AbstractID: 2924 Title: A Feasibility Study of Atlas-based Image Segmentation in 3D Treatment Planning

Purpose:
To develop and evaluate a fully automatic atlas-based image segmentation method for radiotherapy treatment planning.

Method and Materials:
A very important part of 3-dimensional radiotherapy treatment planning is the contouring of normal regions of interests (ROIs). Currently, automatic image segmentation tools provided in treatment planning systems are usually based on edge detection and may not always be satisfactory. Atlas-based image segmentation is a promising method that uses deformable image registration to register the target images with reference images containing previously contoured ROIs. Atlas-based image segmentation utilizes all of the information in the images and has the potential to perform better than edge-detection based algorithms, in which only the edge information is used.

The performance of atlas-based image segmentation relies on the deformable image registration algorithm. We implemented a fast variational deformable image registration algorithm. The algorithm was tested at three common radiotherapy sites: head/neck, chest and pelvis. Physicians manually contoured the ROIs in the reference CT images. The new, randomly selected target images were automatically contoured. The results were evaluated by the physicians.

Results:
The entire process was completed in less than 15 minutes using a single CPU computer. The ROI masks were transformed into the new images using the displacement maps from deformable image registration. Contours were regenerated from the ROI masks and imported into the Pinnacle^{TM} treatment planning system. In all three clinical sites, the majority of generated ROI's required only minor further modifications.

Conclusions:
Atlas-based image segmentation is a powerful automatic contouring tool. Our algorithm provides excellent results in a majority of clinical cases. Implementation of atlas-based image segmentation may reduce the time required by physicians to contour normal structure ROI's in treatment planning. Additionally, it opens up the possibility of standardizing ROI contours, such as the parotid, in head and neck IMRT.