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NEURAL NETWORK SLIDING MODE CONTROL AND VIBRATION SUPPRESSION OF FLEXIBLE JOINT MANIPULATOR OF THE SPACE STATION WITH FLEXIBLE ARMS

Abstract

The applications of the manipulator of space station are becoming much broader and broader with the continuous and deep exploration of the space. The manipulator of space station will be used in helping or replacing the astronauts to accomplish their space tasks, such as capturing and releasing the satellite, as well as assembling the station. In this way, the manipulator of space station can not only reduce the dangerous situation and the labor intensity for the astronauts, increase the efficiency and quality of their work, but also save the cost of space groping. Therefore, the manipulator of space station, which has broad potential applications, plays an increasingly important role in space activities, and has been a research hot that attracts close attentions from all over the world.

The flexibility of the manipulator of space station system mainly embodies in arm bar of flexible manipulator of the space station and hinge joints that connect with each arm bar. Because of the complexity of the manipulator of space station system structure, previous researchers paid less attention on the system which both have flexible joint and flexible arms. Thus this paper discusses dynamics simulation of flexible joint the manipulator of space station with flexible arms system, motion control algorithm design and hierarchical points order active inhibition problem of arm and joints double flexible vibration that all under the situation of parameter uncertain. According to momentum and moment of momentum conservation relationship, and also based on Lagrange equations, linear torsion spring and hypothesis modal method, we herein deduce system dynamics model. On the base of it, considering about actual situation that each joint hinge has strong flexibility for the manipulator of space station practical application, we herein introduce joint flexible compensation controller and combined with singular perturbation technology to decompose the whole system into motor moment power subsystem and flexible arm subsystem with independent time scale. For motor moment power subsystem, we design moment differential feedback controller to inhibit system elastic vibration which caused by joint flexibility. For flexible arm subsystem, we propose an neural network sliding mode control scheme that based on the concept of virtual force. For using the concept of virtual force, we may achieve the control target that not only tracking expected trajectory, but also inhibiting flexible vibration of flexible arm by only designing a control input. Computer numerical simulation comparison experiment testifies the reliability and availability of this scheme.