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DYNAMICS CONTROL AND VIBRATION SUPPRESSION OF FLEXIBLE DUAL-ARM SPACE ROBOT FOR FACILITY CONSTRUCTION IN LOW GRAVITY ENVIRONMENT

Abstract

Space robots are mainly used to assist astronauts in space missions, especially in building space stations, repairing failed satellites, cleaning up orbital debris, and other important roles. The vibration problems of space robots are influenced by environmental conditions and structural design, which limit their efficiency in performing space missions. The precision assembly of facility construction in low-gravity environments likewise limits the progress of space robots on their missions. Precise collaboration using flexible dual-arm space robots in multiple angles and conditions is the key to achieving precise and efficient space construction tasks. Because the two arms of the flexible dual-arm space robot collaborate, they can each separately or together to complete their work. The division of labor and cooperation can improve the efficiency of space robots. On the other hand, the flexible dual-arm space robot can coordinate the operation of multi-axis movements through the control unit, thus achieving synchronized space construction. The two-armed space robot inherits the advantages of single-armed robot automation, and with high self-regulation as well as learning, it can adapt to the complex and harsh space working environment, and has important application value in the space field. Therefore, this paper investigates the dynamics of a flexible two-arm space robot during the construction of a facility in a low-gravity environment and gives an integrated algorithm for motion control vibration synchronization suppression. Firstly, a flexible two-arm space robot dynamics model in which the base, arm and joints are all flexible was established. Then a reduced-order decoupling of the complex nonlinear rigid-flexible coupled dynamics model is performed to decompose it on different time intervals. A two-arm collaborative motion controller, as well as links flexible vibration suppressors, designed for a slow time range subsystem. The optimal control algorithm to suppress the flexible vibration of the base and joint are designed for the subsystem with fast time range. Finally, simulation experiments are performed using the total controller. The results show that the proposed algorithm enables cooperative control of a flexible dual-arm space robot for facility construction in a low-gravity environment, while suppressing multi-component flexural vibrations present in the system and improving efficiency.