IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures - Dynamics and Microdynamics (3)

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TIME-DELAY ESTIMATION BASED ADAPTIVE IMPEDANCE CONTROL OF A FREE-FLYING SPACE MANIPULATOR'S WIPING A SURFACE

Abstract

The end-effector of the manipulator needs to maintain contact with external environments in course of its on-orbit wiping operation. To protect the manipulator and the object to be cleaned, as well as to ensure the surface to be cleaned effectively, the contact surface pressure and friction need to be maintained their expectations. However, friction has been ignored in course of the previous dynamic modeling, which may affect the surface contact forces' tracking accuracy. Meanwhile, the complex and variable environments make it more difficult to track the desired surface contact forces. Therefore, dynamic modeling and an adaptive impedance control of a free-flying space manipulator's wiping a surface are studied. First, the Lagrange dynamic model of a free-floating space manipulator's wiping operation was derived, in which the contact surface forces were involved. Second, the impedance control model was established based on position constraints and contact forces constraints between the end-effector and the surface. Then, a time-delay estimation based adaptive impedance control was proposed, in which the estimators of the dynamic uncertainties and the damping parameters were adjusted adaptively. Finally, numerical simulations were conducted, in which the desired contact forces were followed perfectly whilst the expected trajectories were asymptotically tracked.