

AbstractID: 14046 Title: Improving IGRT Efficiency using GPU-based Ultrafast Reconstruction of DTS/CBCT and DRR

Purpose: One challenge of on-line image-guided radiation therapy is requirement of immediate availability of reconstructed 3D or 4D images for evaluation. This study is to develop a highly data-parallel version and platform of accelerating reconstruction for digital tomosynthesis (DTS)/Cone-Beam CT (CBCT) and digitally-reconstructed radiographs (DRR) based on ray-tracing algorithm.

Method and Materials: A modified FDK algorithm of tomographic image reconstruction is being implemented on a CUDA-based commercial graphics processing unit (GPU). This algorithm is developed to address time-consuming process of reconstructing DTS/CBCT, and DRR. The original projection images are first allocated to the textures on the graphic card. Based on the cone-beam geometry, the projection matrix for each gantry rotation is generated from the ray intersection and overlaid to the GPU memory. A unique thread ID will be assigned to each voxel volume for further computation. Global computation kernel of FDK processing is called from shared memory of each block on GPU. The reconstructed 3D data is then transferred back to CPU after synchronization. Image quality of the reconstructed images with both hardware and software techniques is compared using differential contrast-to-signal ratio (CNR) and pixel signal-to-noise ratio (PSNR) for various clinical sites including lung, pelvis and head&neck.

Results: With the new algorithm, the times for reconstructing DTS and DRR are improved by a factor of 100 using Quadro FX5800 and 30 using GT9600, respectively, over the conventional software method. The DTS/CBCT for a lung patient can be reconstructed and rendered with 4 to 51 seconds dependent on the number of projections. Consistency comparison of images reconstructed using both hardware and software techniques shows greater than both consistency and image resolution increasing.

Conclusion: A GPU-accelerated ultra-fast reconstruction allows real-time on-board imaging process to be completed within a minute to improve the efficiency of IGRT applications.