

DESIGN OF RIGID-FLEXIBLE SATELLITE CONTROL USING THE SDRE METHOD

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Keywords: nonlinear control law, rigid-flexible satellite, SDRE method

Abstract

Complex space missions involving large angle maneuvers and rapid attitude control, require new non-linear control techniques to design the Satellite Control System (SCS) in order to have reliability and adequate performance. In that context, in this paper one investigates a new SCS technique based on the State Dependent Riccati Equation (SDRE) methodology which can be considered as an adaptive form of the Linear Quadratic Regulator (LQR) allowing to control of systems with nonlinear dynamics. To do this, a nonlinear mathematical model of a flexible rotatory beam is built through the Lagrangian formulation which can represent a rigid-flexible satellite. The flexible displacement is modelled using the assumed modes theory and a structural damping is added applying the Rayleigh technique. After that, one investigates the influence of the nonlinear terms in the rigid-flexible model. The SDRE controller objectives are to control the hub angular position and simultaneously to damp the flexible displacements. A computational procedure is developed which allows drawing a performance map of the system showing all SDRE reachable performances. Using this control algorithm, one can obtain the Pareto's border representing the set of optimal performances. On the other hand, analyzing the influence of the weight matrixes terms, it is shown that it is possible to get the Pareto's border performances using only a few terms of the SDRE weight matrixes. On the basis of this analysis, a control law enabling to get weight matrixes' values as a function of a required performance is developed. Last of all, state dependent weight matrixes are used to show that they can improve the system performance. Based on the results, it turned out that the SDRE's performance is better than the LQR's one, not only because it can deal with nonlinearities, but also because its design is more flexible and permits to control the rigid-flexible satellite in the same time interval and spending less energy.