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ERMES: EXPERIMENTAL RENDEZVOUS IN MICROGRAVITY ENVIRONMENT STUDY

Abstract

In the last decades the application of small satellites has increased substantially due to their wide use in technological, scientific and commercial domains. The coming of the new space economy has led to the opening of the market to small companies whose technological challenge is to develop miniaturized systems with high reliability and performance. As a result the number of orbiting CubeSats has increased a lot, in fact it has more than tripled over the last few years, so they have become an interesting subject of study. Proximity navigation systems for autonomous small satellites are continuously examined, due to their effectiveness for several applications, e.g. related to on-orbit servicing.

In particular, this paper is concerned with the design and development of a test for an autonomous docking maneuver between CubeSats to be performed on a parabolic flight in order to take advantage of a reduced-gravity environment. The main challenge of the proposed experiment lies in the dimension of the satellites involved, that implies the use of a miniaturized Guidance Navigation and Control system. The GNC system, based on a cold-gas propulsion subsystem and reaction wheels, will be used to perform proximity navigation manoeuvres in order to obtain the required alignment for the interfaces to dock. Similar experiments have already been conducted proving the feasibility and potential of such a technology, for example the University of Padova has a grounded heritage in this field due to other projects and publications about technological demonstrations of autonomous rendezvous. Concerning docking interfaces, two mechanical configurations are considered and will be tested, respectively a probe-drogue and an androgynous one, both developed by the University of Padova in order to be applied on miniaturized

systems.

The development path includes tests in the laboratory for preliminary evaluations concerning the position and attitude control software and the performances of the miniaturized propulsive system, in view of a test in microgravity conditions. Such an experiment will be accomplished during a parabolic flight so as to reproduce the orbital behaviour in the most accurate way possible and to get relevant data. Multiple flights are planned to allow the testing of different configurations separately and repeatedly.

This paper presents a detailed description of the experiment system, the results of the preliminary tests of the propulsive subsystem and the simulations carried out in the laboratory on a frictionless table.