AbstractID: 6557 Title: Topology Preserving Diffusion Registration Incorporate with Gradient Orientation Information

Purpose: The goal of this study was to develop an image intensity-based diffusion registration algorithm that can be used for reliable automatic delineation of anatomical structures on daily CT images. The constraint of the topology preservation method used in this algorithm ensures that the transformations are reliable and accurate.
Method and Materials: To achieve accurate deformable image registration using a diffusion-based method, we proposed to incorporate the gradient orientation information into the driving force in diffusion registration. This is similar to the symmetric force in the demons algorithm. We also introduced to use the positive Jacobian constraint, which is the fundamental requirement for topology preservation, as a guideline to determine the smoothing parameter in the diffusion algorithm to ensure that a realistic registration can be achieved. The planning contours were mapped onto the daily CT image using the displacement field after the deformable image registration. The contour mapping serves as a validation of the algorithm proposed in this study. The performance of the proposed algorithm for register 3D CT images of prostate and head and neck cancer patients were evaluated by visually assessing the agreement of the anatomical structures with deformed contours in target image.
Results: The contours deformed with the topology preservation method are more accurate segmentation of the anatomical structures, compared to a similar method without this constraint. The positivity of Jacobian provided a way to evaluate the performance of the registration and to serve as guidance for selecting smoothing parameters.
Conclusion: We proposed a diffusion registration algorithm incorporated with the intensity gradient information and the positive Jacobian constraint that ensures the transformations to topologically preservation of anatomical structures. Compared to demons algorithm, the proposed algorithm is more computational efficient and accurate, especially for prostate CT images registration.

The research is in part sponsored by Varian.