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3D RECONSTRUCTION OF A SPACE DEBRIS FROM IN SITU INSPECTION EXPLOITING CUBESATS

Abstract

Active Debris Removal and On-Orbit Servicing missions have become of high importance with the exponential increase of the space debris population. The success rate of those missions depends on the level of knowledge of the target geometry and dynamic conditions. Hence, the inspection of the target becomes of critical relevance. In the last decades, some inspection missions have been performed employing satellites belonging to different classes. Among all, small satellites, like CubeSats, have been proven to be a worthwhile solution due to their low cost and fast development. This work considers a possible future inspection mission that exploits a set of CubeSats with the objective of inspecting a non-cooperative target (information on the relative pose are not provided) and gathering the information needed to perform the Close Proximity Operations phase safely. The CubeSats fly in formation around the target observing it from multiple points of view at the same time and collecting two-dimensional (2D) RGB images of the non-cooperative target to fully reconstruct its three-dimensional (3D) geometry. This approach ensures full coverage of the target in short time and, consequently, to acquire data in similar conditions from multiples locations. During the inspection phase, optical cameras are used since they are low-cost and low power demanding with respect to other state of art technologies like laser imaging. The relative motion between the inspector and the target is unknown since the tumbling motion of the latter cannot be evaluated a priori in the case of a non-cooperative target. This represents a challenge for the computer vision algorithms since the relative pose between the two bodies is unknown. This work presents the preliminary numerical analyses that have been performed to investigate the problems related to the challenges that the orbital environment presents. A synthetic data set of 2D images has been created to emulate those that can be taken by a camera mounted on a CubeSat in the space environment. Then, the 3D reconstruction is carried out by employing standard computer vision algorithms. Finally, the 3D model obtained from the reconstruction is confronted with the original CAD model used to create the synthetic images.