
Morphing As-Designed Databases for Lattice Materials with Image-Based Models to Capture Manufacturing-Induced Effects

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Abstract

With the advent of metal additive manufacturing, lattice materials - valued for their high stiffness-to-weight ratio - have become increasingly accessible for industrial applications. The inherently multiscale nature of these materials requires the use of specialized methods to study their mechanical behavior at the macroscopic scale. Data-driven methods have demonstrated improved efficiency compared to the FE² method, primarily due to their ability to capitalize on precomputed simulation results at the mesoscopic scale rather than recomputing them repeatedly. However, despite this advantage, building dense databases remains computationally expensive due to the 6-dimensionality of the strain space. Furthermore, it has been shown in the literature, and confirmed by previous work through the use of image-based models (often referred to as "as-manufactured" cell configuration), that the mechanical behavior of lattice materials is influenced by manufacturing variability. To account for these effects without performing a full design of experiments (DOE) on image-based RVEs, we propose leveraging the rich database generated from the "as-designed" CAD-based RVEs as a foundation. A morphing process will be explored, based on a lighter DOE conducted on image-based RVEs, to approximate the mechanical behavior of the as-manufactured material. By using interpolation techniques, such as radial basis functions (RBFs) or other methods, with a limited number of simulations, we aim to approximate databases that account for geometric variations caused by manufacturing. This approach may reduce computational costs by avoiding exhaustive (and numerically unaffordable) re-computation.

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