A Cell By Cell Anisotropic Adaptive Mesh ALE Method

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In this work a cell by cell anisotropic adaptive mesh technique is combined with a staggered mesh Lagrangian plus remap Arbitrary Lagrangian Eulerian method.

Many features of interest, such as shocks, involve large variations in one dominant direction. Anisotropic refinement of elements can increase the resolution in the direction of interest without wasting refinement in the other directions. The method developed here combines the advantages of ALE with increasing the number of elements through cell by cell anisotropic refinement. The use of local refinement avoids the prohibitively large number of elements and nodes that would be required if the resolution was increased throughout the entire domain.

The quadrilateral elements may be subdivided anisotropically in only one direction, or isotropically in both directions. The elements are subdivided in their local directions, the refinement is aligned with the ALE mesh, which is often aligned with the flow directions or features of interest. Anisotropic refinement on the ALE mesh is therefore particularly efficient and beneficial.

Cell by cell refinement is used rather than selecting a group or cluster of elements to refine as in structured Adaptive Mesh Refinement. An efficient solution procedure is developed that solves only on the finest resolution existing on each part of the mesh, rather than solving on every refinement level. The solution is obtained on the Dynamic Mesh, which contains coarse, isotropic and anisotropically refined elements; this can be viewed as solving on an unstructured mesh where disjoint or hanging nodes are used at resolution transitions.

Results are presented for a range of test problems. The adaptive method achieves the same accuracy as a uniformly fine calculation in a fraction of the time.