AbstractID: 9561 Title: Moving towards real time adaptive radiation therapy: integrating patient imaging, plan adaptation and radiation delivery

Purpose: To propose a new approach to on-line adaptive radiation therapy (ART) in which daily image acquisition, plan adaptation and radiation delivery are performed concurrently. **Method and Materials:** Daily imaging was performed using an on-board cone beam CT imaging system. X-ray projections were continuously acquired as the gantry rotates between treatment positions. A filtered back-projection algorithm was used to reconstruct 3D digital tomosynthesis (DTS) images from the limited angle x-ray projection data. An edge detection algorithm was used to automatically segment the 3D DTS images as the gantry arrives at each treatment position. The treatment plan was then re-optimized for the most recent DTS image contours using modified direct aperture optimization (DAO). To test our system, a model representing an average prostate case was generated. A treatment plan based on this original anatomy was created using our DAO system. To simulate inter-fractional prostate deformations, three clinically relevant deformations (labeled: small, medium and large) were modeled by systematically deforming the original anatomy. The ability of our integrated approach to adapt the original treatment plan to account for the anatomy deformations was investigated. **Results:** The original treatment plan becomes clinically unacceptable for all three deformations, based on the dose-volume constraints from the Radiotherapy and Oncology Group 0415 prostate protocol. Using our integrated approach to on-line ART, the original treatment plan was successfully adapted to arrive at a clinically acceptable plan for all three anatomy deformations, with the treatment time drastically reduced compared to the current on-line ART procedure. **Conclusion:** We have developed a new approach to on-line ART in which image acquisition, plan adaptation and radiation delivery are temporally integrated. We have shown that it can successfully adapt the original treatment plan for three clinically relevant prostate deformations while considerably reducing treatment time.