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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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PARAMETRIC ANALYSIS OF A CONTROLLED DEPLOYABLE SPACE MANIPULATOR USED FOR CAPTURING A NON-COOPERATIVE SATELLITE

Abstract

In the near future robotic systems will be playing an increasingly important role in space applications such as repairing, refueling, re-orbiting spacecraft and cleaning up the increasing amount of space debris. Space Manipulator Systems (SMSs) are robotic systems made of a bus (which has its own actuators such as thrusters and reaction wheels) equipped with one or more deployable arms. The present paper focuses on the issue of maintaining a stable first contact between the arms terminal parts (i.e. the end-effectors) and a non-cooperative target satellite, before the actual grasp is performed. The selected approach is a modified version of the Impedance Control algorithm, in which 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. Attention is given to developing a parametric analysis of a deployable multi-link manipulator analyzing the effects of variations in the number of links, links geometric properties and configuration, end-effector layout and control gains values on the operational range of the manipulator itself. The number of arms the SMS is equipped with surely affects the complexity and reliability level of the entire system and is a relevant parameter that is taken into consideration as well. An optimization of the overall system is in this way achieved. The effects of non-modeled dynamics in control determination such as arms joint friction and flexibility, structural flexibility concerning the manipulator and target satellite appendages are evaluated as well and their impact on control effectiveness is analyzed. The performance of the proposed control architecture and the parametric analysis are studied by means of a co-simulation involving the MSC Adams multibody code (for describing the dynamics of the space robot and target) together with Simulink (for the determination of the control actions). The co-simulation has proved itself being a particularly useful tool to implement robust control applied to detailed dynamic systems giving accurate information about the system dynamics and the opportunity to choose the complexity level of the model the control determination is based upon.