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LOW COST ADAPTIVE REMESHING STRATEGIES FOR THE SOLUTION OF STRUCTURAL SHAPE OPTIMIZATION PROBLEMS USING HYBRID (EVOLUTIONARY-GRADIENT) METHODS

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ABSTRACT

Gradient based methods used in structural shape optimization usually converge quickly but only to the closest local optimum. Evolutionary algorithms have the ability to escape from local optima but require the structural analysis of a considerable number of different designs. Hybrid methods combining the use of these two techniques are powerful tools for the solution of shape optimization problems as they exploit the benefits of both.

The shape optimization processes require the structural analysis of several different designs. The computational cost related to the analysis of each design is therefore a critical issue. The discretization error associated to the finite element analysis of each design during the optimization process plays an important role over the convergence of the optimization algorithms as non optimal solutions, which do not satisfy the constraints, are obtained if this error is not sufficiently low [1]. Therefore, adaptive analysis techniques should be used to ensure a minimum quality of the results of the structural analysis of each design to guarantee the convergence of the optimization process to the real solution. However, adapted meshes obtained from traditional adaptive remeshing strategies, where each design has to be analyzed more than once, cause a high computational cost.

In this work we have developed a basic implementation of a hybrid algorithm for structural shape optimization problems which first uses the evolutionary algorithm to capture a solution close to the global optimal solution, avoiding local optima, and then uses a gradient-based algorithm for a quick convergence to the final solution. The main

characteristic of the proposed algorithm is that the adapted meshes for the analysis of each design are directly obtained without a full adaptive analysis for each of them. The direct generation of the adapted meshes is based on the use of sensitivity analysis of all magnitudes related with adaptive remeshing (location of nodes, error estimation, etc.) with respect to the design variables. When the evolutionary algorithm drives the optimization process, the sensitivity analysis (performed only once over a reference geometry) is used to project the results of the corresponding analysis to all other designs to be analyzed in each generation of individuals [2]. When the gradient-based method drives the optimization, the sensitivity analysis is used to project the results associated to a given design into the next geometry to be analyzed [3]. In both cases, the projected information allows generating an appropriate adapted mesh for each new design in one shot, greatly reducing the computational cost compared to standard strategies.

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