AbstractID: 7053 Title: Streaming Architectures for Cone-beam CT Image Reconstruction and Deformable Registration

Purpose: To develop data-parallel algorithms for tomographic reconstruction and deformable registration within a stream-processing paradigm, and execute them on cheap stream processors such as graphics processing units (GPUs).

Method and Materials: In the computer sciences, the stream-processing paradigm is emerging as a cost-effective way of solving large-scale parallel computing problems. This is due to the recent introduction of high-performance stream-processing hardware such as the Cell processor and GPUs---both are commodity stream (or vector) processors, designed specifically to support large-scale parallel computing on a single chip. This presentation describes how to use the stream-processing model to significantly accelerate the complex problems of data reconstruction and fusion for radiotherapy. Highly data-parallel models were developed for: (1) the Feldkamp, Davis, and Kress (FDK) reconstruction algorithm, and (2) Demon's algorithm for optical-flow based deformable registration. These models were implemented within the Brook programming environment and executed on an nVIDIA 8800 GPU.

Results: The performance of GPU-based implementations of the FDK and Demon's algorithms was analyzed using data obtained from an IGRT testbed of a preserved swine lung. The results indicate a substantial speedup of up to 17 times for FDK, and up to 33 times for Demons, when compared with a 2.4 GHz Intel Duo-Core processor. In addition, the GPU was found to be capable of high-quality reconstructions, with differences within a few Hounsfield unit.

Conclusions: Results indicate that data-parallel image-processing algorithms, when properly designed and executed on a GPU, achieve significant speedup when compared to high-end desktop CPUs. The acceleration of key data-processing stages will decrease the time needed to perform image-guided patient positioning and analysis.