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Isogeometric multiresolution optimisation of lattice-skin structures

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We introduce the isogeometric shape optimisation of lattice-skin structures consisting of thin-shells coupled to conformal lattices. Lattice-skin structures usually exhibit a very low weight while maintaining a good structural performance and are becoming increasingly important for additively manufactured products. The mid-surface of the thin-shell is represented with subdivision surfaces, and control meshes with different resolutions describing the same geometry are used for geometry representation, finite element analysis and optimisation. The coupling of the thin-shell with the lattice structure is achieved by means of Lagrange multipliers. A gradient-based optimisation technique is implemented to minimise the compliance of the whole lattice-skin structure. During iterative shape optimisation, the finite element analysis of the thin-shell is performed with subdivision basis functions corresponding to a sufficiently fine control mesh, and the geometry is updated starting from the coarsest control mesh and proceeding to increasingly finer control meshes. By virtue of the multiresolution editing semantics, updating the coarse control mesh leads to large-scale geometry changes and updating the fine control mesh leads to small-scale geometry changes. This approach prevents the appearance of non-physical geometry ossillations as well as control mesh pathologies. In addition to the thin-shell, the conformal lattice structure comprised of truss or beam elements is shape and topology optimised. The aim of the lattice topology optimisation is to remove lattice members which have a negligible effect on the overall structural performance.

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