MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Microgravity Sciences Onboard the International Space Station and Beyond - Part 2 (7)

Author: Mr. Andrea Correnti
University of Padua, Italy

Dr. Silvio Cocuzza
CISAS – "G. Colombo" Center of Studies and Activities for Space, University of Padova, Italy

AUGMENTED WORKSPACE OF A MULTI-DOF SPACE MANIPULATOR FOR REACTIONLESS TARGET CAPTURE

Abstract

The importance of capturing operations of free-floating objects by a space robot can be expected to increase in the near future. In particular, the minimization of the dynamic disturbances transferred to the base spacecraft by a space manipulator is an important issue in space missions because it leads to fuel savings of the Attitude Control System and, therefore, to an increased operating life of the system. Recently, an original reaction control method for redundant space manipulators based on Constrained Least Squares has been proposed, which has several advantages with respect to the previous local optimization methods in the literature, such as a simple mathematical formulation, the possibility to use simple least-squares real-time routines for the solution, and the possibility to take into account the joint limits and the joint velocity and acceleration limits of the manipulator. In this paper the proposed reaction control method is used in order to define and study in detail the workspace in which a zero reaction torque can be obtained, defined as the Zero Reaction Workspace. The innovative content of this paper is mainly related to the study of the most important operational parameters which influence the Zero Reaction Workspace, in order to fully exploit it during the operations of a space manipulator. In particular, the dependence of the Zero Reaction Workspace on the end-effector initial position, on the robot initial configuration, and on the end-effector velocity has been studied. Moreover, the study takes into account the influence of some important inertial properties of the system (other than those of the robotic arm) such as the base/arm mass ratio and the payload mass. The presented concepts are demonstrated by means of simulated tests in microgravity environment of a real robot prototype previously tested in microgravity in an ESA Parabolic Flight campaign and then extensively tested in an on ground simulated microgravity test facility.