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LICIACUBE: TECHNICAL CHALLENGES OF PIONEERING DEEP-SPACE EXPLORATION WITH MICRO-SATELLITES

Abstract

In the context of the first planetary defence mission, when the humankind deflected the orbit of an asteroid at 11 million kilometres from Earth, a small satellite has been developed to be the witness of the event. The context is the binary system composed by two asteroids, where the target is Dimorphos, the natural satellite of Didymos. The primary mission was called Double Asteroid Redirection Test (DART), and it was aimed at verifying the possibility to change the orbit of Dimorphos around Didymos, through the kinetic impact of a 500Kg-class probe at more than 6 km/s. To contribute to mission verification and acquire images of the impact and the generated ejecta plume, Argotec, an Italian aerospace company based in Turin and Maryland, has been selected by the Italian space Agency (ASI) for the design and development of LICIACube (Light Italian Cubesat for Imaging of Asteroids) spacecraft, a high reliability 6U probe based on the HAWK small-satellite platform. LICIACube has been launched as DART piggyback in November 2021 and has been deployed 15 days before the impact, in September 2022. LICIACube is the first entirely Italian spacecraft to operate in deep space. Solar panels deployment, orbital manoeuvres, and payloads calibration have been the first operations executed autonomously and successfully by LICIACube soon after release. To acquire historical pictures of the impact and its consequences, the small satellite hosts two optical payloads: a narrow-field panchromatic camera to acquire images from a great distance with a high level of spatial definition, and a wide-field RGB camera for a multicolour analysis of the asteroid environment. Thanks to image recognition and autonomous navigation algorithms installed on LICIACube FERMI OBC, the satellite executed the flyby close to the asteroid, at a safe distance to avoid the debris generated by the impact. More than 600 pictures of Dimorphos have been acquired before and after the impact. All the data collected by the spacecraft have been received at Argotec Mission Control Centre, in Turin, where they have been processed and shared with the scientific community. NASA investigation team confirmed that the impact has successfully deflected the orbit of Dimorphos, thanks to the contribution of LICIACube pictures and different ground-based and space-based telescopes. This paper aims not only at describing the LICIA spacecraft, but also at discussing some challenges overcame during the mission, focussing on Argotec technology at the heart of the HAWK platform.