AbstractID: 6825 Title: Incorporating organ deformation/patient setup into inverse planning (I): Algorithm and Implementation

The dose distribution in an organ of interest cannot be correctly reconstructed without knowledge of internal organ motion/deformation, setup inaccuracies, and temporal density variations in the patient, thereby limiting the capability of conventional inverse planning optimization. We have developed an inverse planning system which constructs the optimal dose distribution by considering organ/patient temporal geometric variation, as determined from multiple CT and portal image feedback. This inverse planning system consists of the following components: (1) organ subvolume registration and occupancy frequency reconstruction, which accounts for both organ motion/deformation and setup error, (2) fraction and cumulative dose distribution reconstruction in the organ, which accounts for both the temporal position of organ subvolumes and temporal density of the patient, and (3) objective function and constraint evaluation, which incorporates the temporal information of organ dose distribution.

The inverse planning system was tested on prostate cancer patients, each with multiple CT images (15~18 CTs) and daily portal images acquired during the treatment course. The optimal treatment plan produces a heterogeneous dose in regions adjacent to target/critical normal structure boundaries to spare normal tissue and compensate for target dose loss. The gradient of the dose distribution in this region depends on the occupancy density of both the target and normal organs. The plan demonstrates significant improvement of both tumor control and normal tissue complication probability. In summary, incorporation of treatment-imaging feedback into inverse planning shows great potential for treatment optimization and dose escalation.