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ARGOS: CALIBRATED FACILITY FOR IMAGE BASED RELATIVE NAVIGATION TECHNOLOGIES ON GROUND VERIFICATION AND TESTING

Abstract

To be accepted for flight, Guidance Navigation and Control (GNC) algorithms require running Hardware/Processor-In-the-Loop (HIL/PIL) tests campaigns in highly representative environment. To support this phase, Politecnico di Milano developed the Advanced Robotics & GNC Optical-based Simulator (ARGOS), an experimental facility to support such tests for image-based GNC algorithms. The facility offers multiple configurations, covering different space mission scenarios, including both natural and artificial targets.

The features offered and scenarios supported by the facility are discussed in the paper, with a deep insight on the activities which led to the current level of precision the hardware infrastructure offers.

ARGOS is equipped with a 2400x2000 mm lunar terrain diorama for planetary landing, satellites and asteroids mock-ups for proximity operations reproduction. The tip of 6 DoF robotic arm hosts the navigation sensors; the arm is controlled so that its tip follows the trajectory risen from the desired spacecraft dynamics in proximity of the target. Two sets of LEDs - manually orientable to tune the illumination conditions with respect to target - complete the infrastructure.

As representative of ARGOS capabilities, the paper discusses the set-ups for testing image based navigation according to two currently relevant scenarios: a Moon landing and a Space Debris inspecting and flying around. To be properly employed, the facility requires to be calibrated. This paper proposes a vision-based calibration procedure consisting in reconstructing a dense point-cloud of the target for obtaining a ground truth with the needed accuracy, possibly overcoming the issues related with manufacturing errors. Another approach is also considered, i.e. exploiting the ground truth available prior to manufacturing. The accuracy obtained with the two approaches is here discussed, highlighting benefits and limitations. Finally, an imaging campaign for testing the navigation algorithm is conducted, retrieving the ground truth camera pose by means of optical markers. The obtained images are compared to the corresponding synthetic images and employed for the algorithm testing.

Results are critically presented in the paper, confirming the adequacy to adopt the proposed technique to successfully calibrate the facility with the required level of accuracy for a broad set of applications.