary asteroid. The fleet scientific objectives are the binary gravity field reconstruction, any binary natural emission detection, 3D thermogravimetry and imaging. Therefore, a camera, a microbalance and corner cube retroreflectors is the set of selected payloads. Three combinations of 6 1U cubesat have been traded off to get the best science return according to the tight constraints imposed by the nanosatellites available technology, the harsh environment they would operate in and the science requirements. Moreover, the peculiar dynamics the gravitational binary asteroid environment provokes on vehicles flying in its proximity has been analyzed to exploit at the best its properties to minimize the nanosatellite fleet control while maximizing the desired trajectory evolution in time. To this end a precise up to date available model for the Dydimos bodies has been used, including in the well-known 3 body problem modelling, the rotational behavior of each of the asteroids. All beneficial locations around the stable L4 and L5 and unstable L1,2,3 have been traded off to design the most convenient operational lifetime of each fleet architecture. The paper presents in details the results of the three architectures design, highlighting benefits and limitations, with particular attention to nanosatellite formation flying and control by means of the natural three body gravitational environment they would operate in.