

Purpose: Tumor motion tracking in liver stereotactic body radiation therapy (SBRT) is highly desirable for improvement of treatment accuracy, dose conformity and sparing of healthy tissue. On-board megavoltage (MV) x-ray imaging has unique advantages for assessment of tumor location during treatment. This work proposes a novel method to track tumor motion in MV images using cone-beam CT (CBCT) projections as prior knowledge.

Methods: The learning based tumor tracking method consists of main two steps. First, a prior of 3D tumor motion is estimated from CBCT projections. Relying on the detection of implanted kV fiducials, the tumor motion trajectory is constructed along the CBCT projection angles. 3D tumor locations are then reconstructed from the trajectory. Further, a prior for tumor motion in EPID images are generated by projecting 3D motion on the MV imager plane. Second, tracking is carried out in an incremental learning framework, which adapts the sequential tracking knowledge into current estimation. The prior knowledge of tumor motion obtained in the first step is therefore integrated into estimation. For robust real-time tracking, the algorithm is implemented by a sequential incremental update technique.

Results: Patient data acquired from a liver SBRT treatment is used to validate our algorithm. Half-fan CBCT projections acquired in three fractions were used to estimate 3D tumor motion. A total of 700 EPID images were analyzed for tumor tracking. All results were evaluated by clinician-defined tumor positions and manual tumor tracks. The average root mean square error for tumor tracking is 0.89 ± 0.21 mm.

Conclusions: A novel learning based tracking algorithm has been developed for tumor tracking in MV images. With the fast incremental online updating technique, our algorithm is well suited for real-time tumor tracking and in-treatment applications.