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TOPOLOGY OPTIMIZATION OF STRUCTURES IN CONTACT

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Abstract: Appropriate modeling of the boundary conditions is crucial to the design of structural components. Poor modeling results in poor designs. Of these conditions, contact is the one that dominates countless physical situations, e.g., crashworthiness, wear, and lubrication, etc. Indeed, contact is present in every structure because loads are transferred from one body to another via contact. However, contact modeling is challenging so it is often replaced by simple traction and/or displacement boundary conditions which compromises the accuracy of the simulation. Works in the Topology Optimization (TO) of structures in contact are primarily restricted to rigid obstacle problems. Contact of bodies with nonconforming mating meshes requires more advance segment-to-segment modeling techniques, which are rarely used. Indeed, most of the numerical examples are two-dimensional. Our research is devoted to the TO of structures in contact using more advanced modeling techniques to address design problems with multiple deformable components in contact. Since the contact problem is computationally expensive, we use efficient optimization algorithms which require sensitivity analysis. Novel features of our proposed work include the use of a general continuum formulation of the contact model, making it suitable for large deformation problems and arbitrary discretizations. Also, we use a mortar segment-to-segment approach to solve the contact problem of two deformable bodies with dissimilar meshes. Moreover, we use a B-spline design parameterization to 1) reduce the number of design variables in comparison to element-wise parameterizations and 2) regularize the TO problem. Additionally, we propose to use the following well-known techniques: penalty and augmented Lagrangian methods to enforce contact constraints, analytical adjoint sensitivity analysis to compute the gradients of general functionals, efficient gradient-based optimization algorithms to effectively transverse the design space, e.g., the Interior Point Optimizer (IPOPT), and the SIMP density method of TO. Finally, we will provide numerical examples to validate our study.