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GROUND FACILITY FOR VISION BASED PLANETARY LANDING: SETUP AND TESTING

Abstract

This paper presents the setup activities of a new test facility for autonomous optical navigation systems for planetary landing maneuvers, at Politecnico di Milano, Aerospace Science and Technology Department (PoliMi-DAER), to rise the low TRL of such a technology. An even higher level of both absolute and relative precision is going to be required by the next generation of space landing systems, together with a high degree of autonomous navigation, Hazard Detection and Avoidance (HDA) and retargeting capabilities. Vision-Based Navigation is a promising technology to answer the challenge. Due to scarceness of affordable and complete datasets from real missions, most of the vision-based navigation algorithms developed so far rely on synthetic images. The effectiveness of this approach can be confirmed by validation through ground testing, while the overall system performance can be assessed only by connecting the single parts in loop simulations, being the performance of each subsystem affects the others. Therefore, to further enhance the visual navigation system technology readiness level, to set up a facility to run experiments represents the natural step forward. The facility here presented is a Hardware-in-the-Loop environment, to qualify both HW and SW breadboards up to TRL 4, with possible future enhancements to qualify flight models to TRL 5. The first facility exploitation is dealing with HDA maps generations and visual based Terrain Relative Navigation (TRN) verification and validation, already developed and numerically verified in house, for planetary and asteroids landing maneuvers. The facility setup includes a 2.4 meters wide scaled 3D model of the lunar surface, with the role to simulate the terrain geometry and a small mockup of asteroid; a 7DoF Mitsubishi PA-10 robot arm, designed to carry the navigation sensors suite and simulating the lander dynamics; a 5600 K LED lighting system and a dimming system, to provide a fully controllable illumination environment. The visual sensor assembly is mounted on the end effector of the robot that can be moved over simulated lunar terrain in a scaled environment. After briefing introducing the implemented algorithms for HDA, RTN and Adaptive Guidance (AG), the facility implementation, the calibration and functional tests are presented together with the obtained results with the first campaign of validation for the HDA, TRN an AG.