Reanalysis based Geometrical Optimization and Applications in Structure Designs

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Abstract

In recent years, a variety of reanalysis methods have been developed. These methods can be mainly divided into two categories: direct methods and approximate methods. Direct methods, such as Sherman-Morrison-Woodbury (SMW) formula and Independent Coefficients (IC), are usually suitable for low-rank or local modifications, and many of them can obtain an exact solution of the modified structure. Approximate methods, such as Combined Approximation (CA) and Epsilon algorithm, usually do not obtain an exact solution, but high-rank or global modifications can usually be well disposed. The efficiency of reanalysis methods has been well demonstrated by many researchers, and they are claimed to be suitable for multidisciplinary optimization problems. However, applications in real optimization problems are seldom seen in presented works. The main bottleneck is that the optimization procedure cannot usually form a closed loop. First, the geometrical modification cannot be represented by mesh directly. Second, the geometrical parameters are difficult to be defined explicitly.

In this study, we proposed a mesh updating strategy, in which we describe a mesh using a 'key points – curves – surfaces' data structure. With this structure, variety of geometrical parameters can be used as design variables to control the shape of a mesh. The design variables can be various geometrical parameters: coordinates of key points, radius of circles and cross profile. The definition of design variables enables the reanalysis methods to be applied to real engineering optimization problems.

Two reanalysis methods are employed in this study to accelerate the optimization process: CA method and IC method. The developed reanalysis assisted optimization structure is applied to two real engineering designs: a B-pillar and a half body (Fig. 1). The results validated that our optimization strategy is effective and efficient for engineering geometrical optimization problems.
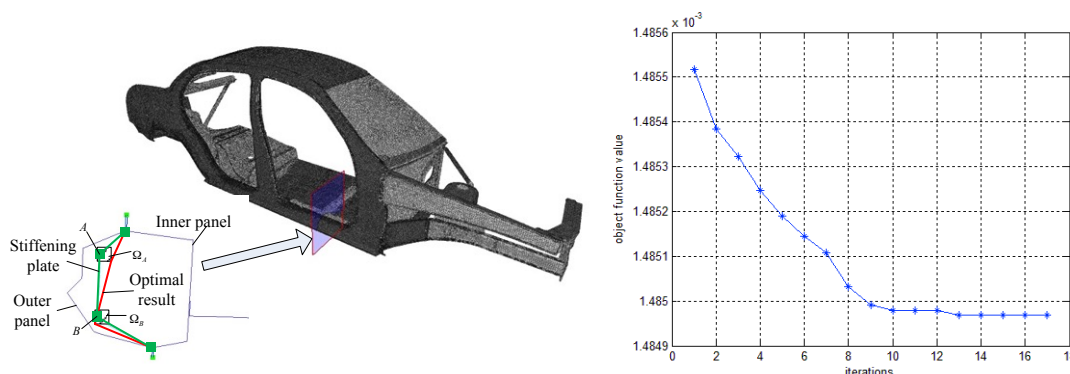
Fig. 1 Optimization of half body