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COUPLING DYNAMICS AND EXPERIMENT OF CRAWLING ROBOT AND SPACE STRUCTURE FOR ON-ORBIT ASSEMBLY

Abstract

Recent years have witnessed the resurgence of space-based solar power research, and in particular the solar power satellite (SPS) has received much attention due to its potential for generating clean electrical power. The structural dimensions of a SPS are usually very large and complex. Subject to the limitations of rocket carrying capacities and fairing sizes, the on-orbit assembly could be a promising way to construct such extra-large space structures. Nowadays, the development of space robot technology has made on-orbit assembly much more possible. Among various space robots, the crawling robots have multiple functions, and are suitable for large-scale, long-distance and long-term assembly tasks. However, the coupling effect between the crawling robot and the space structure will have significant influence, which could cause structural vibration and meanwhile affect robot assembly operation. To deal with this problem, the coupling dynamics and experiment of crawling robot and space structure for on-orbit assembly are investigated in this paper. A crawling robot and truss structure are chosen as research objective, and the coupling dynamic model is firstly developed. The dynamic responses and coupling mechanism are then analyzed. The motion gait and controller of crawling robot are designed. To validate the numerical results, an experiment system has been established, including assembly structure modules, a three-arm crawling assembly robot developed by ourself and sensors, etc, as shown in following figure. The numerical simulations and experiments are finally provided, and the results have demonstrated that different gait and motion speeds of crawling robot maybe cause structure vibration. Meanwhile, structure vibration maybe also affect robot operation precision during assembly, which could even lead to the failure of the assembly task. The proposed model and method can be used for on-orbit assembly task of a large SPS in the future.