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SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Systems and Infrastructures to Implement Future Building Blocks in Space Exploration and Development (2)

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NONSINGULAR FUZZY TERMINAL SLIDING MODE CONTROL BASED ON SINGULAR SUPPRESSION AND ELASTIC VIBRATION SUPPRESSING OF FREE-FLOATING SPACE ROBOT WITH FLEXIBLE JOINTS

Abstract

Space robot system will play more and more important function in future space activities, and its research get the attention of all parties. If ignore the existence of flexible joint in dynamics modeling and designing control method of free-floating space robot, it will be seriously influenced for precision and stability of control system. The dynamics modeling, motion trajectory tracking control design and flexible vibration suppression of free-floating flexible-joints space robot with uncertain parameters is discussed. The system's dynamic equations are established by using the linear momentum conservation, angular momentum conservation and the Lagrange equation. Based on the above results, in order to realize the motion trajectory's asymptotic tracking of the space robot and suppress the elastic vibration caused by the flexible-joint. The system is decomposed into a slow-subsystem and a fast-subsystem using double time scale decomposition of singular perturbation theory. For the slow-subsystem, the fuzzy adaptive nonsingular terminal sliding mode control scheme is designed to achieve the desired motion trajectory's asymptotic tracking. Said control method takes nonsingular terminal sliding mode manifold, and according to fuzzy logic system is employed to adaptively adjust the switching term of output of the controller, consequently, not only conquer the limitation of uncertainties of system that should be known in designing, but also get rid of the disadvantage of sliding mode controller vibration. For the fast-subsystem, a velocity difference feedback controller is proposed to suppress the elastic vibration caused by the flexible-joint, guarantee the stability of the system. In the simulation, a free-floating flexible-joint space robot system with two rigid links and two flexible joints is taken as an example. The simulation results prove the efficiency of the control scheme. This paper work is supported by the National Natural Science Foundation of China (Grant No.11072061), Fujian Provincial Natural Science Foundation (Grant No. 2010J01003).