A new Approach to Variable-Topology Shape Design Using a Constraint on the Perimeter

This paper introduces a new method for variable-topology shape optimization of elastic structures called the perimeter method. An upper-bound constraint on the perimeter of the solid part of the structure ensures a well-posed design problem. The perimeter constraint allows the designer to control the number of holes in the optimal design and to establish their characteristic length scale. Finite element procedures based on this approach generate practical designs that are convergent with respect to grid refinement. Thus, an arbitrary level of geometric resolution can be achieved, so single-step procedures for topology design and detailed shape design are possible. The perimeter method eliminates the need for relaxation, thereby circumventing the complexities and restrictions of the homogenization approach to topology design. The new method is suitable for implementation with existing finite element analysis and optimization software systems.