AbstractID: 3181 Title: Image Interpolation in 4D CT Using a BSpline Deformable Registration Model

Purpose: To develop a method for deriving phase-binned 3D CT images through the interpolation of CT images at 2~3 known phase points..

Method and Materials: 4D-CT dataset for 3 patients were acquired. The deformation between inhale and exhale phases was quantified using a BSpline image registration model. During the registration calculation, the displacement coefficients defined on a lattice of nodes overlaid on the image were iteratively modified until optimal match was achieved. Images at an arbitrary phase were deduced by direct interpolation of the node coefficients. The interpolated images were compared with the actual 4D dataset and the results were evaluated by measuring the displacements of implanted fiducials in the two sets of images. Checkerboard and subtraction images between the interpolated and actual images were also computed.

Results: The model was capable of describing the patient-specific anatomical deformation between the inhale and exhale phases and generating images at intermediate phases with a 3 mm accuracy. Subtraction images indicated only 0.1% of voxels having a difference >20 HU. The technique also mapped the organ contours at a known phase to other phases and provided an effective way for designing patient-specific margins in the presence of respiratory motion. Finally, the technique lead to a 90% reduction in the stored data because the 4D CT dataset of 25 million pixels can now be described by only a few thousand BSpline lattice points.

Conclusion: Organ deformation during the breathing process can be modeled by using an interpolation of the deformation field with 3mm accuracy. To obtain images at any phase during a breathing cycle, it seems adequate to acquire only 2~3 sets of images at some distinct phases such as inhale and exhale points. The technique offers a practical solution for 4D-CT acquisition with greatly reduced radiation dose and binning artifacts.