21st IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Post Mission Disposal and Space Debris Removal 1 - SEM (5)

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A NON-SINGULAR FIXED-TIME COMPLIANCE CONTROL OF SPACE ROBOT WITH SDBD CAPTURING DEBRIS OPERATION

Abstract

At present, there is a large amount of debris in space. The existence of space debris greatly wastes the limited space orbit and affects the satellite launch plans of all countries in the world. Using space robots to clean up space debris has great and far-reaching significance, but it also has great challenges. Because space debris has a certain velocity, it is inevitable that the robot will have violent contact and impact in the process of capturing debris. In order to prevent the robot from being damaged by the impact load, a spring-damper buffer device (SDBD) is added to the joints. The SDBD can absorb the energy in the process of contact and impact through the spring, and the damper is used to suppress the flexible vibration generated by the spring. The dynamic modes of dual-arm space robot open-loop system and debris system before capture are established by using Lagrange function based on dissipation theory. Combined with Newton's third law, velocity constraints of capture points and closed-chain geometric constraints, the closed-chain dynamic model of hybrid system after capture is obtained, and the impact effect and impact force are calculated utilize the momentum conservation. In order to improve the efficiency of space robots cleaning up space debris, it is of great research value to carry out fast calm control of the post-capture system. Sliding mode control (SMC) is a stable and effective control strategy due to its simple structure and strong robustness. However, SMC has slow convergence speed and can only keep asymptotic convergence. The chattering problem is also an important reason that restricts its control accuracy. Although the terminal sliding mode control (TSMC) uses a non-linear surface to ensure robustness and fast convergence, the chattering problem has not been solved and may be singular. Based on the above analysis, a non-singular fast sliding mode control (NFSMC) is proposed, which combines the advantages of fast convergence speed and strong robustness of TSMC, as well as chattering resistance of super-twisting sliding mode control (STSMC). The stability of the hybrid system is proved by the Lyapunov theorem. The protection effect of SDBD and the effectiveness of control strategy are verified by numerical simulation. The results show that the maximum impact torque can be reduced by 46.32