Paper ID: 23903
student

MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Poster Session (P)

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DYNAMICS MODELING AND RADIAL BASIS FUNCTION NEURAL NETWORK ADAPTIVE CONTROL OF DUAL-ARM FLEXIBLE-JOINT SPACE ROBOT WITH PARAMETER UNKNOWN

Abstract

Space robot system will play more and more important function in future space activities, and its research get the attention of all parties. At present, the study of space robot mostly focused on rigid manipulator or flexible manipulator. But in practical applications, space robot joints often exist flexibility. Like some latest space robot plans from the United States, Japan, and Europe, they have required space robot not only just to do the simple auxiliary on-orbit assembly work for space station large components by tele-robot arm (Canada Arm) , but should have the abilities of satellite's orbit assembly, maintenance, repair, recovery, on-orbit fuel filling, orbit transfer, and space junk debris cleaning. Under such situation, it should be taken into consideration that the influence of articulated joints flexible against control accuracy which was ever been ignored in extensive operation, while now in the design of control system that required by space robot for high precision operation tasks. The dynamic modeling and control algorithm design problems of free-floating dual-arm space robot with normal flexible joints and an uncontrolled base were discussed. With the Lagrangian approach and the linear, angular momentum conversation, the full-controlled dynamic equations of the free-floating dual-arm flexible-joint space robot are analyzed and established. Based on above results, for the case of strong joint flexibility of space robot practical use, mathematical models which been suit for design of control system are established by using a joint flexibility compensation controller, combined with double time scale decomposition of singular perturbation theory. Using said mathematical model, a radial basis function neural network adaptive control algorithm for the slow-subsystem with unknown parameters to track the desired trajectory in joint space is proposed on the premise that the stability of the fast-subsystem is guaranteed. According to Lyapunov Theory, it has been proved the tracing error boundedness of the whole closed-loop system. A planar flexible-joint space robot is simulated to confirm the validity of the presented control algorithm. This paper work is supported by the National Natural Science Foundation of China (Grant No.11372073), Fujian Provincial Natural Science Foundation (Grant No. 2010J01003).