AbstractID: 6710 Title: A Multi-Resolution, Multi-Scale, Mutual Information Technique for Registration of High- and Low-kVp Projections in Dual-Energy Imaging

Purpose:
In dual-energy (DE) imaging, double-shot acquisition provides superior DQE and detectability index compared to sandwiched detectors, but introduces the potential for misregistration artifacts (e.g., respiratory, cardiac, and bulk motion). This paper reports a projection registration scheme operating at various levels of scale and resolution to resolve misregistration errors prior to DE decomposition.

Method and Materials:
The method is based on joint histograms of the high- and low-kVp images (or ROIs therein), with optimal image transformations computed to maximize the mutual information between the images. The image is subdivided into a series of ROIs, with an optimal transformation computed for each ROI. Large ROIs are downsampled to reduce the computational complexity of the optimization. The ROI transformations are smoothed and interpolated to determine a pixel-wise transformation for the entire image. This is repeated with progressively smaller ROIs.

Results:
The results demonstrate that large scale ROIs (400x400 pixel) are effective in correcting bulk patient motion such as drift or relaxation. A second pass with a smaller ROI (200x200 pixel) corrects breathing and cardiac motion. A final pass with yet smaller ROIs (100x100 pixels) is effective at correcting the motion of fine bronchio-vascular structure. The combination of these in an iterative multi-resolution, multi-scale method effectively registers the high- and low-kVp projections such that DE images exhibit significantly reduced motion artifacts – particularly in the scapulae, aorta, heart, liver, and bronchioles. Expert radiologist readings suggest a significant improvement in image quality and diagnostic performance.

Conclusion:
The iterative, multi-resolution, multi-scale registration corrects misregistration progressively at scales ranging from bulk anatomical drift down to smaller scale motion such as that of fine pulmonary vasculature. The approach is a vital part of the DE image processing chain that has been implemented for a clinical DE imaging trial with 200 patients.

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