Implementation of a fast Monte Carlo scatter correction for cone-beam computed tomography

An iterative scatter correction algorithm [1] was implemented on real CBCT data. The steps of the correction algorithm are shown in Figure 1. First, the raw CBCT projection images are reconstructed using a filtered back-projection algorithm. The voxels of the reconstructed phantom are then converted from attenuation coefficient values to physical densities. This density phantom is then imported to a fast Monte Carlo CBCT simulation, which calculates the primary and scattered photon projection contributions. A scatter correction is then applied to the projection pixel data. The algorithm then returns to the first step and performs a reconstruction on the corrected projection images. The iteration procedure continues until a termination criteria has been reached.

Figure 2 shows the X and Y attenuation profiles through a reconstructed Solid Water™ phantom. The scatter correction appears to be producing a sharper edge at the air/phantom boundary, as well as reducing a cupping artifact in the X profile. In a region centered on the Solid Water™, the corrected scan attenuation coefficients approach a Gaussian distribution near the theoretical attenuation coefficient value of 0.22 cm⁻¹ (see Figure 3). In future work, the clinical ground truth attenuation coefficient for the Solid Water™ phantom will be measured with a diagnostic CT scanner.

These results show promise for the ability of the scatter correction algorithm to improve image quality in CBCT images. If sufficient image quality is attained, CBCT images could be reliably used in the framework of adaptive radiotherapy for dose calculations, image registration and autocontouring.