AbstractID: 13340 Title: Ultra-fast digital tomosynthesis reconstruction using CUDA programming for real-time image-guided radiation therapy

Purpose: To present an ultra-fast, reconstruction technique for digital tomosynthesis (DTS) imaging using GPU programming based on the Compute Unified Device Architecture (CUDA) platform (NVIDIA Corporation, Santa Clara, CA). The standard algorithm proposed by Feldkamp, Davis, and Kress (FDK) was used for acceleration.

Methods and Materials: The CBCT projections data were initially loaded onto the CPU RAM after image acquisition, then each projection image was sent to the GPU for preprocessing and back projection computations, until all projections are used to build the pseudo 3D DTS image volume. For convolution filtering of the preprocessing step, we have accelerated the Fourier transform calculations by utilizing the CUFFT (or CUDA FFT) library provided through CUDA. For the back projection step, which is the most time consuming part for CPU, we have parallelized the tasks as threads in GPU to gain massive speed up by assigning 512-block-size with number-of-slices-blocks (for 512×512×number-of-slices reconstruction volume), all executed simultaneously.

Results: The GPU-based implementation achieved, at most, 1.3 and 2.5 seconds to complete full reconstruction of 512×512×256 volume, for the full-fan and half-fan modes, respectively. Increasing the number of reconstructed slices had negligible impact on the overall time. In addition, these ultra-fast reconstruction times did not have negative impact on the integrity of the reconstructed images as there were negligible visual and pixel-value discrepancies between the CPU- and GPU-based implementations. This resulted in speed improvement of > 87 times compared with the central processing unit (CPU)-based implementation, with visually identical images and negligible pixel-value discrepancy.

Conclusions: We have developed an ultra-fast, reconstruction technique for DTS using CUDA-based GPU programming. With this achievement, we have shown that time allocation for image reconstruction is virtually eliminated and the future efforts, therefore, can now be directed towards utilizing the information contained in the images for real-time image-guided RT.