LAGRANGIAN SIMULATION OF EXTREME DEFORMATIONS: AUTOMATED POLYHEDRAL MESHING AND SOLUTION REMAPPING

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Very large deformations of solid materials exhibiting complex constitutive response pose some interesting challenges in relation to their effective computational treatment. The complicated material model strongly implicates a Lagrangian approach, but the extreme distortions confound a single material-fixed discretization. Arbitrary Lagrangian-Eulerian (ALE) techniques were developed with the intent of achieving some of the favorable properties of both purely-Lagrangian and purely-Eulerian approaches: freedom from deformation-induced degradation in the quality of the approximation space, with some control over the advection-related error. However, ALE methods only offer a partial solution, as the advection operators normally used require that the mesh topology remain fixed. This restriction is undesirable for a number of reasons, particularly if the topology of the body itself evolves with the solution (e.g. fracture).

A computational scheme for problems of this type is described which represents the integration of two innovative elements: the *Variable Element Topology Finite Element Method* (VETFEM), and a conservative material state remapping scheme. The former is a displacement based, finite element like method in which the elements are not constrained by a requirement of similarity with a (e.g. cubic) canonical element. Instead, VET elements may take the form of arbitrary polyhedra. In most respects they may be considered generalizations of the standard eight-node trilinear hexahedral element. Meanwhile, solution state remapping across mesh realizations is accomplished via weak enforcement of equality between the fields on the new and old meshes. A direct implementation of this scheme requires determination of the volumes of intersection among assemblages of disjoint polyhedra – a burdensome problem in computational geometry. Instead, the volume-partition problem is approximated by a constrained optimization problem, which can be readily and efficiently coded. The meshing flexibility afforded by the VETFEM is used to effect automated remeshing of highly distorted bodies, via Boolean geometric operations on a covering structured hex mesh. The state remapping scheme is then applied to continue the solution on the new mesh.

Keywords: remeshing, remapping, Lagrangian