SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Systems and Infrastructures to Implement Future Building Blocks in Space Exploration and Development (2)

Author: Prof. Giovanni B. Palmerini
Sapienza University of Rome, Italy

Dr. Marco Sabatini
Sapienza University of Rome, Italy
Mr. Andrea De Cesaris
Sapienza University of Rome, Italy

ROBOTICS OPERATIONS FROM SMALL SPACEPLANES FOR CUBESATS SERVICING

Abstract

Worldwide success of CubeSat programs promoted these platforms for educational purposes and scientific measurements of the LEO environment. The miniaturization trend supports the improvement of CubeSats' capabilities, and suggests the opportunity – as already attained in case of larger spacecraft - to have in orbit servicing for these smaller platforms. To be noticed that such a servicing should not be focused on the refurbishment, which is likely not worthwhile for these satellites. Instead, servicing will be aimed to recovery samples to be returned to Earth or to re-locate the CubeSats in different orbits. Vehicles intended for such a mission would be unmanned and largely autonomous, with a a precursor represented by the Intermediate Experimental Vehicle (IXV), a 5 meters length, 2 tons mass spaceplane operated by ESA. This paper intends to focus on the robotics related to these in-orbit servicing operations, that strongly differ from the Canadarm-like operations of the Space Shuttle or ISS. The volume of the cargo bay of the spaceplane is minute (even less than 1 cubic meter), so that the length of each link ends up to be quite short and the number of the joints cannot be increased to leav room for payload. The resulting service volume of the arm will be extremely limited, still fitting the scale of the serviced satellite, i.e. the CubeSats. Unfortunately the relative velocity associated with an orbital rendezvous, as well as the performance of the joint motors, do not scale together with the dimensions, so that collision risks and maneuvering should be carefully assessed differently with respect to "standard" space proximity operations. To be more sounding, the present work builds on the activities performed by Sapienza - Università di Roma in the frame of a study on future automatic missions in LEO, funded by the Italian Ministry for Research and led by Thales Alenia Space (SAPERE-STRONG project). This study includes a preliminary design for a small orbital plane, called PRIDE, whose inertia and geometric characteristics have been considered for the present analysis. Specifically, the paper will deal with the accommodation of the robotic arm in PRIDE and with its operations, describing in details the deployment, the grasping and the recovery in a mission involving a CubeSat target. The reference to PRIDE allows to understand the special requirements for the system's mechanics, and to extract issues and considerations that apply in general to all servicing operations involving small orbiting platforms.