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COLLISION DYNAMICS FOR DUAL-ARM SPACE ROBOT CAPTURING A TARGET AND RECURRENT FUZZY NEURAL NETWORK CONTROL FOR CLOSED CHAIN SYSTEM

Abstract

With the increase of human activities in space, the space robot has played a more and more important role. The development of Space technology put forward higher requirements on the performance of the space robot, the dual-arm space robot has movement stability and load ability, will become an important tool in the future space missions. Space station remote manipulator system and its end effector–SPDM put into use, which means that dual arm space robot has been used in the space. Dual–arm system is similar to the upper limbs of primate, which is more advantageous to carry objects, ensure the control accuracy. In the process of space robot to complete various missions, actuators is inevitably impacted by target. Space robot itself is in a state of weightlessness in space, which may lead to large angle rotation is dangerous for the space facilities. For space robot arms grab task, coupling motion relations are between arms and base, make its control design scheme is become more difficult than ground robot. In addition, the existences of dual-arm space robot with closed chain constraint and controller redundancy add the difficulty of control design. In this paper, the impact effect analysis for a dual-arm space robot capturing a satellite and the coordinated stabilization control problem for closed chain system are discussed. At first, the dynamic equations of dual-arm space robot and satellite are obtained by multi-body theory. The response of the dual-arm space robot impacted by the target is analyzed by momentum conservation law; the dynamic evolution process is derived at the same time. Secondly, the recurrent fuzzy neural network control scheme is designed for unstable closed chain system with uncertain system parameter. In order to overcome the effects caused by system parameter perturbation and external disturbance, the recurrent fuzzy neural network is used to approximate the unknown part with H∞ tracking characteristic. Meanwhile, the weighted minimum-norm theory is introduced to distribute torques guarantee that cooperative operation between manipulators. At last, numerical examples simulate the process of collision and the efficiency of the control scheme is verified by the simulation results.

Keywords: Dual-arm space robot; Capture target; Closed chain system; Recurrent fuzzy neural network