Adaptive Isogeometric Phase-Field Approach for Topology Optimization

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ABSTRACT

The recent advancements in additive manufacturing have significantly enhanced the design possibilities in structural engineering. The increased freedom of design enables a wider application of innovative and resource-efficient structures that were previously difficult to fabricate. Example areas of application range from rapid prototyping to patient specific solutions in the medical sector.

A promising method to derive sophisticated designs is topology optimization. Here, material is distributed in a design domain with the objective to maximize the stiffness of the resulting structure at a limited material usage. To obtain the optimal topology, in [1] a phase-field approach using gradient flow is successfully adopted. The phase-field is coupled to the mechanical field, describing regions of dense material and voids. By the means of a gradient penalization the feature length scale of the resulting topology can be controlled to generate geometries suited for additive manufacturing.

In order to improve the resolution of the evolving diffuse boundaries, adaptive isogeometric analysis with truncated hierarchical B-splines is used [2]. The hierarchical structure of the basis allows for quadrature free projection methods to project field variables onto the refined/coarsened mesh [3]. Furthermore, the use of a higher continuous B-spline basis leads to efficient computations due to the higher continuity of the phase-field model. We investigate marking techniques suited to capture the phase transitions arising in the process of optimization. For the purpose of achieving convergence in a computationally efficient manner, we utilize an adaptive time stepping scheme.

In order to compare the method with other approaches and to examine the increase in computational efficiency, our approach is tested in benchmark problems.

REFERENCES

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