AbstractID: 11272 Title: Multi-level regularization approaches of non-parametric deformable registrations

Multi-level regularization approaches of non-parametric deformable registrations

Purpose: Most deformation algorithms using a single value smoother during optimization. We investigate multi-level regularizations (smoothers) during the multi-resolution iteration of two non-parametric deformable registrations (symmetry demon (SD) and diffeomorphic (DM) algorithms) and compare to a conventional single value smoother.

Method and materials: Smoothers were applied at 5 different levels of multi-resolution image registration process. Results were compared in terms of convergence rate, similarity measures (mean square error MSE and normal correlation NC), and Jacobian determinant of the vector displacement field (VDF), which measures how a voxel volume changes after registration. Six patients (mean 400x300x70 pixels) with large internal organ movement (five from 4DCT, one patient who was scanned with full and empty bladder) were evaluated in this study. The liver and lung displacement and bowel movements were approximately 1.5cm. The bladder volume changed by > 250cm^3.

Results: As smoothers increase their convergence rate decreases, however, smaller smoothers also have large negative value of the Jacobian determinant suggesting that the one-to-one mapping has been lost; i.e. image morphology is not preserved. In the SD method, the multi-level smoother calculates faster than the large single value smoother and is equivalent to the smallest single value smoother. For the DM algorithm, since our multi-level smoothers were implemented at the smoothing matrix (S) and the update field (U), calculation times are longer. The similarity measured by MSE, NC, and visual comparisons show that the multi-level implementation has better results than large single value smoothers, and better or equivalent for smallest single value smoother.

Conclusion: Multi-level regularization combined with multi-resolution has the advantage of preserving the morphology of the images and the registration results.