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RELAXATION OF HIGH-ORDER CURVED MESHES IN THE REMESH PHASE OF BLAST

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BLAST [1, 2] is a multi-material arbitrary Lagrangian-Eulerian (ALE) hydrodynamics code based on high-order (HO) finite elements. In this talk we present the details of its remesh phase, where the Lagrangian high-order mesh is optimized via node movement. Our goal is to develop rigorous theory that defines the HO mesh quality, and combine this theory with application-specific physical concepts in BLAST's remesh phase algorithm.

We focus on the method's ability to adapt certain mesh features (e.g., local mesh size) towards a physical quantity (e.g., material interface position) that is known only on the Lagrangian mesh. Furthermore, as BLAST can perform any number of Lagrangian steps between two remesh/remap steps, efficient remesh trigger is essential to provide mesh robustness and minimize the number of remesh/remap steps. We propose methods for the above topics and present the corresponding results in the context of HO meshes and finite elements.

Pointwise mesh quality metrics are defined by utilizing sub-zonal information. These metrics can measure shape, size or alignment of the region around the point of interest. Mesh optimization towards the chosen metric is performed by our HO extension of the Target-Matrix Optimization Paradigm (TMOP) [3]. TMOP uses pre-defined target (or perfect) elements, which is a way for the users to incorporate application-specific physical information into the metric that is optimized. The combination of targets and quality metrics is used to optimize the node positions, so that they are as close as possible to the shape/size/alignment of their targets. The resulting mathematical problem is posed as global or local optimization of the chosen metric over the mesh. As this is a nonlinear problem, we analyze various Newton-based solvers as well as derivative-free solvers. Additional capabilities include limiting the node movement and optimization of any composition of metrics.

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