AbstractID: 8436 Title: Validation and Comparison of 3D Image Registration Approaches for Adaptive IMRT in Head-and-Neck Cancer

Purpose:

3D image registration is a key component in image-guided adaptive radiotherapy. It is imperative that the accuracy of a registration method is assured prior to clinical implementation. However, registration validation is scarcely covered in the literature. In this work, we validated and compared seven registration methods for CT/MRI and MRI/MRI fusion in adaptive radiotherapy treatment planning of head-and-neck tumors.

Method and Materials:

A planning CT image and an MRI image were acquired before the treatment and seven weekly MRIs acquired during an IMRT head-and neck cancer treatment. Seven methods including intensity-based, surface-based, landmark-based, manual, and non-rigid registrations were applied to align 2 pairs of CT/MRI, and 8 pairs of MRI/MRI datasets. For each registration, eight anatomic landmarks were identified in each image. The distance between the transformed landmark position and the manually determined position was calculated. The registration accuracy was estimated by the mean distance.

Results:

The mean distances between CT/MRI and MRI/MRI landmarks were approximately 2.0 mm. For CT/MRI registration, intensity-based registration plus manual adjustment performed the best with the smallest registration error of 1.2 mm. Non-rigid and manual methods both had small errors of 1.5 mm. Surface-based and landmark-based methods had larger errors of 3.3 mm and 2.4 mm, respectively. For MRI/MRI registration, non-rigid methods had the smallest registration error of 1.3 mm. Similarly, surface-based and landmark-based methods had larger errors of 2.8 mm and 2.9 mm, respectively. Non-rigid method and landmark-based methods had the greatest registration error variances.

Conclusions:

We qualitatively and quantitatively evaluated seven methods on CT-MRI and MRI-MRI registration for head-and-neck patient. Careful and quantitative evaluation of the registration accuracy is important for the identification of the optimized registration method, the application of multimodality imaging in treatment planning, and the daily image guidance in treatment delivery.