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Space Structures II Development and Verification (Orbital deployable and dimensionally stable structures, including mechanical and robotic systems and subsystems) (2)

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NEW CONFIGURATION OPTIMIZATION ALGORITHM FOR RECONFIGURATION SPACE MANIPULATOR BASED ON GENERALIZED FLEXIBILITY INDEX

Abstract

It is well known that the space manipulator plays a key role in space operations such as the on-orbit assembly and maintenance. Among these manipulators, the reconfigurable space manipulator (RSM) has received much attentions due to its ability to adjust the D-H parameters to meet various operation requirements. Besides, the RSM can perform serial space operations independently, which is in line with future trends in the development of space technology.

To enhance the performance of the RSM, a new configuration optimization algorithm is proposed, which can suboptimize the D-H parameters for different operations in real time. First, the requirements of the common space operations are transformed into that of the workspace of the RSM. Considering that different operations emphasizes different regions in the whole workspace, a Gaussian mixture model with parameters is constructed to express the weight coefficient of each point in the workspace. Therefore, the operation requirements can be characterized by the model parameters, which unifies the subsequent design. Then, a generalized flexibility index of the RSM is defined to calculate the matching degree between the manipulator configuration and the operation requirement. More specifically, the index is the sum of the flexibility index of each point multiplied by its corresponding weight coefficient. To balance the efficiency and the accuracy of the reconfiguration solution, optimal D-H parameters for the classical operations are pre-solved as the initial point of the local optimization. Based on the kinematics relationship of the RSM, the suboptimal solution can be obtained in real time. Finally, the sensitivity analysis is utilized to realize the reconfiguration solution, which contains the trajectory of the link twist and the link offset from the current D-H parameters to the suboptimal one. For the free-floating space manipulator, it is proved that the trajectory minimizes the disturbance to the platform during the reconfiguration process.

Simulations demonstrate that the proposed algorithm effectively increases the flexibility of the space manipulator, and the reconfiguration process can be realized with less disturbance to the platform, which shows its advantages over the common configuration optimization algorithm.