AbstractID: 9300 Title: An improved Demons algorithm by incorporating accurate voxel motion calculation

Purpose:

The Demons algorithm is widely used for deformable registration of images from the same imaging modality by iteratively solving the gradient constraint equation to build pixel correspondence between the reference and float images. The algorithm itself does not solve the equation completely and it assumes that pixels move in the direction of the gradient, which is not true for most circumstances. We propose a more accurate optical flow or motion vector calculation method to improve the registration performance.

Method and Materials:

For a 3D CT-to-CT registration problem, the Demons algorithm simply uses the gradient at each voxel as the 3D motion vector since one gradient constraint equation has three unknown variables. We first apply the Lucas Kanade method to solve the gradient constraint equation by including more nearby voxels. For some voxels near the contours, the temporal derivatives between the two images are too large, causing unrealistic large motion vectors. Similar to the Demons algorithm, a weighting factor is proposed and added to the original resolution using the Lucas Kanade method. The performance of both algorithms is compared for real patient cases. The float image is generated by rigidly or non-rigidly transforming the reference image. The vector field generated after the registration is compared to the original transformation. The planning prostate CT and CT-on-rails images from the same patient are registered using both methods for comparison. A multi-resolution scheme is also applied to overcome large voxel shift between images.

Results:

Using known translation, rotation or non-rigid deformation fields, the results from this study show the proposed algorithm quantitatively outperforms the Demons algorithm. This is further confirmed by patient studies demonstrating better registration results for the proposed algorithm.

Conclusion:

An improved Demons algorithm is investigated that may have a great potential to improve the registration performance for image-guided radiation therapy.