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: Dr. Silvio Cocuzza
CISAS – "G. Colombo" Center of Studies and Activities for Space, University of Padova, Italy, silvio.cocuzza@unipd.it

NOVEL IDENTIFICATION METHOD OF THE DYNAMIC PARAMETERS OF A SPACE MANIPULATOR

Abstract

The accurate identification of the dynamic parameters of a space manipulator is an important issue in space robotic missions, because it leads to a more accurate control of the manipulator and to reduced energy consumption of the robot actuators and of the Attitude Control System and, therefore, to an increased system operating life. Indeed, the inaccurate knowledge of the robot dynamic parameters leads to an increased energy consumption of the robot actuators from one side and to undesired dynamic attitude disturbance that needs to be compensated by the Attitude Control System from the other side, thus leading to an undesirable high energy consumption and a related significant decrease of the system operating life. In this paper, a new method for the accurate identification of the dynamic parameters of a space manipulator that is operating in a microgravity environment is proposed by means of force measures transferred to the manipulator basement. A set of convenient trajectories are selected to be used as input for the manipulator, and then the dynamic parameters are computed by inverting the developed kinematic and dynamic models of the manipulator. 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. In particular, different robot models are used leading to different identification methods, either considering or neglecting the compliance of the dynamometer used for the force measurements and the compliance of the robot joints, thus leading to the identification of mass, inertia, and barycentre position of the robot links in the former case, and in addition to the identification of the damping and stiffness of the dynamometer and of the robot joints in the latter case. Simulations are carried out in order to identify the robot dynamic parameters and to demonstrate the proposed concepts, and then the experimental validation of the proposed solutions is carried out by means of a planar three degrees of freedom manipulator, which is fixed to ground by means of a dynamometer in order to measure the reactions, and suspended by means of air-bearings on a granite plane in order to perform tests in simulated microgravity without time constraints.