

AbstractID: 2980 Title: Development of a Fast Algorithm for Classifying Data Points as Inside or Outside a Polygon

Purpose: Adaptive IMRT with image guidance requires rapid computation of dose for frequent re-optimization. As patient geometry changes throughout treatment, millions of voxels must be continually associated with the various radiotherapy structures that are delineated for the patient. In beamlet dose models it is advantageous to identify only those voxels which can receive significant dose. Both of these tasks rely on a rapid point-in-polygon classification algorithm, which has not been improved since Siddon's work in the 1980s. We present a new algorithm that significantly outperforms the standard algorithm.

Method and Materials: A point-in-polygon classification algorithm was developed. Current algorithms spend substantial computational time calculating cross products between polygon vertices and grid points to establish intersection points. We present a method where entire rows of dose points are classified together using a single ray. Further, we avoid computing cross products by translating the structure polygons so that rays are cast along the +X axis (assuming polygons lie in X-Y planes). Crossings are observed where vertices display a change in Y coordinate sign. This algorithm was compared to the Siddon algorithm, with our in-house treatment-planning system for both associating voxels with radiotherapy structures and targets and for voxel down sampling using stereographic projection.

Results: Our new point-in-polygon technique shows considerable decrease in calculation times. 1.7 million voxels classified in 14 structure polygons produced a 100 fold decrease (2.1 vs. 213 s on a 3.6 GHz p4 PC) in computational time. Voxel down sampling using stereographic projection in the computation of 1,466 beamlets produced a 1.8 fold decrease (185.2 vs. 334.5 s) in computational time.

Conclusion: Significant improvement in performance over the existing cross-product method for polygons has been observed with the new algorithm. However, parallel computation is still currently required to produce a typical IMRT treatment plan in less than one minute.