AbstractID: 8761 Title: Application of Principal Component Analysis for marker-less lung tumor tracking with beam's-eye-view EPID images

Purpose: Recent studies have shown the impact of beam's-eye-view (BEV) imaging during radiotherapy to monitor the tumor location. This information can be used for real-time interventions, treatment setup and verification, adaptive radiotherapy and delivered dose calculation. Although the tumor-lung tissue density contrast can be poor, we show that it can be sufficient for tracking without implanted markers. The pre-treatment 4DCT information used to plan the treatment is employed to ascertain the tumor motion during the treatment.

Methods and Materials: Exit radiation is passively acquired during lung tumor radiotherapy by operating an EPID in *cine* mode. The *cine*-EPID in-treatment images and the pre-treatment phase-specific DRRs are registered and corrected for setup induced affine transformations. DRRs are made from each of the 10 phase bins from the 4DCT simulation scan. Principal Components Analysis is able to discriminate small differences between similar images by shifting the image space axes to cause significant differences. The multidimensional image space is generated using the collection of DRR and EPID images. Each image can be represented as a linear combination of the best principal components. Using the projection coefficients, a multidimensional distance between the images is computed to compare each in-treatment image with the ten phase-specific DRRs. The maximum similarity is found by computing the minimum distance between the images so the phase-specific DRR and in-treatment EPID image are matched.

Results: We were able to attribute the phase information to at least 75 % of the acquired in-treatment images. The methodology was tested on the DRR images alone with 90 % phase recovery.

Conclusion: We have developed a PCA-based algorithm that enabled us to quantify the differences between the tumor motion within the planning 4DCT and the actual tumor motion during the treatment.

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