Paper ID: 38295
interactive
student

SPACE SYSTEMS SYMPOSIUM (D1)
Interactive Presentations (IP)

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ANTI-DEAD-ZONE AND FRICTION FOR TWO FLEXIBLE LINKS SPACE ROBOT WITH INTEGRATION OF MOTION AND VIBRATION BASED ON RECURRENT CEREBELLUM MODEL NEURAL NETWORK CONTROL

Abstract

Space robot systems will play an important role in the space projects. The application of space robot systems in outer space can improve astronauts' working efficiency and save on expenses effectively. Because of the flexible space robot has many advantages such as light weight, long arms, heavy load, more and more attention has being paid to the research area of the dynamic analysis and control of flexible space robot. For a space manipulator with two flexible arms, there is not only dynamic coupling among the rigid motion and the flexible vibration, but also coupling relationship between the vibration of two flexible arms. On the other hand, joint torque output dead-zone will affect the tracking error and may cause the limit cycle oscillation, and even lead to control failure, thus the space mission can't be completed. The angle tracking and flexible vibration suppression integrated control for two flexible links free-floating space robot with joint torque output dead-zone, friction and external disturbance are discussed. First of all, the two flexible links are regarded as Euler-Bernoulli beams, and the dynamic equations of the all flexible space manipulator system are derived. Secondly, under the condition of system inertia parameters, dynamic friction parameters and the width of dead-zone is uncertainty, a recurrent cerebellar model articulation controller neural network and an adaptive dead-zone compensator are designed to track the rigid desired trajectory of base and two joints. Thirdly, in order to damp out vibration, conception of virtual control force is used to design hybrid trajectory which integrate both flexible mode and rigid motion and a control scheme based on hybrid trajectory is proposed. The friction double observers is utilized to estimate the unmeasurable internal friction state and the dead-zone precompensator is designed to eliminate the impact of joint torque output dead-zone. The recurrent cerebellar model articulation neural network is applied to approximate uncertainties terms of dynamic equation including friction errors and external disturbances. The dead-zone width and LuGre friction parameters is adjusted by adaptive laws. The hybrid trajectory method not only ensures the robustness of the rigid motion, but also suppresses the vibration of two flexible links actively so as to improve the tracking performance. The Lyapunov theory proves that the filtering error is ultimately uniformly bounded. Finally, the results of computer simulation show the efficiency of the proposed control method.