2D Isogeometric Shape Optimization considering both control point positions and weights as design variables

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Abstract

NURBS (Non-uniform Rational B-spline) has been widely used as a standard shape representation technique for shape optimization due to its accuracy and efficiency in the integration of CAD and CAE. Although NURBS represents geometry by positions of control points and its weights, until now most of shape optimization studies use only control point positions as design variables. In some shape optimization processes control points come closer to each other. This deteriorates the mesh quality and hampers the convergence. Control point weights enable conical shape representation such as circle and ellipse and more flexible curve representation. If weights are considered as additional design variables, more refined shape control could be expected.

In this work, a new 2D isogeometric shape optimization based on spline finite element method is proposed. Both positions and weights of NURBS control points are used as design variables and shape optimization algorithm is composed of position optimization step and weight optimization step. In order to prevent the disadvantage for location of control points in the limited space cases, a new shape optimization algorithm starts with control point positions as design variables. If the closest distance of two neighboring control points is less than the threshold value during the position optimization step, weights become the design variables. The proposed NURBS based shape optimization is applied to some benchmarking problems. It is shown that a new shape optimization algorithm has advantages in conical shape representation and in the treatment for location of control points in the limited space cases.

Keywords: Shape optimization, Isogeometric analysis, NURBS, control point, weight