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DYNAMIC MODELING AND ROBUST CONTROL FOR A FREE-FLYING FLEXIBLE-LINK AND FLEXIBLE-JOINT SPACE MANIPULATOR WITH AN ELASTIC BASE

Abstract

Dynamic modelling and robust control of a free-flying flexible-link flexible-joint space manipulator with an elastic base are investigated. In this system there are unknown but bounded external disturbances and parameters. First the dynamic model of a free-flying space manipulator with two flexible links, two flexible joints and an elastic base is established by the momentum conservation and the Lagrange equations. Second based on singular perturbation approach and choosing appropriate local coordinate frame, the interactions of rigid and flexible motion and the interactions of flexible motion are decoupled, and a singularly perturbed model has been derived. This singularly perturbed model consists of a flexible-joint fast subsystem, a flexible-link elastic-base fast subsystem and a rigid subsystem. Then a reduced-order controller is proposed. This controller consists of a rigid control component and two fast control components. Based on the bound of the uncertainty, a robust control algorithm is proposed for the rigid counterpart. A PD flexible-joint fast subsystem controller stabilizes the elastic vibrations at the joints, and a optimal flexible-link elastic-base fast subsystem controller damps out the vibrations of the flexible link and the elastic base. Numerical simulations show that the base's, the links' and joints' vibrations have been stabilized effectively with good tracking performance.