AbstractID: 8975 Title: Arc-Modulated Radiation Therapy (AMRT): A Novel Method for Rotational Radiation Therapy

Purpose

To develop a prototype treatment planning system for Arc-Modulated Radiation Therapy (AMRT), which delivers the optimal radiation distribution with only one beam rotation.

Method and Materials

The AMRT planning starts with inverse planning, typically using 36 equally-spaced (fixed) beams and producing 36 continuous intensity maps. After inverse planning, an AMRT leaf sequencing algorithm converts the optimized intensity patterns to a sequence of MLC apertures along a single arc. Finally, a homegrown Monte-Carlo superposition-based dose calculation engine is used to quickly and accurately evaluate the plan qualities.

A big challenge to AMRT is leaf sequencing. Our algorithm is based on a key observation that if each optimized intensity pattern is delivered through its neighboring beam angles within a $\pm 5^{o}$ range, there is only negligible error on the resulting dose distribution. Thus, the sequencing problem becomes how to guarantee the interconnectedness of the MLC apertures along the single arc, while reproducing or closely approximating the optimized intensity patterns. We model this problem as computing shortest paths in directed acyclic graphs, and solve it efficiently using various algorithmic techniques.

Results

We applied our AMRT approach to 18 clinical cases with a wide range of treatment sites. In terms of dose conformity, we observed that AMRT plans outperform gantry-fixed IMRT plans and rival intensity-modulated arc therapy (IMAT) plans. In terms of delivery efficiency, AMRT plans are much more efficient and can be delivered in less than 5 minutes for complex head-and-neck cases. The AMRT planning time is currently about 1-2 hours.

Conclusion

We developed a prototype treatment planning system for AMRT, which delivers the optimal radiation distribution with only one beam rotation. Experimental studies demonstrated the potentials of our new approach to dynamic IMRT which warrants further investigations.