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EXPERIMENTAL ORBITAL RENDEZVOUS OPERATIONS VIA VISUAL BASED TECHNIQUES

Abstract

Complex space operations, such as rendezvous, on orbit servicing and docking, always require remarkable accuracy and high safety levels. While these maneuvers often relied on human control or supervision, in recent years automation is becoming an urgent need. Visual based techniques show many characteristics that make them an excellent candidate for navigation and guidance, such as: accurate and easily interpretable relative position determination, autonomy and robustness of control laws, and a proven history in space missions. In the effort for assessing full autonomy, ground test campaigns have a key role in determining the actual performance of these systems. In this paper, an experimental testbed for close proximity operations is presented. A free floating platform, equipped with cold gas thrusters is used to perform rendezvous missions with respect to a target body. The first issue to be solved is the target identification via a camera mounted on the chaser platform; the success percentage of different algorithms will be also evaluated taking the limited on board computing resources into account. Once the target is acquired, the performance of the relevant guidance laws for completing the rendezvous operations basically depends on the accuracy of target image attribution, and on the relative position and velocity determination between target and chaser. As for the first issue, it is not uncommon that during the maneuver the target image could be blurred or even exit from the camera field of view. To prevent this behavior, which would lead to a mission sudden stop and restart from the target acquisition phase, the degrees of freedom of the satellite are increased allowing an independent, but coordinated motion of the camera with respect to the hosting platform. This enhanced capability to track the target also reflects in new possibility for the relative position determination issue. An approach is here proposed for exploiting the target image for a dual scope: evaluating the control actions needed to complete the rendezvous and at the same time determine the chaser-target relative velocity and distance, a fundamental measurement for the chaser control. In this way the navigation system of the chaser is reduced to a gyroscope and a camera, but on the other hand a failure or a low performance in the image acquisition and process could lead to poor mission results. The effects of different visual techniques will be therefore analyzed and main advantages and drawbacks will be reported.