AbstractID: 12969 Title: Implementation and Evaluation of Various DRR Algorithms on GPU

Purpose: The Digitally Reconstructed Radio-graph (DRR) is a fundamental computation task in cancer radiotherapy. It is used in 2D-3D patient registration, dose calculation, and iterative 3D and 4D cone-beam CT reconstruction (CBCT). Most DRR algorithms are designed to run on a single processor (CPU). However, significant speed up factors are realized by running DRR algorithms on recently developed graphical processing units (GPUs). It is the goal of this work to systematically evaluate various DRR algorithms running on GPU with emphases on computational efficiency and reliability. **Method and Materials:** We have implemented and evaluated three different DRR algorithms on both CPU and GPU. To test the speed of each algorithm, we simulate DRR projections of a XCAT phantom data set at 360 directions in a full rotation about the superior-inferior axis on an NVIDIA Tesla C1060 GPU card and a 2.27GHz Intel Xeon CPU. Speedup factors were then calculated. To test accuracy, the aforementioned projections were used as input to a Feldkamp–Davis–Kress 3D reconstruction, the current standard CBCT reconstruction algorithm. We then calculated the mean squared error (MSE) between the original and reconstructed data sets. In these tests we simulated a detector resolution of 512x384 and CBCT data resolution or 512x512x104. **Results:** We found a modified version Siddon's algorithm to run the fastest on GPU, with an average projection time of 30 ms. A distance-driven algorithm had the smallest MSE of 3.11×10^{-6} cm^2. A fixed stride ray-casting algorithm had a speedup factor of 204. **Conclusion:** We found substantial speedup factors for DRR algorithms running on GPU. The accuracy of each algorithm has also been objectively tested. Having a clear picture of the behavior of each algorithm will enable researchers to make an informed decision about which algorithm to implement in their own future work.