AbstractID: 11238 Title: Performance of MPC-Based Adaptive Radiotherapy Optimization

Purpose:
An adaptive re-planning framework was used to account for tissue deformation during RT treatment courses. The framework is based on a multivariate control concept called model predictive control (MPC). A variety of control rules and optimization schemes were investigated using a prioritization-based optimization method. Performance of the MPC control was evaluated with conventional evaluation metrics such as DVH, coverage, and homogeneity as well as model-based plan evaluation metrics.

Method and Materials:
The Head/Neck IMRT treatment process was simulated using mid-course CT scans, tracking treatment doses to tissues at the voxel level. Off-line adaptation was performed with the changing patient model, updating the state of the process along with the dose-to-date information. Constrained optimizations were performed for re-planning as well as for pre-treatment planning. Multivariate control schemes including maximum constraint violation were utilized for re-planning.

Results:
With the adaptation of the treatment plan to the patient-specific anatomical changes, the predicted outputs could be efficiently controlled improving the robustness to those changes. Although the results show that the general trend in the predicted outputs follow the tissue volume changes, the clinical decision to re-plan should be made by assessing the total predicted treatment output expectations. For cases investigated, a limited number (3~4) of re-plans were sufficient to control high priority outputs while the use of a tighter tolerance increased the number of re-plans. Re-plans were triggered mostly by the target coverage criteria. The studied course simulations indicate that significant changes are shown early in treatment. Therefore, frequent updates of the patient models may be necessary and critical to plan adaptation.

Conclusion:
The proposed multivariate control framework provided an intuitive method of articulating clinicians' decisions and priorities for re-planning. In addition, the use of prioritization in re-optimization may allow more efficient re-planning which requires fewer planning resources.

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