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A Novative Optimal Shape Design Based on an Isogeometric Approach: Application to Optimization of Surface Shapes With Discontinuous Curvature

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Abstract

Nowadays, industrial problems require to use more and more intensively optimization methodologies in the numerical design process. The common workflow relies on different steps: first a parameterized shape (CAD model) is designed, then meshed in order to finally perform a finite elements analysis. During the optimization procedure, meshing and finite elements steps are repeated at each iteration step until an optimal solution is found.

The standard methodology presents several limits: design time, computational cost and the need to CAD return corrupting the optimization expectations. Besides, meshing is based on multiple approximations on the original shape which downgrade the precision of simulation results.

In this work on surface shapes, we propose an innovative design method based on an isogeometric approach using deep shell models. An isogeometric analysis consists in running calculations on the geometry of the shape without meshing it. This technique uses a shape function that is defined with the CAD model surfaces which are Bézier's patches in our case. Shell models such as Koiter's or Naghdi's enable, indeed, high curvature variations with the help of a few number of patches. In our methodology, each patch is considered as a Koiter's shell and the patches are connected with respect to shell junction conditions allowing to carry out optimization of shapes with discontinuous curvature. The shape is optimized by using the CAD shape functions and more precisely the control points of the Bézier's patches as optimization variables. The first results indicate that the optimization problem is well posed and that approach enlarge the exploration of the design space and permits to consider more complex shapes.