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EDITORIAL

Introduction to the Special Issue on Novel Methods of Topology Optimization and Engineering Applications

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Topology optimization, aiming to allocate the available material to maximize system performance while satisfying multiple constraints, has experienced tremendous progress. This special issue focuses on the new progress of topology optimization methods and their applications, especially theoretical development, numerical implementation and potential applications.

A total of 12 manuscripts have been passed by a robust peer-reviewed process. All articles are authored by researchers from world-wide universities, and reflect state of the research progress.

The first paper "Robust topology optimization of periodic multi-Material functionally graded structures under loading uncertainties" by Li et al. [1] provided a more robust and effective multi-material design method for functionally graded structures considering periodic constraint with load uncertainties. The authors also presented a comparison of proposed model with deterministic method under different numbers of sub-regions.

The second paper "A combined shape and topology optimization based on isogeometric boundary element method for 3D acoustics" by Wang et al. [2] proposed a combined shape and topology optimization algorithm based on isogeometric boundary element method for 3D acoustics. The key treatment involves using adjoint variable method in shape sensitivity analysis with respect to non-uniform rational basis splines control points, and in topology sensitivity analysis with respect to the artificial densities of sound absorption material.

In the third paper entitled "Fatigue topology optimization design based on distortion energy theory and independent continuous mapping method", Ye et al. [3] proposed a topology optimization model to achieve the lightweight structure with the fatigue life constraints based on the independent continuous mapping (ICM) method. Fatigue life constraints are explicitly transformed to distortion energy constraints by taking advantage of distortion energy theory. This scheme further expands the theoretical application of the ICM method.

In the fourth paper "A parameter-free approach to determine the Lagrange multiplier in the level set method by using the BESO", Zong et al. [4] provided a more convenient and effective approach to determine the Lagrange multiplier for the constraint of material volume in the Level Set Method. The authors also compare the proposed method with the augmented Lagrange multiplier method through several examples.

In the fifth paper "Multi-material topology optimization of structures using an ordered ersatz material model", Liu et al. [5] proposed a new and easily implemented multi-material topology optimization approach using an ordered ersatz material model. The numerical examples clearly demonstrate the effectiveness and robustness of the proposed approach.

In the sixth paper "Functionally graded cellular structure design using the subdomain level set method with local volume constraints", Chen et al. [6] proposed a novel approach for designing functionally graded cellular structure is proposed based on a subdomain parameterized level set method (PLSM) under local volume constraints (LVC).

In the seventh paper entitled "Thermoelastic structural topology optimization based on moving morphable components framework", Yan et al. [7] proposed an efficient approach to investigate structural topology optimization of thermoelastic structures considering two kinds of objectives of minimum structural compliance and elastic strain energy based on moving morphable component (MMC) method.

In the eighth paper "An Improved Graphics Processing Unit Acceleration Approach for Three-Dimensional Structural Topology Optimization Using the Element-Free Galerkin Method", Lu et al. [8] proposed an improved graphics processing unit (GPU) acceleration approach for three-dimensional structural topology optimization using the element-free Galerkin (EFG) method. The proposed method can effectively eliminate the race condition under parallelization.

The ninth paper "An improved Data-driven topology optimization method using feature pyramid networks with physical constraints" by Luo et al. [9] presented a feature pyramid network with physical constraints to accelerate the design of topology optimization. A model with physical constraints not only guarantees high precision but also has better physical performance than a model without physical constraints.

In the tenth paper "Fail-safe topology optimization of continuum structures with multiple constraints based on ICM method", Du et al. [10] presented a topology optimization model to solve the topology optimization problem with the stress and displacement constraints considering the fail-safe. The optimization results with more material, more complex configuration and higher redundancy can meet the stress and displacement constraints when local damage occurs.

In the eleventh paper "An XBi-CFAO Method for the Optimization of Multi-Layered Variable Stiffness Composites Using Isogeometric Analysis", Mei et al. [11] presented an effective fiber angle optimization method for two and multi-layered variable stiffness composites. A gradient-based fiber angle optimization method is developed based on isogeometric analysis (IGA). Firstly, the element densities and fiber angles for two and multi-layered composites are synchronously optimized using an extended Bi-layered continuous fiber angle optimization method (XBi-CFAO).

The twelfth paper "Topology Optimization with Aperiodic Load Fatigue Constraints Based on Bidirectional Evolutionary Structural Optimization" by Li et al. [12] proposed a fatigue constraint topology optimization method based on bidirectional evolutionary structural optimization (BESO) under an aperiodic load. In view of the severe nonlinearity of fatigue damage with respect to design variables, effective stress cycles are extracted through transient dynamic analysis.

As a final remark, we wish this special issue will contribute to new breakthroughs in topology optimization methods and applications, with an emphasis on theory, numerical implementations, and possible applications.

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