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Invited Paper

Deep Learning Assisted Design Optimization of Mechanically Efficient Architected Material

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ABSTRACT

Lattice-truss structures have a high performance-to-weight ratio due to their highly efficient material distribution in a given lattice volume. However, their inherently large porosity results in higher anisotropy, and brittleness compared to the base material. Most works to date have focused on modifying the spatial arrangement of beam elements to overcome these limitations, but only simple beam geometries have been adopted due to the infinitely large design space associated with probing and varying beam shapes. Here we present a generative deep learning-based approach to enhance the elastic modulus, strength, and toughness of lattice structures with minimal tradeoffs by optimizing the shape of beam elements for a suite of lattice structures. The generative deep learning-based approach leverages the fast inference of neural networks to accelerate the optimization process. We fabricate our lattice designs using additive manufacturing to validate the optimization approach; experimental and simulation results show good agreement. The mechanical properties are significantly improved due to the effect of distributed stress fields and deformation modes according to the beam shape and lattice type.

REFERENCES

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