AbstractID: 13811 Title: Image Deformation Based on a Marionette Model

Purpose: Adaptive radiation therapy is enabled by a deformation process that warps the planning image to images acquired daily throughout the treatment regimen. A new method of image deformation, proposed at ICCR 2010, emphasizes the anatomical significance of the results. Instead of allowing each image voxel to move in any direction, only a few anatomical motions are permissible. This work carries the idea forward with improvements to the model for weight loss.

Method and Materials: The planning image and daily image are segmented automatically to label each voxel according to the tissue type represented. The differences between the segmentations are analyzed to generate a deformation field governed by six parameters. Deviations between the skin surfaces are attributed to weight loss, and are reconciled by expanding fatty tissue outward in a radial and elliptic fashion. This anatomically-constrained field is then used to initialize a free-form deformation that accounts for any motion not captured by the model.

Results: The method was validated on 30 clinical head/neck datasets from three clinics where the daily images are megavoltage CT. The average processing time, for volumes with roughly 110 slices and 256x256 pixels per slice, is only 52 seconds on a standard PC, without any human interaction. We generated animations that gradually warp the daily image to the planning image, and the movies produced by the marionette method are noticeably more visually pleasing, owing to the anatomic integrity. The solution was observed by experts to address problems with distorted bones, the spinal cord leaving its cavity, muscle tissue leaking into nodal regions, and parotid gland issues near the periphery.

Conclusion: Most of the changes observed across a course of treatment can be captured by a simple anatomical model. Using a model to initially constrain the deformation field can help mitigate deformation errors.

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