

MULTIDISCIPLINARY OPTIMIZATION OF LATTICE STRUCTURES FOR A MORPHING WING USING NEURAL IMPLICIT GEOMETRY

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Abstract

Lattice structures consist of repeated, similar-shaped unit cells and are commonly found in modern engineering applications such as crash structures, acoustic components, or energy-efficient thermal applications. However, the design, analysis and optimization of such structures is still subject of current research. In this presentation we want to show how neural networks can be used to implicitly represent and optimize the geometry of spatially graded lattice structures [1]. We employ the DeepSDF [2] method, where a continuous and low-dimensional latent space is introduced to encode the geometric information. In contrast to traditional topology optimization methods, this allows the restriction of the design space to specific geometries. In our case, the latent space is used to represent the geometry of different unit cells that are stacked to form a lattice structure. Moreover, continuously varying the latent vector over the structure allows a functional grading and optimization.

Unlike other lattice-structure optimization methods, we neither assume a large separation of scale nor periodicity. Instead, we perform a full-scale finite element analysis at each optimization step. The required mesh is obtained by a differentiable extension of the dual marching cubes algorithm [3], which enables gradient-based optimization. We demonstrate the effectiveness of the proposed method on a morphing wing example, where we consider the mechanical stiffness as well as the aerodynamic response.

References

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