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VIBRATION CONTROL OF A FLEXIBLE SPACE MANIPULATOR DURING ON ORBIT OPERATIONS

Abstract

Space manipulators are complex systems, composed by robotic arms accommodated on an orbiting platform. They can be used to perform a variety of tasks: launch of satellites; retrieval of spacecraft for inspection, maintenance and repair; movement of cargo; conduct of experiments and so on. Their operating mode requires extreme accuracy and smoothness because of the delicate assembly involved, the risk of potentially destructive collisions, and to the extraordinary environment, . However, in order to respect the mass at launch requirements, manipulators'arms are usually very light and flexible, and their motion involves significant structural vibrations, expecially after a grasping maneouver. In order to fulfill the maneuvers of space robotic systems it is hence necessary to properly model all the forces acting on the space robot.

The model must include the orbital motion, gravity gradient, aerodynamic effects, as well as flexibility of the links and of the joints. The case is furthermore complicated by the fact that the manipulator, together with its supporting spacecraft, is an unconstrained body. Therefore the motion of any of its parts affects the entire system configuration. The governing equations of the dynamics of such robotic systems are highly nonlinear and fully coupled. The present paper aims to design and study different strategies and control devices that could be used to reduce the structural vibrations of a space manipulator with flexible links during its on orbit operations like the grasping and the recovery of a large payload-to-manipulator mass ratio. In particular a recent wave-based -control technique will be compared with an optimized adaptative vibration control via piezo electric devices. Performance of different strategies and algorithms will be also analyzed in terms of control effort, flexible response of the manipulator and computational cost.