Paper ID: 22523
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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures - Dynamics and Microdynamics (3)

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DYNAMIC/CONTROL INTERACTIONS BETWEEN FLEXIBLE ORBITING SPACE-ROBOT DURING GRASPING, DOCKING AND POST-DOCKING MANEUVERS

Abstract

Robotic systems are expected to play an increasingly important role in future space activities, such as repairing, upgrading, refuelling, and re-orbiting spacecraft. These technologies could potentially extend the life of satellites, enhance the capability of space systems, reduce the operation costs, and clean up the increasing space debris. Recent proposals for missions involving the use of space manipulators and/or automated transfer vehicles are presented as a solution for a lot of problems which now affect the procedures and the performance of the in-orbit space systems. Other projects involving space manipulators have been developed by DARPA [1] aiming to demonstrate several satellite servicing operations and technologies including rendez-vous, proximity operations and station-keeping, capture, docking, fluid transfer (specifically, "hydrazine"), and ORU (Orbit Replaceable Unit) transfer. Of course the dynamic coupling between the manipulator and its base mounting flexible solar arrays is very difficult to model. Furthermore the motion planning of a space robots is usually much more complicated than the motion planning of fixed-base manipulators. In this paper first of all the authors present a mixed NE/EL formulation suitable for synthesizing optimal control strategies during the deploying manoeuvres of robotic arms mounted on flexible orbiting platform (i.e the chaser). Then the dynamics and control interactions between the chaser and a target, also considered flexible, will be studied in three different phases: a) the grasping phase where contact forces between the manipulator and the target are evaluated and their effects on the attitude and dynamics of both the spacecraft are analysed; b) the docking phase where the mutual interaction of both the flexibility of the bodies and the control laws are studied; c) a post docking manoeuvre where the two spacecraft move as a single body and the attitude and/or orbiting control laws must take the full coupled full system into account. Several numerical examples will complete the work.

[1] R.B.Friend, "Orbital express program summary and mission overview". Proceedings of SPIE, Sensors and Systems for Space Applications II, pp. 695801–695803 (2008)