

## Multiscale Topology Optimization using Subspace-based Model Reduction Method

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**Abstract** High performance of the spacecraft structure is required in the special environment, it includes mechanical performance and operational performance, etc. When performing tasks, the spaceborne equipment requires high precision. Therefore, the design of lightweight, high stability and high reliability structure is essential for spacecraft. Topology optimization is widely used in structural design. However, there are some problems in the structure after macro topology optimization, such as checkerboard, local optimal solution and other phenomena. Despite a long calculation period, the obtained structure is often not smooth enough and hard to manufacture. Aiming to this issue, this paper proposes a combined method of multiscale topology optimization method and multi-substructure multi-frequency quasi-static Ritz vector (MMQSRV) method. Firstly, a shape interpolation technology is used to generate microstructures. Those microstructures are predicted the effective characteristics by Kriging metamodel, and then they are used to build the macrostructure. Furthermore, variable thickness sheet (VTS) method is used to get the structure of free distribution of materials. Due to the similar topological characteristics, the interfaces of microstructures are well connected. In addition, on the macro scale, based on the Ritz vector method, the MMQSRV method simplifies the model matrix and effectively guarantees the computational efficiency and accuracy by Krylov Subspace Method. This method optimizes the microstructure and macrostructure, and curtail the iteration period of topology optimization.

**Keywords:** Model reduction method; Multiscale topology optimization; Ritz vector method; Krylov subspace.

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