Realization Method for Transforming Topology Optimization Design to Additive Manufacturing Structures

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Realization Method for Transforming Topology Optimization Design to Additive Manufacturing Structures

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Abstract：Topology optimization is a powerful design approach for determining the optimal topology in the form of discrete densities or continuous boundaries to obtain desired functional performances. One of the important drawbacks, however, is that a serious gap exists between the topology results, especially obtained based on the density framework, and the parameterized CAD models that are ready for subsequent optimization and manufacturing. In this paper, a new method for interpreting the topology optimization results to the STL models which are suitable for additive manufacturing and parameterized CAD models which are suitable for shape optimization is proposed. First, we extract the skeleton of the topology optimization results to ensure the shape preserving, and the filter method is used to ensure the characteristic preserving. After this process, the distribution of the nodes in the boundary of the topology optimization results is denser, which benefits the subsequent curve fitting. By using the curvature and its derivative of the uniform B-spline curve, an adaptive B-spline fitting method is proposed to get a parametric CAD model with fewest control points. A case study is presented to demonstrate the process of the proposed method and another two examples are presented to demonstrate the effectiveness of the proposed method.

Keywords: Topology optimization; Additive manufacturing; Characteristic preserving; Adaptive fitting; Shape optimization.

1 Introduction

Topology optimization has been regarded as one of the most generic types of optimization problem and has been used to improve initial designs by variation of its geometrical and material properties regarding a set of prescribed objectives and constraints. It does not require a pre-established design and can give some new, even unanticipated design ideas to designers. The study of topology optimization has become the research hotspot over the past three decades in the structural optimization community. Many different approaches have been proposed, including density approach (Bendsøe and Sigmund, 1999; Zhou and Rozvany, 1991a), level set approach(Allaire et al., 2002; Wang et al., 2003), evolutionary approaches (ESO/BESO) (Xie and Steven, 1993) and several others. Interested readers can refer to (Sigmund and Maute, 2013) for more details about the topology optimization approaches. Among all these approaches, the density

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