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Isogeometric Topology Optimization using dual evolution of boundary element method and Level-set method

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Abstract

Isogeometric analysis (IGA) which was proposed by Hughes et al. employs non-uniform rational B-spline (NURBS) used for computer aided design (CAD) modeling and analysis. The IGA rapidly widened its application to structural vibrations, fluid-structure interactions and isogeometric shell analysis. Especially, among these applications, isogeometric optimization is widely studied by many researchers. Shape optimization has several merits such as higher order geometric information, exact geometry and integrated framework of design and optimization. Unfortunately, there have been few applications of the topology optimization method for IGA. Moreover, they are not satisfied with isogeometric concept such as exact geometry and integrated framework of CAD and analysis.

In this study, topology optimization is formulated by simultaneously considering evolution processes for zero level-set boundary and NURBS curves, which is called dual evolution. IGA using boundary integral equation (BIE) is used. And also, shape design sensitivity analysis (DSA) of IGA using BIE is derived. Level set function is updated by solving Hamilton-Jacobi (H-J) equation. The velocity of H-J equation is distributed through velocity extension of the obtained sensitivities. To obtain NURBS curves corresponding the updated zero level-set boundary, NURBS curves evolves in the direction to minimize energy functional (snake model). The evolution of NURBS curve stops zero level-set boundary. Topological variation is detected through level-set function value. In occurring topological change, NURBS curves are modified by using the information of updated level-set function. Through these processes, the advantages of both two representations are combined. NURBS curve gives accurate response and sensitivity results based on exact geometric representation. Level-set model facilitates topological change. Several numerical examples are presented to demonstrate the advantages of the proposed methodology.