AbstractID: 10978 Title: Using total-variation regularization for IMRT inverse planning with field-specific numbers of segments

Purpose:

Currently, there are two types of treatment planning algorithms for intensity modulated radiation therapy (IMRT). The beamlet-based algorithm generates fluence maps with high complexity, resulting in large numbers of segments in the delivery. The segment-based direct aperture optimization (DAO) algorithm uses a small number of segments. However, the number of segments is typically pre-fixed, and the optimization is computationally intensive. In this work, a regularization based algorithm is proposed to overcome the drawbacks of the DAO method.

Method and Materials:

Instead of smoothing the fluence maps, we include a total-variation term in the optimization objective function to reduce the number of signal levels of the fluence maps and therefore the number of deliverable apertures. As compared to the DAO algorithm, our method has an efficient form of quadratic optimization, with an additional advantage of optimizing field specific numbers of segments based on the modulation complexity.

Results:

The proposed approach is evaluated using two clinical cases. Provided that the clinical acceptance criteria of the treatment plan are satisfied, for the prostate patient, the total number of segments is reduced from 61 using the Eclipse planning system to 35 using the proposed algorithm; for the head and neck patient, the total number of segments is reduced from 107 to 28. The head and neck result is also compared to that using an equal number of 4 segments for each field. The comparison shows that using field-specific numbers of segments achieves a much improved dose distribution.

Conclusion:

A total-variation based inverse planning method is proposed in this work. As compared to other existing methods, the proposed algorithm is derived using different principles and implemented efficiently. The patient studies show that the proposed algorithm significantly reduces the total number of segments used in the treatment without compromising the delivered dose distribution.