AbstractID: 5741 Title: Fast Efficient Global Fluence Map Optimization Using a Parallelized Objective Function for IMRT Treatment Planning

Purpose: Adaptive intensity modulated radiation therapy (IMRT) with image guidance requires frequent re-optimization of the dose distribution for treatment plan verification. We present an efficient and robust algorithm that solves fluence map optimizations (FMO) for IMRT and provides good target coverage of homogeneous targets ($R_{95\%} \geq R_{Rx}$), while at the same time maintaining dose to critical structures within specified tolerances.

Method and Materials: An analytic non-linear convex model was developed that uses a projected gradient algorithm with Armijo line search to solve fluence map optimizations for IMRT treatment planning. Voxel based penalty functions and a fluence non-negativity constraint were applied for the iterative minimization of a parallelized convex objective function on a dual node processor. Model parameters were tuned for three treatment sites (H&N, CNS, and prostate) and results assessed in-terms of algorithm speed, fluence maps and dose volume histograms. All cases were investigated for 5, 7, 9, and 11 equidistant beam angles and a generic set of parameters that provide good results obtained for each site. Improvements in plan quality are achieved on a case-by-case basis through dynamic parameter weighting.

Results: Our implemented projected gradient algorithm model solved FMO's, on a dual node processor, for the three sites in 0.34-8.55 seconds corresponding to 10-75 iterations. Dynamic weighting produced tighter target coverage, while still maintaining critical organs within acceptable tolerances with only a small increase in FMO calculation times.

Conclusion: The FMO optimization algorithm described shows that voxel based fluence map optimizations are feasible down to <10 second time scales while still achieving good target coverage and critical structure sparing for IMRT treatment verification and planning. A Further 25% improvement in FMO calculation time is expected using up to 6 node parallelization.

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