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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures II - Development and Verification (Deployable and Dimensionally Stable Structures) (2)

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IMPEDANCE CONTROL OF A MULTI-ARM SPACE ROBOT FOR CAPTURING A NON-COOPERATIVE TARGET

Abstract

Robotic systems are playing a more and more important role in space applications such as construction, assistance and maintenance of on-orbit space structures. Space free-flying robots (SFFRs) are robotic systems made of a platform (which has its own actuators such as thrusters, reaction wheels, etc.) equipped with one or more deployable manipulators. Unlike industrial robots which have their base fixed to the ground, the base of a SFFR is affected by the dynamic reaction forces due to the motion of both the manipulators and the captured target bodies. In order to effectively control a SFFR it is of fundamental importance to model this behavior. The present paper will focus on the issue of maintaining a stable contact between the manipulator's end point (i.e. the end-effector) and a target object after the first contact. Impedance control is a suitable strategy to solve this problem. In this approach the end-effector is controlled in order to make it behave like a mass-spring-damper system regardless of the reaction motion of the base so to absorb the impact energy. It is worth noting that the task to maintain the contact between the end-effector and the target will be carried out without a real grasp in order to reduce the complexity of the mechanical-structural design of the system.

The usual approach consists in considering a point mass target and one-dimensional contact dynamics; however, the contact between the chaser and the target could generate a perturbation on the attitude of the target. On account of this, in the present work a rigid body target and a two-dimensional contact dynamics will be considered. Furthermore, different configurations of the SFFR (one manipulator vs. two manipulators) and their effectiveness will be analyzed. The performance of the proposed control architecture will be evaluated by means of a co-simulation involving the MSC Adams multi-body code (for describing the dynamics of the space robot and target) together with SIMULINK (for the determination of the control actions). The co-simulation is a particularly useful tool to implement robust control applied on detailed dynamic systems. Of course, since the mechanical parameters used to model the contact phase between two bodies are not always known a priori, the controller must be robust enough to overcome this problem. Different control algorithms will be presented and several numerical results complete the work.