SYMPOSIUM ON STEPPING STONES TO THE FUTURE: STRATEGIES, ARCHITECTURES, CONCEPTS AND TECHNOLOGIES (D3)
Novel Concepts and Technologies for the Exploration and Utilization of Space (2)

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KEY DESIGN PARAMETERS IN THE BASE REACTION CONTROL OF REDUNDANT SPACE MANIPULATORS

Abstract

The kinematic control of a redundant robotic arm can be realized by means of local optimal inverse kinematic resolutions that drive the end-effector along a desired path, following the realization of optimal joint trajectories. The dynamic interaction with the base is a distinctive attribute of space manipulators, affecting both the inner microgravity environment and the attitude dynamics of the spacecraft. Such an interaction can be handled in different ways, and the local optimal resolution that minimizes the base reactions is here considered, which was recently developed by the authors. In this paper a sensitivity analysis of the performances of the optimization is carried out by means of a Monte Carlo simulation campaign, and the influence of a variation in the inertial and geometrical parameters of the robot with respect to the base reactions minimization is examined. The study on the variation in the manipulator parameters, allows to formulate advantageous considerations both from a control and a design point of view. At first, the presented investigation is useful in order to deal with control issues arising by the change in the system parameters due to the grasping of a payload by the end-effector, which determines an adjustment of the necessary joint torques, and a modification of the resulting base reactions that may not be negligible. Furthermore, the recognition of the most influent variables towards the performances of the kinematic control, produces significant indications in the perspective of the development of stable local kinematic laws with good and regular global behaviour. On the other side, from the design point of view, the parametric study on the variation in the geometric and inertial parameters, around a preliminary conceived layout of the robotic arm, constitutes a valuable tool for the enhancement of the dynamic behaviour of the arm. In the simulation process, a 2D planar manipulator is considered as a test case. The simulator was validated for a modular robot manipulator prototype, tested during an ESA parabolic flight campaign. The reaction forces and torques exerted to the base are analysed, together with the correspondent joint-trajectory solutions.