Morphing and Modification of Unstructured Meshes

by
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Abstract

Mesh modification for time evolving domains can be carried out by a three stage combination of mesh movement, mesh coarsening and mesh enrichment. One application of this three stage procedure forms one cycle of dynamic adaptation. The extent of domain deformation that can be accommodated during one cycle depends on how far the r-refinement stage can stretch the cells without creating an invalid mesh with negative cell volumes. Mesh coarsening based on edge collapse is then carried out to remove points associated with cells that have become badly shaped during the r-refinement stage. Finally, mesh enrichment serves to re-create a mesh whose cell quality is comparable to that of the original mesh. At each stage one is operating on a valid (i.e. conforming, space filling and non-overlapping) mesh which thus avoids the difficulties that are associated with opening up pockets and remeshing.

Unstructured meshes of triangles in 2D, or tetrahedra in 3D, are particularly well suited to mesh modification since local refinement and/or coarsening can be achieved without the introduction of hanging nodes or other artifices that often plague adaptation schemes for structured meshes. The mesh modification technique will be described and a number of examples will be presented to illustrate its application to the simulation of time dependent problems involving a domain whose shape is undergoing substantial deformation.

A second topic to be discussed is the interpolation of data from an arbitrary cloud of points. This is often needed when transferring the computed solution between two unrelated meshes or when working with a meshless method. The interpolant is required to fit the data at the original mesh points exactly. This is achieved by combining a linear interpolation scheme with a least squares method to estimate the higher order terms. Details of the approach will be presented together with discussion of necessary conditions to ensure invertibility of the covariance matrix.