AbstractID: 10581 Title: A diaphragm tracking algorithm for megavoltage cone beam CT projection data

Purpose: To test a novel algorithm for diaphragm detection in 2D views of cone-beam computed tomography (CBCT) raw data.

Method and Materials: 6 Siemens megavoltage CBCT scans of lungs were analyzed. For each scan, a user identified the diaphragm apex in two full exhale and two full inhale views to determine exhale and inhale bounding points, respectively, in room coordinates. Projecting bounding points into other views creates opposite corners of a bounding rectangle that is enlarged to create a cost function region (CFR). A cost image is created by multiplying the gradients of the Gaussian filtered CFR with a gradient direction matching function, based on diaphragm contour training sets. The sum of cost image values along a parabolic path is $V(a, x_0, y_0, t)$, where the parameter set (a, x_0, y_0, t) describes a parabola whose vertex is constrained within the bounding rectangle of the view at index t. Dynamic programming finds the path in this 4D parameter space that maximizes the sum of V, over all views, subject to smoothness constraints between adjacent views. The results were compared to the expert-identified diaphragm apex. Errors were calculated in room coordinates as the root-mean-square distances between the expert's points and the parabola's vertices in all 200 views. Room coordinates were calculated by interpolated ray-tracing.

Results: The diaphragm was successfully detected in all 6 data sets, even for views with poor image quality and confounding objects. Each CBCT scan analysis (200 views) took about 35 seconds on a 2.66 GHz Intel quad-core 2 CPU. The average cranio-caudal position error was 1.58 ± 0.44 mm. Other directions were not assessed due to uncertainties in expert identification, so future studies will use anthropomorphic motion phantoms.

Conclusion: The diaphragm detection algorithm is sufficiently quick and accurate for motion determination prior to radiation therapy.