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# HIL TESTING OF A VISION-BASED AUTONOMOUS GNC FOR THE AIM MISSION

**Abstract**

In the last years, GMV has led several ESA projects devoted to technology development of autonomous GNC for proximity operations and landing on asteroids. These activities allowed developing vision-based GNC and image processing (IP) algorithms and to test them in several environments to increase their Technology Readiness Level (TRL) in preparation for flight. The validation steps involved tests with pure SW model simulation, up to HW in the Loop (HIL) in representative space environment, in which the GNC SW is running on a LEON2 computer and the IP on an FPGA and images are provided by a COTS camera HW model. The last missing step, which is described in this paper, was to perform HIL testing using a space representative HW camera, which improves testing realism and fidelity and gives further insights into the use of optical navigation, directly applicable to future ESA missions. The camera used for this purpose is the ESA-developed navigation camera NPAL (Navigation for Planetary Approach and Landing) breadboard. HIL validation was performed in two different facilities at GMV premises. As a first step, the HIL optical laboratory was used, where the camera is optically stimulated using images generated by a rendering SW. As a second step, the HIL robotic facility (GMV's platform-ART®) was used, where the camera is stimulated by a real scene of an asteroid mock-up and the kinematic and illumination conditions of the scenario are provided by the motion of robotic arms. The selected scenario for this validation has been the ESA's Asteroid Impact Mission (AIM), targeted at the Didymos binary asteroid system, whose goal is to demonstrate technologies for future asteroid missions, to carry out fundamental asteroid research and to assess the capabilities of a kinetic impactor for planetary defence (this last goal performed in collaboration with NASA-led DART as part of the AIDA mission). One of the main challenges for the AIM mission is the delivery of the MASCOT-2 lander on the surface of the secondary asteroid, requiring a completely autonomous and advanced GNC system, due to the close proximity to the surface. This phase of the AIM mission is particularly suited for testing the GNC system developed so far. The HIL testing results showed that the performances obtained in the HIL tests are consistent with the ones obtained with the previous simulations, thus demonstrating that the GNC and IP system is robust to the use of a space-representative navigation camera.