IAF SPACE EXPLORATION SYMPOSIUM (A3)
Small Bodies Missions and Technologies (Part 1) (4A)

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SMALLSAT MISSION TO DIDYMOS: ENHANCED GNC DESIGN FOR THE LICIA SCIENCE RETURN MAXIMISATION

Abstract

The interest in near earth objects (NEOs) has widely spread among space agencies during the past decades, not only due to the valuable scientific data these objects can provide, but also for the potential hazard they represent for our planet. In particular, to date there still isn't a validated technique to deflect NEOs on a collision course with Earth. The DART mission, developed by NASA, aims at filling this gap, by testing the effectiveness of a kinetic impactor on the binary asteroid system "Didymos". In 2022 the spacecraft will hit the smaller asteroid of the binary system, slowing down the moonlet speed with respect to the larger body, permitting the assessment of the impact effectiveness by ground observation measurements. The impact will also generate a cone of ejected particles, of great interest for current numerical impact models validation, which however will be hardly visible from ground. In this context, a bilateral agreement between NASA and Italian Space Agency (ASI) allowed to embark a 6-units CubeSat on DART, called Light Italian Cubesat for Imaging of Asteroids (LICIA). Deployed before the impact, it will fly by the asteroid at the right distance to observe the ejecta evolution and will also be exploited for observation of the asteroid's side not visible from DART, to help estimating the overall volume. The LICIA spacecraft and mission are being developed by ASI through an italian consortium composed by Istituto Nazionale di Astrofisica (INAF), Università di Bologna (UniBo), Argotec, and Politecnico di Milano (PoliMi), respectively covering the fields of mission science and payload, orbit determination, platform development, and mission analysis. The present paper covers all aspects related to trajectory refinement and attitude guidance and control design. The trajectory modifications are described as result of several mission adjustments from the other subsystems and from operations, with particular emphasis on the sensitivity to the deployment epoch and time windows required for ground tracking. A robustness analysis will confirm the feasibility of each option for the trajectory, and will serve as input for designing

and testing a suitable attitude control technique for the CubeSat. The possibility of storing different gains for a proportional-derivative controller are investigated, to adjust reaction wheels action according to the uncertainties of the trajectory at flyby. Ultimately, the performance of the derived design is evaluated by closing the attitude loop with the centroid-targeting navigation algorithm, and simulating the quality of the images from the payload camera.