

Purpose: It is desirable to preserve mass and topology at every element during deformable image registration. We present some preliminary results using an ALE mesh for deformable image registration of head and neck tumors.

Method and Materials: Arbitrary Lagrangian-Eulerian (ALE) moving mesh is a finite-element based technique that preserves mass and topology during deformation. The displacement of the moving boundary can propagate to the interior nodes throughout the domain. A smooth mesh deformation can be obtained by solving partial-differential equations (PDEs) for the mesh displacements. We adopted this technique in deformable image registration. The idea of our image registration, currently contour-based, is to generate ALE mesh in a reference image, move the external boundary (or surface) to match the boundary in a target image, and track the contours of the interior organs or tumors, which are deformed by the ALE mesh movement. The software COMSOL Multiphysics (Comsol, Inc., MA) was used.

Results: The image registration was tested with two-dimensional images, using structure contours of head and neck tumors. Two sets of CT images and structure contours taken before and after chemotherapy, respectively, were used. The external contour obtained before the chemotherapy was moved to match the external contour obtained after the chemotherapy. Displacement vectors of the domain enclosed by the external contour were derived from the moving mesh, which were then examined with the deformation of gross target volume (GTV) contour. A warped GTV contour was obtained by applying the displacement vectors to the GTV obtained before the chemotherapy. The result showed that the warped GTV nearly agreed with the GTV obtained after the chemotherapy, except a small part.

Conclusion: The preliminary study shows promising application of deformed mesh in image registration. Further studies in three dimensions and comparing the agreements between our methods and elastic-mechanical modeling will be included.