Form-finding of topologically complex shells using isogeometric analysis and trimmed surfaces

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For form-finding of topologically complex or trimmed shells, the domain needs to be handled with multiple untrimmed patches due to the characteristic of tensor product form of NURBS surface in the conventional isogeometric analysis. In the present research, the form-finding of topologically complex shells using trimmed surface analysis (TSA) [1] is performed. The trimmed surface analysis is the isogeometric analysis utilizing the information of trimmed surface from CAD programs directly into the analysis. With this approach, a topologically complex geometry can be handled efficiently without constructing multiple untrimmed patches. Additionally, the model geometry and field variable can be preserved their continuities within the domain. The 2D trimmed surface analysis is extended and appropriately modified for structural analysis and form-finding of shells. The shell surface is expressed by the untrimmed NURBS surface, and the inner boundaries and trimmed outer boundaries are described by the trimming curves. For the form-finding, not only the coordinates of surface control points, but also the coordinates of trimming curve control points are set as design variables so that the surface curvature and trimming curves can change during the optimization. The shape sensitivities are formulated with respect to the coordinates of surface control points and trimming curve control points. The gradient based optimization algorithm MMA [2] is applied for updating design variables. A number of examples for form-finding of topologically complex shells are handled by the proposed method.

Keywords: Form finding, Shape optimization, Isogeometric analysis, Trimmed shells, NURBS

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