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OBSERVER-BASED AUGMENTED SINGULAR PERTURBATION ADAPTIVE CONTROL OF FREE-FLOATING FLEXIBLE SPACE MANIPULATOR

Abstract

Singular perturbation adaptive control only with angular position measurements and flexible deformation is designed for free-floating space manipulators with multiple flexible links and unknown physical parameters. The dynamical Lagrange equation is established based on assumed mode technique. A singular perturbation model has been formulated and used for designing a reduced-order controller. This controller consists of a slow control component and a fast control component. High-precision measurements of base attitude and joint displacements and link coordinate are available on flexible space robot manipulators. In contrast, base attitude angular velocity and joint velocity and link coordinate rate measurements which increase the cost are, in many cases, contaminated by noise. A sliding velocity observer based augmented adaptive control law is constructed for the slow counterpart of the flexible manipulator. The fast subsystem controller is designed with the estimated velocity by linear observer to damp out the vibration of the flexible link using optimal Linear Quadratic Regulator (LQR) method. Numerical simulations by undertaking a computer simulation of a two-flexible-link manipulator using the fourth-order Runge–Kutta integration method show that the link vibrations have been stabilized effectively with good observing and good tracking performance. In the meantime it shows that the manipulator inertia parameters, which are assumed to be initially unknown, can be precisely estimated within the first half second of a typical run.