Purpose: To develop an algorithm for tracking lung tumors in rotational cone-beam KV x-ray projections based on combined markerless diaphragm and tumor tracking.
Methods: A combined tracking algorithm which uses surrogate-based tracking for angles at which the tumor is difficult to track directly is implemented. Direct tumor and diaphragm tracking are performed using template matching based on templates from 4DCT. A volume of interest is defined around the diaphragm apex and used to develop diaphragm templates. A linear model relating diaphragm apex and tumor positions is developed based on 4DCT. The tracked position of the diaphragm apex is used to calculate tumor positions based on the linear models. The two tracking signals are combined by selecting the method expected to be more accurate at each angle. Since direct tumor tracking is often difficult when the tumor is occluded by the spine and central structures in projections, diaphragm-based tracking is used when the tumor is expected to overlap with these structures in the projections. Direct tracking is used when the tumor is expected to be more visible. The methods are applied to anatomical digital phantom and patient cases.
Results: For the digital phantom, the e95 was 1.1 mm with direct tracking, 0.9 mm with diaphragm-based tracking, and 1.1 mm with combined tracking. The correspond erms values were (0.6, 0.4, 0.6) mm. In patient 1, the e95 was 1.9 mm with direct tracking, 1.7 mm with diaphragm-based tracking, and 1.7 mm with combined tracking. Corresponding erms values were (1.0, 0.9, 0.8) mm. In patient 2, the e95 was 4.6 mm with direct tracking, 3.0 mm with diaphragm-based tracking, and 2.9 mm with combined tracking. The corresponding erms values were 2.5, 1.7, 1.6) mm.
Conclusion: A combined tracking algorithm was developed which incorporates benefits of both diaphragm-based and direct tumor tracking.