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HYBRID-TRAJECTORY BASED AUGMENTED ADAPTIVE CONTROL OF FREE-FLOATING FLEXIBLE SPACE MANIPULATOR

Abstract

Space robots are built very light in order to save expensive launch energy and to extend the orbit life, which results in considerable link flexibilities. Most of the present works are devoted to space manipulator with only one flexible link. Due to the interactions of rigid and flexible motion and the interactions of flexible motion of the flexible links, controlling space manipulator with multi flexible links is more complex and more challenging than controlling one with only one flexible link. Hybrid-trajectory based augmented adaptive control was addressed for free-floating multi-flexible-link space manipulator with unknown physical parameters and external disturbances. The dynamic model of a free-floating space manipulator with multi flexible links was established by the momentum conservation, the assumed mode technique and the Lagrange equations. Based on singular perturbation approach and choosing appropriate local coordinate frame, the interactions of rigid and flexible motion and the interactions of flexible motion of the flexible links were decoupled, and a slow subsystem and a flexible-link fast subsystem were obtained. To suppress the flexible link vibrations, hybrid trajectories of joints were generated from terminal trajectories by using the virtual force concept. An augmented adaptive controller to the slow subsystem was proposed to track the hybrid trajectories. The hybrid-trajectory based augmented adaptive controller ensures that flexible vibrations of the multi-flexible-links space manipulator are stabilized effectively with good tracking performance. Numerical simulation by undertaking a computer simulation of a two-flexible-link manipulator using the fourth-order Runge–Kutta integration method demonstrated the proposed controller was feasible and effective. In the meantime it showed that the manipulator inertia parameters, which were assumed to be initially unknown, could be precisely estimated within the first half second of a typical run. The virtue of this control scheme is that the linear position, linear velocity, linear acceleration of the base needn't be measured directly.