ASTRODYNAMICS SYMPOSIUM (C1)
Multibody Dynamics (8)

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PERFORMANCE ANALYSIS OF LINEAR AND NONLINEAR CONTROL STRATEGIES FOR FLEXIBLE SPACE MANIPULATORS

Abstract

The dynamics of a flexible space manipulator is highly coupled and complex, since it depends on orbital forces and perturbations, on orbital torques (gravity gradient and aerodynamic disturbance) and on the flexible behaviour of the links. A fully nonlinear model for a multibody system composed by a generic number of flexible links, suitable for an efficient numerical simulation, is detailed and implemented. Once the dynamics of interest has been assessed, dedicated control strategies can be implemented, tested, and then compared in order to define their relevant performance. Required total power, maximum torque level, maximum flexible oscillations, computational cost are considered in defining performance index.

Given the complexity of the system, the design of the control laws needed to achieve the manipulator goal is not a trivial task. Two approaches are followed to control the multibody system: (i) a proper nonlinear regulator, in which the control actions are based on the fully nonlinear dynamics of the system; (ii) a linear controller, based on a simplified and linearized model of the dynamics. Both linear and non linear control techniques are implemented and applied to the complete non linear dynamics.

Concerning nonlinear approach, a FLT (Feedback Linearization Technique) is considered: thanks to a nonlinear model of the multibody dynamics, the regulator acts both for cancelling the nonlinearities of the system and for introducing a linear compensator to achieve the desired output.

Regarding the linear approach, a robust control of the system using both the LQR and H-infinity is applied to the space manipulator. In this way the nonlinear system is controlled by means of well known linear regulators, which are evaluated and periodically updated according to the reference trajectory.

Robustness of the controllers will be investigated by considering uncertainties regarding both the parameters describing external environment, and the plant physical characteristics. The behaviour of the proposed regulators is in general deeply affected by the reliability of the dynamic model which they take into account: the decrease in the performance is analysed as a function of the mismatch of this internal model with respect to the actual space manipulator dynamics.