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FAST SLIDING MODE VARIABLE STRUCTURE IMPEDANCE CONTROL FOR ON-ORBIT INSERTION AND EXTRACTION OF DUAL ARM SPACE ROBOT

Abstract

As a manned spacecraft operating in low earth orbit for a long time, the space station mostly relies on astronauts to perform complex and precise space operation tasks such as plugging, screwing and handling of components during its operation. Due to the limited operation space, long operation time and high accuracy requirements, when astronauts go out to perform such space operation tasks, they have some problems, such as high cost, low efficiency and high risk. Therefore, it is of great practical significance to use space manipulator to complete such space missions instead of astronauts. The impedance control of the on-orbit insertion and extraction operation of the dual arm space robot is discussed in this paper. Firstly, based on the second kind of Lagrange equation, motion and geometric constraints, as well as the relationship between the manipulator end and the forces of insertion and extraction, the system dynamics model of on orbit insertion and extraction operation process of dual arm space manipulator with uncontrolled carrier position and controlled attitude is established. Secondly, the Jacobian equation of motion is established by using the geometric position relationship of the system; and combined with the principle of impedance control, a second-order linear impedance model is established. Then, based on the above model, the impedance control strategy of space manipulator on-orbit insertion and extraction operation is designed, and a variable structure controller based on fast and nonlinear sliding surface is designed to compensate the dynamic uncertainty. Besides, fuzzy control method is introduced to eliminate chattering of variable structure controller. And in fuzzy controller, the sliding surface and the weight of compensation controller is respectively regard as the input and and output. Since this scheme avoids the introduction of synovial differential signal, which reduces the amount of calculation and makes it easier to be extended to engineering application. Finally, the effectiveness of the proposed control strategy is verified by numerical simulation.