

Purpose:

Respiratory-correlated (4D) CT scans produce a set of images corresponding to different phases of the breathing cycle. In lung cancer treatment, a potential application of 4D cone-beam CT (CBCT) scans taken on the treatment unit is to measure the tumor trajectory before each treatment, to verify whether the motion remains stable over the course of treatment. This presentation describes techniques we are developing for tumor trajectory measurement with 4D CBCT on our Varian linacs.

Methods:

A CBCT scan of a phantom placed on a periodically moving platform is taken on a Varian iX unit. The Varian RPM system is used to record the “breathing” phase vs time, and this information is used to sort the projection images into phase bins. For each phase bin an image is reconstructed using conventional Feldkamp-Davis-Kress filtered backprojection.

The “tumor” region is contoured manually on one phase image, and a deformable registration algorithm is used to calculate the shift in points on the region’s surface from this phase to each other phase. The centroid of these surface points is used as a measure of the tumor position.

Results:

The deformable registration algorithm succeeds on test data consisting of clinical 4DCT scans of lung cancer patients taken on a CT simulator. Tumor motions of a few mm are measured.

Preliminary 4D CBCT phantom images taken at the normal gantry rotation speed of 6 degrees/second show significant streak artifacts since the angular spacing between projections is large (>10 degrees); this low image quality is not suitable for the registration algorithm.

Conclusions:

Deformable image registration between phases is a practical method to measure lung tumor trajectory. In a 4D CBCT scan, reducing the gantry rotation speed is necessary to improve image quality: we plan to investigate this on a Varian TrueBeam unit.