SPACE EXPLORATION SYMPOSIUM (A3)
Interactive Presentations (IP)

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GUIDANCE, NAVIGATION AND CONTROL DURING THE LANDER DEPLOYMENT PHASE OF THE ASTEROID IMPACT MISSION (AIM)

Abstract

The Asteroid Impact Mission (AIM) is the european contribution to a joint ESA/NASA mission to investigate the double asteroid system Didymos, a small near-earth Asteroid which will pass within 0.1AU of the Earth in October 2022. Within the scope of this mission, a small ballistic lander (MASCOT-2, a refly of the MASCOT lander currently onboard JAXA's Hayabusa-2) is to be placed on the surface of the Didymos system's moon, a body unofficially known as 'Didymoon'. The challenges surrounding this small body landing originate from the fact that the ballistic lander needs to be released at a very close range (within 200m), and with a very high accuracy (¡1cm/s) relative to an object which is 170m wide and which orbits at ¡3 Radii from the main body. Given the specificities of the Didymos system, as well as the multiple unknowns still left to unveil (the moon's gravity field and exact topography, whether it is or not tidally locked, how eccentric is its orbit...), past approaches proposed for small body landings are but partially applicable here, and the study of a customized approach to the lander deployment was required during the early mission development phases. The goal of this paper is to present the results from this effort, with an emphasis toward the integration of technical and operational aspects, and the application, to the extent possible, of the many lessons learned from both the operational Rosetta mission and from past experience in small body missions. We first present the sequence timeline and the applicable constraints and requirements guiding its design (related to power, communications, autonomy, robustness, observability of MASCOT-2, etc.). Next, we present the trajectory design and the operations timeline which comply with the above-mentioned constraints. We then show each of the Guidance, Navigation and Control algorithms - including the proposed image processing algorithms - that are required to execute

the proposed strategy and achieve the demanding GNC requirements established by the mission design (in particular, the position dispersion targets at MASCOT-2 release). Finally, we present the results obtained from the implementation of the full GNC loop into a high-fidelity simulation tool, which was set up for the purposes of verifying the deployment strategy, and of demonstrating the validity of our approach with respect to this challenging phase of the Asteroid Impact Mission.