The Feasible Set Method for Rezoning in Arbitrary Lagrangian Eulerian Methods

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Abstract

Arbitrary Eulerian Lagrangian (ALE) methods are popular for the simulation of continuum mechanics problems with large shear deformation. These ALE methods [2, 4] consist of a Lagrangian step in which the mesh nodes move along with the fluid motion, a rezone step in which the mesh is modified to improve its quality, and a remap step in which the solution is transferred from the Lagrangian mesh to the new improved mesh.

The idea for the feasible set mesh smoothing method is based on the mesh untangling methods described in [3, 5]. In [3] an algorithm for untangling an invalid mesh is described as follows. Each vertex that is connected to at least one invalid mesh cell is visited and repositioned directly to a point in its feasible set (or kernel) to make all its connected mesh cells valid. They define the feasible set of a vertex to be the set of all locations of the vertex for which all mesh cells connected to the vertex will be valid, however, in the process of finding a new location for a tangled vertex, this feasible set is not explicitly calculated. The approach presented in [5], is based on calculating the feasible set explicitly, and not just a smaller subset as in [3]. This provides more flexibility for choosing a vertex location.

Any robust mesh smoothing method that is based on the successive repositioning of mesh vertices should maintain mesh validity. This is to say that such a mesh smoothing method should reposition a vertex somewhere within its feasible set. This observation is the basis for the feasible set mesh smoothing method. The basic idea is to explicitly compute the feasible set for every mesh vertex and smooth the mesh by repositioning the mesh vertices to a more optimal position within their feasible sets. In [1] the feasible set mesh smoothing method method is described for 2D polygonal meshes. In this talk we will describe this method in both 2D and 3D and give examples that highlight the method's robustness and flexibiltiy.

References

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