Coupled Mesh Lagrangian/ALE Modeling: Opportunities and Challenges

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The success of Lagrangian contact modeling leads one to believe that important aspects of this capability may be used for multi-material modeling when only a portion of the simulation can be represented in a Lagrangian frame. We review current experience with two dual mesh technologies where one of these meshes is a Lagrangian mesh and the other is an Arbitrary Lagrangian/Eulerian (ALE) mesh. These methods are cast in the framework of an operator-split ALE algorithm where a Lagrangian step is followed by a remesh/remap step.

An interface-coupled methodology is considered first. This technique is applicable to problems involving contact between materials of dissimilar compliance [1,2]. The technique models the more compliant (soft) material as ALE while the less compliant (hard) material and associated interface are modeled in a Lagrangian fashion. Loads are transferred between the hard and soft materials via explicit transient dynamics contact algorithms [3]. The use of these contact algorithms remove the requirement of node-to-node matching at the soft-hard interface. In the context of the operator-split ALE algorithm, a single Lagrangian step is performed using a mesh to mesh contact algorithm. At the end of the Lagrangian step the meshes will be slightly offset at the interface but non-interpenetrating. The ALE mesh nodes at the interface are then remeshed to their initial location relative to the Lagrangian body faces and the ALE mesh is smoothed, translated and rotated to follow Lagrangian body. Robust remeshing in the ALE region is required for success of this algorithm, and we describe current work in this area.

The second method is an overlapping grid methodology that requires mapping of information between a Lagrangian mesh and an ALE mesh.. The Lagrangian mesh describes a relatively hard body that interacts with softer material contained in the ALE mesh. A predicted solution for the velocity field is performed independently on both meshes. Element-centered velocity and momentum are transferred between the meshes using the volume transfer capability implemented in contact algorithms [3]. Data from the ALE mesh is mapped to a *phantom* mesh that surrounds the Lagrangian mesh, providing for the reaction to the predicted motion of the Lagrangian material. Data from the Lagrangian mesh is mapped directly to the ALE mesh. A momentum balance is performed on both meshes to adjust the velocity field to account for the interaction of the material from the other mesh. Subsequent, remeshing and remapping of the ALE mesh is performed to allow large deformation of the softer material. We overview current progress using this approach and discuss avenues for future research and development.

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References

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