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Adaptive Prostate Planning Based on Megavoltage Computed Tomography Images Enhanced by Nonlinear Diffusion Filtering

Megavoltage CT (MVCT) images are primarily used for setup verification in the helical tomotherapy system. Thus, the image quality is not designed to be comparable to that of kilovolt CT (KVCT) images which were used for treatment planning, due to the fact that the incident photons in MV beam were attenuated mainly by Compton scattering. It is hard to use the MVCT images for adaptive treatment planning because of the poor image quality. The current commercial system does not support deformable registration to account for deformable organ volume and shape changes. A coherence-enhanced diffusion filtering algorithm was used to improve the MVCT image contrast. This denoising technique first proposed by Meilckert and Scharr not only reduced the image noise, it also preserves edge locations and orientations at the same time. The processed MVCT image sets were thus registered through a deformable registration algorithm (demons algorithm) and the optimized transformation matrix was applied to the corresponding dose matrix in each fraction. The dose-volume histograms (DVH) of important organs like bladder and rectum were compared to the planning DVHs and a new plan can be used for the remaining fractions through the commercial Tomotherapy Planning System if dose limits for these important organs may be surpassed. Our preliminary results from one prostate cancer patient with 35 fractions show that the approach is feasible.

References

Joachim Weikert and Hanno Scharr , A scheme for coherence-enhancing diffusion filtering with optimizaed rotation invariance, Journal of Visual Communication and Image Representation, Special Issue On Partial Differential Equations In Image Processing, Computer Vision, And Computer Graphics, pages 103-118, 2002