A multi-material topology optimization method considering enclosed feature

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Abstract

Compared with completely solid structures, structures with enclosed feature as shell-infill configuration is capable of providing superior mechanical performances. With the popularity of additive manufacturing, these types of structures are favorable by practical engineering applications. From the perspective of conceptual design, how to generate the corresponding topologies with such light-weight configuration has been attracting more attentions.

In this work, an enclosed-feature structural topology optimization method is proposed under moving morphable bi-material component (MMBC) description. A fundamental MMBC is developed to explicitly describe the concerned light-weight configuration with better mechanical performance. Based on the MMBC, the merging mechanism and related topology of multiple MMBCs are reformulated using Boolean operation. A bi-material interpolation scheme is employed to obtain the corresponding material property for individual element, in which an offset-based virtual domain is applied to guarantee the completely uniform-thickness exterior material domain. Sensitivity analysis of the compliance objective and volume constraint are given with respect to the MMBC design variables. Two numerical examples are systematically investigated to demonstrate the effectiveness of the proposed method.

Keywords: Topology optimization; moving morphable bi-material component (MMBC); virtual design domain; enclosed feature; sensitivity analysis

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