AbstractID: 13688 Title: A Dynamical System Approach for Real-time IMRT Optimization

Purpose: Real-time adaptation of IMRT treatment plans to daily changes in anatomy is a necessary task for adaptive radiotherapy. Re-optimization of radiation beam weights is maybe needed for some treatment fraction, which is computationally expensive and practically inefficient. Therefore, we are developing a new optimization algorithm for real-time IMRT re-planning using a dynamical systems approach. **Method and Materials:** IMRT planning is viewed as an adaptive control design and is solved by a discrete-time dynamical systems approach. We developed a constrained Kalman filter (CKF) to obtain optimal estimates of the desired beam weights subject to prescribed constraints recursively according to the changes in tumor geometry. Our proposed method eliminates the necessity of performing the fluence-map optimization at each treatment and, instead, adopts previous optimization to recursively compute optimal fluence-maps for subsequent treatment fractions. As a validation we demonstrated our method using digital phantom data. **Results:** To generate benchmark data, we used an offline solver to calculate the optimal pencil beam weights for two treatments, where an organ-at-risk is represented by disk shape and a horse shoe shape structure was selected as the PTV in one treatment and was deformed in the second treatment, which is used as a test case. In our experiments, the CKF yielded similar performance to the offline solver on the test case in terms of mean-squared error and dose-volume histograms with fraction of the required time. It also showed robustness to initialization conditions. **Conclusion:** We presented a new efficient algorithm based on recursive filtering for IMRT planning. This algorithm is capable of developing complete treatment plan taking into account changes in tumor geometry while avoiding re-optimization of radiation beam weights for each treatment fraction. **Conflict of Interest:** Part of this work was supported by NSF grant and Varian Medical Systems.