ASTRODYNAMICS SYMPOSIUM (C1)
Attitude Dynamics (3)

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DYNAMIC CONTROL OF REDUNDANT SPACE MANIPULATORS SUITABLE FOR REAL-TIME APPLICATIONS

Abstract

The control of the reactions exerted on the base spacecraft during manipulator operations is an important issue in space robotics applications, because it leads to reduced energy consumption of the Attitude Control System, thus extending the operating life of the entire system. In this paper a locally optimal reaction control solution for redundant manipulators is presented, which is based on a Constrained Least Squares approach. The solution is then introduced in a more general theory, which comprises the Extended Task-Space and the Task Priority solutions. Moreover, the features of this reaction control technique are compared to those of the Reaction Null-Space solution, with particular attention to the case in which the available degrees of freedom are not to sufficient to obtain a null reaction. The proposed solution exhibits several advantages with respect to the previous solutions proposed in the literature for the reaction control of redundant space manipulators, such as a simple mathematical formulation, the possibility to solve it in real-time by using state of the art routines, and the possibility to take into account the joint limit and the joint velocity and acceleration limits directly inside the solution algorithms. Moreover, the use of the Weighting Method for the solution of the Constrained Least Squares problem leads to two additional advantages: the solution can be easily applied to multicriteria optimization, in which a different weight can be given to each criterion and, in addition, the optimization performance can be enhanced by relaxing the end-effector tracking requirements. The above mentioned favourable characteristics of the proposed solution are demonstrated by simulation, and then experimentally validated by means of a planar redundant manipulator. The manipulator prototype is fixed on ground by means of a dynamometer in order to measure the reactions transferred to ground, and suspended by means of air-bearings in order to compensate the links deflection due to the gravity force, thus performing tests in simulated microgravity.