Adaptive Topology Optimization of Unstructured Lattices

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ABSTRACT

Additive manufacturing technologies allow one to contemplate innovative designs of lattice structures as alternatives to complex solid parts. Interest in such structures comes from the fact that they can be much lighter while being capable of achieving similar mechanical requirements. For instance, lattice structures have recently drawn a lot of attention in aeronautical applications, where even a small reduction in aircraft mass can lead to substantial savings in fuel consumption, or in biomedical applications, in the case where one is interested in designing patient-specific bio-compatible prostheses.

However, optimal design of lattices can become a challenging endeavor due to the broad versatility of additive manufacturing technologies. In order to fully take advantage of the extensive freedom offered by additive manufacturing, several optimization techniques have been developed in recent years, such as the Solid Isotropic Material Penalization (SIMP) method [1] or the so-called Ground Structure Method (GSM) [2]. The objectives of the talk will be to present an alternative methodology [3] for topology optimization of lattices based, on one hand, on a semi-analytic mechanical description of the lattice, for which each truss is described in terms of the one-dimensional Euler-Bernoulli model, and, on the other hand, on an adaptive process. The proposed topology optimization problem aims at minimizing the compliance of the lattice structure with respect to the position of its nodes when subjected to geometrical constraints. The finite-dimensional optimization problem is solved using the interior-point method with equality and inequality constraints.

Finally, in order to search a solution in smaller design spaces, an adaptive process is considered in which the initial configuration consists of a coarse lattice (with few trusses) that is gradually populated with new trusses in the relevant regions. We will present the theoretical framework of the adaptive method and demonstrate the performance of the approach on some numerical examples.

REFERENCES

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