

AbstractID: 10252 Title: Impact of 4D cone beam CT view-aliasing artifact on nonrigid registration accuracy

Purpose: To evaluate the effect of 4D cone beam CT view-aliasing artifact on nonrigid registration accuracy.

Method and Materials: End exhalation (EE) and end inhalation (EI) volumes from a 4D multi-slice CT image (4DCT) of a research subject were registered using a small deformation inverse consistent linear elastic (SICLE) registration algorithm to produce a reference displacement vector field (DVF) between the two images. Artificial cone beam CT projections were generated for the EE and EI volumes at several different angular sampling patterns, mimicking 4D cone beam CT (4DCBCT) acquisition in a free-breathing patient. The projections were reconstructed into EE and EI 4DCBCT phase images containing view-aliasing artifact due to angular undersampling, but without CBCT scatter and beam hardening artifacts. The EE and EI 4DCBCT images were registered using the SICLE algorithm to produce a test DVF. Test DVFs were generated at a range of angular frequencies from 0.17 projections per degree to 1.83 projections per degree (full angular sampling on a commercial cone beam CT system). The norm of the voxel by voxel vector difference between the test DVF and reference DVF within the patient's delineated lung volume was calculated.

Results: The mean absolute error was significantly associated with the projection angular frequency ($p < 0.05$, exponential regression, $R^2=0.996$). The median error was below 0.2 cm and 90% of the error was below 0.3 cm for the lowest frequency evaluated here of 60 projections per phase. However, above a sampling frequency of 0.33 projections per degree (120 projections per phase), 90% of the error was less than 0.1 cm in relation to the 4DCT registration.

Conclusion: Using at least 120 projections per phase, view-aliasing artifact had a minimal effect on the registration accuracy for the SICLE algorithm due to inherent elastic and smoothing constraints in the algorithm.