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ADAPTIVE NONLINEAR OBSERVER-BASED SLIDING MODE CONTROL FOR A FLEXIBLE-BASE TWO-FLEXIBLE-LINK AND TWO-FLEXIBLE-JOINT SPACE ROBOT CAPTURING NON COOPERATIVE SATELLITE

Abstract

With the deepening of space exploration, the number of satellites launched into space each year continues to increase. This meets the needs of human production and life, but faces various problems caused by satellite failure or malfunction. Timely repair of malfunctioning satellites and cleanup of orbital junk not only save space development costs but also ensure the proper operation of space technology. In recent years, the space robots that have been put into practical stage can perform the task of capturing non-cooperative satellites better, but their manipulation accuracy is largely limited by the structural flexibility of system bases, links and joints, and the adoption of slow running is time-consuming and labor-intensive, so this paper focuses on the problem of capturing non-cooperative spacecraft by flexible-base two-flexible-link and two-flexible-joint (FBFLFJ) space robots and gives a sliding mode control method for motion vibration integration based on adaptive nonlinear observer. First, the dynamics model of FBFLFJ space robot and non-cooperative spacecraft before capture is established according to Lagrange's equation, and the collision impact effect is analyzed. Second, the dynamics model of the combined system after the completion of capture is established, and the model is decomposed into fast and slow subsystems. A new adaptive nonlinear perturbation observer is designed for slow subsystem to estimate the external forces due to unknown constant loads, and the gain of the nonlinear observer is designed using an adaptive technique to extend the applicability of the perturbation observer. And the stability of the observer is verified using Lyapunov function. Then, the virtual force and linear quadratic optimal algorithm are used to suppress the system base, links, and joints multiple vibrations simultaneously, and to realize the stable tracking of the combined system. The simulation results show that the collision impact force affects the stability of the system during the grasping process, and the controller proposed in this paper can not only suppress the multiple flexible vibrations of the system base, links and joints at the same time, but also make the combined system stable in the specified desired state.