MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Poster Session (P)

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RECENT ADVANCES IN THE REACTIONLESS CONTROL DURING THE OPERATIONS OF DEXTEROUS SPACE MANIPULATORS

Abstract

In space robotic missions, the reactionless motion of the manipulator is an important requirement in order not to affect the base spacecraft attitude during the operations thus maintaining the communication link with the ground station and in the meantime saving Attitude Control System fuel. This control method can be used in several space robotic missions, such as in satellites refuelling, repairing, servicing, for the removal of space debris, and for the construction of large space structures in orbit. In this paper a recently introduced reaction control method is used in order to study in detail the shape and the main characteristics of the Zero Reaction Workspace, which is the workspace in which a zero reaction torque or force (or weighted combinations) can be transferred to the base spacecraft during the manipulator operations. The innovative content of this paper is mainly related to the study of the most important design and 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 robot degrees of freedom, on the end-effector initial position, on the robot initial configuration, on the robot joint limits, and on the end-effector velocity has been studied. Moreover, the study takes also 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.