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Space Structures II - Development and Verification (Deployable and Dimensionally Stable Structures) (2)

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DEPLOYMENT AND POST GRASPING ISSUES FOR A LIGHT WEIGHT ROBOTIC ARM MOUNTED ON A SMALL SPACE-SERVICES

Abstract

With the end of the shuttle era, NASA turned its attention to facilitate the success of commercial spacecraft for cargo and crew transportation to low-Earth orbit. Aerospace firms such as Blue Origin and SpaceX developed and successfully lunched unmanned space capsules to deliver goods, spare parts and experiments to and from the International Space Station and they are now developing commercial crew programs. In this frame ESA developed and launched an Intermediate eXperimental Vehicle (IXV) to test cutting-edge systems to provide Europe with an independent reentry capability. Of course both US commercial cargos and the European spaceplane could be in the near future used for satellite servicing and disposal missions. On account of this, small and light weight robotic arms, must be developed in the near future to equip this new generation of space cargo systems with the operational capacity to move and/or grasp orbiting objects. This work will focus on the analysis of different issues that may arise when a light-weight robotic arm mounted on a small spaceplane -similar to the ESA-IXV- is employed to grasp a nearby orbiting object. It is well known that a space manipulator, together with its supporting spacecraft, behaves as an unconstrained body. Therefore the motion of any of its parts affects the entire system configuration. This aspect is even more important when the inertia properties of the space-platform are comparable with the ones of the robotic arm and of the payload (once grabbed).In particular the elastic characteristics of the robotic arm will be analyzed as a function of the link dimensions and joint locations. Even though the maneuvers of robotic arms are typically quite slow, in the case of the grasping of uncooperative targets this could not be true, due to the residual velocity and to the gravity gradient forces. The light weight characteristics together with the fast operations may induce undesired elastic oscillations on the links, and consequently transmitted to the overall multibody system. This will result in additional stresses with respect to the ideal all-rigid case, in particular to the joints and the motors of the robotic arm. The present work has been developed by Sapienza-Università di Roma, taking inspiration from the activities performed in the wider framework of the SAPERE-STRONG project, funded by the Italian Ministry for Research and led by Thales-Alenia-Space Italia, focused on the design of a small Italian re-entry vehicle with orbital operations capabilities.