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SYMPOSIUM ON STEPPING STONES TO THE FUTURE: STRATEGIES, ARCHITECTURES, CONCEPTS AND TECHNOLOGIES (D3)
Novel Concepts and Technologies for the Exploration and Utilization of Space (2)

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STUDY OF VARIABLE TOPOLOGY-TRANSFORMABLE SPACECRAFT

Abstract

In order to adapt to the multi-functional requirements or space environment of space exploration and increasingly complicated space operations, modern spacecraft systems require the design of modern spacecraft structure towards the reconfiguration, modularization and transformation. The conventional spacecraft structures are facing more and more new challenges, such as rapid response and long-term on-orbit maneuver. This paper proposes to resolve these problems using variable topology-transformable spacecraft. The variable topology-transformable spacecraft is a sort of new spacecraft, which is proposed with a background of increasingly complicated and multiple space missions. It should be noted particularly that the variable topology-transformable spacecraft can change its topology configuration, kinematic or dynamic parameters during the process of movement. The variable topology-transformable spacecraft which is based on the Variable topology mechanism is a new type of spacecraft of self-reconfiguration. By the combination and split of the modules, the change of connecting relationship and changing the type of kinematic pair, variable topology mechanism can change the spacecraft configuration in the process of missions on orbit adapting to different space operations and expanding the scope of application of the conventional spacecraft. The methodology of the research of the design and structure dynamics of variable topology-transformable spacecraft is outlined in this paper. Firstly, three transformable mechanisms (Hinge-unfolded Pattern, Drawer-like Pattern and Bolted Pattern) which are the basis of variable topology-transformable spacecraft are designed. Secondly, based on orbital and functional requirements, the thermal environment of the variable topology-transformable spacecraft is analyzed with STK® and other simulation tools. Thirdly, complicated transformable process is divided into several single transformable processes, and the system topology configuration of the spacecraft in these sub-processes remains. Fourthly, the structure dynamics simulation of single transformable process is completed based on transformable mechanisms design and weightless and thermal environment analysis with ANSYS®, ADAMS®. The simulation result is considered as the spacecraft structure parameters at the moment of the end of this single transformable process. Finally, the spacecraft structure parameters at the end of the last single transformable process are supposed to be the initial parameters of the next one. Therefore, the whole transformable process simulation with topology method is completed by iterating the analysis process above. More functions, more development. And we can conclude that it is meaningful application for reference to takes variable topology-transformable spacecraft in the future.