

UNTANGLING OF 2D TRIANGULAR AND QUADRILATERAL MESHES IN ALE SIMULATIONS

PAVEL VACHAL[¶], MIKHAIL J. SHASHKOV[†], & RAO V. GARIMELLA[‡]

[¶]Czech Technical University in Prague,
Czech Republic

^{†‡}MS B284, T-7,
Los Alamos National Laboratory,
Los Alamos, NM USA

ABSTRACT: A procedure is presented to untangle unstructured 2D meshes containing inverted elements by node repositioning. The inverted elements may result from node movement in flow simulations and in large deformation problems such as metal forming. Meshes with inverted elements may also be created due to the limitations of mesh generation algorithms particularly for non-simplicial mesh generation. The untangling procedure uses a combination of direct node placement based on geometric computation of the feasible set and node repositioning driven by numerical optimization of an element area based objective function. It is shown that a combination of the feasible set based method and the optimization method achieves the best results in untangling the mesh. Preliminary results are also presented for untangling of 3D unstructured meshes by the same approach.

KEY WORDS: Mesh untangling, inverted elements, triangles, quadrilaterals

Introduction

Arbitrary Lagrangian-Eulerian or ALE methods are a popular class of methods for simulating flow problems and large deformation problems [1, 2]. ALE methods consists of a Lagrangian step in which the mesh nodes move according to the flow of the material, a rezone step in which the mesh is modified to improve its quality and the remapping step in which the solution is transferred from the old mesh to the new, improved mesh. In [3, 4, 5], methods were described to improve quality of the mesh while keeping it close to the original mesh. However, in order to improve the meshes by the methods described in [3, 4, 5], all elements of the starting mesh must be valid or non-inverted. Therefore, if the Lagrangian step of an ALE simulation causes the mesh to become tangled (i.e., it has some elements that become inverted), the mesh must be untangled before the mesh improvement procedures are applied to it.

The need for untangling meshes also exists when a mesh generation procedure is unable to create all valid elements in a mesh. This situation may be encountered

[¶]vachal@lanl.gov

[†]shashkov@lanl.gov

[‡]rao@lanl.gov