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DECENTRALIZED ADAPTIVE NEURAL NETWORK STABILIZATION CONTROL AND VIBRATION SUPPRESSION OF FLEXIBLE ROBOT MANIPULATOR DURING CAPTURE A TARGET

Abstract

With deepening research in the field of outer space exploration, the importance of space robot manipulator is increasing. The maintenance of infrastructure, removal of space debris and capturing inactive satellites are the missions of space manipulator. The impact between target and end effector of manipulator is inevitable during space missions. At the same time, the development trend of the future space robot is light weight, high strength and flexibility. Flexibility of space robot manipulator has a very important practical significance. In this paper, we analyze the impact effect of space robot capturing a motion target on orbit, and the vibration control problem about flexible manipulator in post-impact process is discussed. Firstly, the assumed modes method is used to describe the flexible link elastic deformation, with the Lagrangian approach and ignoring the higher order vibration mode, the dynamics model of space robot is derived. Combined the Newton Euler method, the dynamics model of target is derived. Secondly, based on the law of conservation of momentum and the force transferring, the impact dynamics during capture operation is established. The combined system of target and space manipulator is formed in post-impact process. At last, based on the singular perturbation theory, the combined system is decomposed into two subsystems in different time-scale: fast subsystem and slow subsystem. The fast subsystem stands for the flexible vibration of combined system, and the slow subsystem stands for rigid motion of the combined system. A decentralized adaptive neural network control method is designed for the slow subsystem. The stabilization control algorithm of slow subsystem is designed by applying the direct feedback linearization theory and decentralized control method. Introduce neural network to the control algorithm to eliminate external disturbance, compensate the interconnections and system error. A vibration control algorithm of fast subsystem is designed by using linear quadratic regulator (LQR) theory. Superposed the two control algorithms of the slow subsystem and the fast subsystem, a combined control scheme is obtained. The simulation results show that the proposed control scheme is efficient.