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SCIENTIFIC AND TECHNOLOGICAL OBJECTIVES FOR THE NAVCAM PAYLOAD OF HERA'S MILANI CUBESAT TO BINARY ASTEROID DIDYMOS

Abstract

The Asteroid Impact and Deflection Assessment (AIDA) collaboration, consisting of NASA's DART mission and ESA's Hera mission, aims to test the capability of a kinetic impactor to deflect an asteroid. At the end of September 2022, DART successfully impacted the secondary of the binary asteroid system Didymos, called Dimorphos. Hera will rendezvous with the binary system in early 2027, and plans to deploy two CubeSats in close-proximity of the asteroids. Interplanetary CubeSats provide low-cost opportunities to extend the scientific and technological return of exploration missions. Hera's CubeSats, named Milani and Juventas, will be the first nanosatellites to orbit in the close proximity of a small celestial body and to perform scientific and technological operations around a binary asteroid. Milani's main scientific objectives are to characterize the surface and dynamical environment of both bodies, investigate the dust environment around the system, and provide measurements for determining the gravity field using the ISL. Besides the scientific objectives, the Milani mission also aims to achieve several technological objectives related to testing the effect of the environment on key hardware and validating novel navigation algorithms. One of the payloads of Milani is the NavCam, an optical imager which nominally provides navigational information but will also be used to perform scientific investigations and perform experiments related to autonomous navigation around asteroids. This work describes both the scientific investigations the NavCam will perform, and the setup of the autonomous navigation experiment. The main advantage of the investigations performed using the NavCam is the close-proximity to the target during several

phases of the mission. This allows for high resolution surface imaging, shape modelling of both bodies, and investigation into the presence of orbiting particles inside the system. Besides the scientific objectives, the NavCam will also be used for an opportunistic technology demonstration objective regarding the use of autonomous navigation algorithms on-board a CubeSat. Regarding the navigation experiment, the NavCam will provide several observables, e.g. the phase angle and centre of figure of both bodies, which are then used by a navigation filter to provide state estimates of Milani. These results are then compared with ground based orbit determination to estimate the achieved accuracy of the autonomously estimated state. Both the scientific and technological outputs of Milani will aid the main objectives of the Hera mission, and additionally help inform both the scientific payload selection and navigation system design for future CubeSat missions to asteroids.