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SPACE STATION'S ROBOTIC ARM DURING CAPTURE SATELLITE AND FUZZY NEURAL NETWORK SLIDING MODE CONTROL FOR COMPOUND BODY STABLE MOVEMENT

Abstract

The number of launched spacecraft has progressively increased year by year as the ability to exploit and apply technology in outer space has developed, therefore, great advantages and enormous economic benefits can be gained by on-orbit services through space manipulator. The key points of on-orbit services are the control of autonomous capturing. The space station is the biggest scale spacecraft in human history, which has been representing the most comprehensive, complicated, advanced and integrated level of astronautical technology. It plays an irreplaceable role in many technology areas such as space life science, manned deep space explore, processing of the new materials and so on. In the modular structure of space station assembly process, it is highly dependent upon the space manipulator to transfer function module from the axial lord docking port of node module to radial berthing port of node module. In the extremely harsh space environment, the using of manipulator of the space station for assisting or replacing astronauts in space on orbit capture operation has good prospects. This paper discusses stability control problem for compounded body of space-based robot and target satellite after capturing operation is completed. The dynamical model of the space-based robot system is derived with Lagrange formula, and based on it, coupling momentum and impulse transfer during operation process of space-based robot to capture the target satellite, mathematical models which been suit for the design of control system that for free-floating space-based robot to on-orbit capture floating satellite are established. Using said mathematical model, a nonsingular terminal sliding mode control algorithm based on fuzzy neural network is proposed. The mentioned control algorithm needs neither to parameterize the dynamic equations of the system linearly, nor knows any system parameters. For using self-learning capability of neural network to modify control rules of fuzzy control and membership functions, so that in the identification of system parameter, fuzzy neural network can reduce the number of fuzzy rules, it may be more adapted for practical application of space-based robot system to on-orbit capture. A complete analysis on the stability and the performance are performed by using Lyapunov theory. The correctness and applicability of the control scheme are manifested by simulation and experiment.