AbstractID: 8867 Title: Improving robustness of deformable image registration by pre-processing image intensities

Purpose: Intensity-based deformable algorithms notoriously suffer from low image contrast, as well as intensity inconsistency between the reference and the target images that are usually acquired at different times and/or on different CT or cone-beam CT scanners. The goal of this study is to develop a 3D intensity normalization procedure that ensures intensity consistency and increase the dynamic contrast of both images so that the robustness of image registration can be improved.

Method and Materials: We started the procedure by performing a rigid alignment between the reference and the target image. Subsequently, a local histogram mapping was computed over a volume of interest (VOI) centered at each voxel. This adaptive histogram mapping method enhances local image contrast and matches the intensity distribution better between the reference and target images. To alleviate noise level within the flat region with low image contrast, the histogram within the VOI was redistributed according to a pre-defined clip factor to avoid excess voxels within a particular bin. Finally, a trilinear interpolation was used to calculate adjacent VOIs near the boundary. In this study, we chose to use the accelerated “demons” algorithm in combination with the intensity normalization method. We tested the method using both synthetic images and patient data.

Results: We demonstrated both visually and quantitatively that significant improvement could be achieved for difficult cases where deformable image registration failed without using this procedure. We showed that the method worked well for very large deformations or in low-contrast images. For a prostate case with synthetic deformation, less than 0.5% of voxels have more than 5 HU errors when using the intensity normalization method. This number increased to 12% if pre-processing was not used.

Conclusion: We have implemented an effective pre-processing technique that can improve the quality and robustness of the intensity-based deformable image registration.