SPACE SYSTEMS SYMPOSIUM (D1)
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Author: Dr. Isacco Pretto
CISAS – "G. Colombo" Center of Studies and Activities for Space, University of Padova, Italy,
ispretto@infinito.it

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

BASE DYNAMICS COORDINATION OF MULTIPLE SPACECRAFT MOUNTED MANIPULATORS

Abstract

The motion of spacecraft mounted manipulators generates an interaction with the spacecraft dynamics during manoeuvres, while the attitude parameters are actively controlled in order to maintain communication links of the antennas, and the orientation of solar panels and pointing devices. When more manipulators are supported by the same spacecraft, the composition of the base reaction forces and torques generated by each robotic arm can represent an advantage in terms of the resultant dynamic effect. This paper presents original coordination principles that can be used in order to achieve a mutual compensation and minimization of the reaction loads transferred to the base spacecraft. The reaction-tracking concept for a single manipulator is here proposed, aimed at driving the robotic joints in order to realize a desired base reaction profile, and the associated acceleration-level kinematic control is derived. Subsequently, the coordination problem of two separate manipulators is considered, according to different levels of coordination. The first analyzed configuration consists of an operative manipulator, with a second non-operative manipulator in charge of the compensation of the base reactions. Afterwards, the configuration with two manipulators in operative mode is considered, in which the coordination is undertaken thanks to the availability of a kinematic redundancy. Kinematic control schemes are derived for the different operating conditions in terms of pseudoinverse formulations, and the dynamic problems are set in local optimization forms, leading to the definition of constrained least squares problems. Closed form solutions are given at the joint acceleration level, and simulations are provided for a system of two planar manipulators fixed to the same supporting base, in order to validate the proposed concepts and give an insight on their potentials and limits. Experimental tests have been carried out on a three degrees-of-freedom planar robot prototype, suspended by air bearings over a flat granite plane in order to simulate the microgravity environment, and a custom designed load cell provided dynamic measurements of the base reactions.