AbstractID: 13477 Title: GPU-based ultra fast direct aperture optimization in IMRT treatment planning

Purpose: To develop a graphics processing unit (GPU) based ultra fast direct aperture optimization (DAO) algorithm in intensity modulated radiation therapy (IMRT) treatment planning. **Method and Materials:** While DAO problems are well-studied, most of them focus on heuristic search methods such as simulated annealing and the computational efficiency is often very low. In contrast, we formulate this problem as a large-scale convex programming problem in terms of all multi-leaf collimator (MLC) deliverable apertures and their associated intensities. An exact method called column generation method is used which iteratively adds high-quality deliverable apertures while the treatment plan quality is improved. The efficiency of this approach has been ensured by exploiting fine-grained parallelism to effectively utilize the computational recourses on GPU. **Results:** A clinical prostate IMRT case with various beamlet and voxel sizes is used to evaluate our implementation. High quality treatment plans are obtained at a high efficiency. In particular, for a 9-field prostate case with 5×5 mm^2 beamlet size and $2.5\times2.5\times2.5$ mm^3 voxel size, the implementation takes only 7.1 seconds to generate 50 MLC apertures on an NVIDIA Tesla C1060 GPU. **Conclusion:** This work solved a major problem in developing ultra fast (re-)planning technologies for fast treatment planning in conventional IMRT and for real-time re-planning for online adaptive radiotherapy.