Abstract ID: 17728    Title: A Fourier Technique for Markerless, Self-Sorted 4D-CBCT: Effect of Respiratory Characteristics

Purpose: A self-sorted 4D-CBCT technique was previously demonstrated to be successful at directly extracting motion from projection data using Fourier Transform (FT) principles. The technique employed both phase and magnitude information of the FT to identify peak-inspiration projections. This work investigates the effect of various respiratory characteristics on the robustness of the technique.

Methods: With the 4D Digital Extended Cardiac Torso (XCAT) phantom, sixteen distinct patient respiratory scenarios were simulated. CBCT projections were generated per scenario to examine the effect of potential breathing abnormalities, including four inspiration-to-expiration (I/E) ratios as well as three sets of surrogate patient profiles exhibiting irregularities such as baseline shift (BS) only, inconsistent peak-inspiration amplitudes (IPI) only and a combination of these irregularities. Respiratory cycle (RC) lengths of 3-6s were studied, as well as diaphragmatic motion amplitudes ranging from 0.25-2.0cm. Image acquisition parameters were optimally selected to fulfill sampling requirements of 4D-CBCT reconstruction, while maintaining practical dose and scan times. The accuracy of phase assignment of each FT technique per scenario was quantitatively assessed by computing the average phase difference (APD) to the predetermined gold standard, as well as the percentage of projections assigned within 10% phase (PP10) of the gold standard.

Results: For all scenarios other than the patient surrogate profiles, FT-phase resulted in APD=0% and PP10=100%. The selected profiles exhibiting BS only, IPI only, and both BS and IPI achieved APDs of 1.3%, 1.5%, and 0.4% and PP10s of 100%, 98.8% and 100%, respectively. FT-magnitude performed less ideally, but still within the acceptable window of APD<10% and PP10 around 90% and greater for all factors other than diaphragm motion amplitude, where the robustness was substantially degraded below 1.5cm.

Conclusions: Both Fourier techniques performed robustly across a diverse set of respiratory variables. However, FT-phase was more accurate than FT-magnitude for all studied scenarios.

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