AbstractID: 2931 Title: Image segmentation in 4D CT based on a deformable image registration model

Purpose: While 4D CT provides a powerful tool to study the anatomy change caused by respiration, a hurdle in fully realizing its potentials is how to segment the involved organs efficiently for all breathing phases. Here we investigate a strategy of using deformable image registration for mapping the contours delineated at a known phase to all other phases of the 4D CT images.

Methods and materials: 4D CT image sets for four patients (one esophageal and three lung patients) were acquired by using a GE LightSpeed-QX/I scanner. Ten phase bins were used in the data acquisition. The involved organs were delineated by a physician on the 3D image sets corresponding to the inhale phase point. The images at different phases were registered using a BSpline deformable model implemented in the VTK/ITK platform. The contour points on the inhale phase were automatically mapped to the corresponding points on the images of other phases following the mapping relation established by the deformable model. The performance of the auto-segmentation tool was evaluated by comparing directly with the contours outlined by the physician on selected phases.

Results: The deformable model was capable of accommodating significant variability of structures over time and across different individuals. In all patients, the mean measured error was 1mm for clearly differentiated organs such as the lungs, and 2 mm for medium-sized organs like heart. A maximum error of 4 mm was observed locally for noisy or binning-artifact degraded voxels. Additionally, the method was used to deduce tumor path at any phase, permitting close tailoring of the margins of the tumor targets in the presence of respiration.

Conclusion: Contour evolution in 4D images can be easily defined and tracked using a BSpline deformable model, with no user interaction required. The method provides millimeter-accuracy while eliminating the labor-intensive segmentation procedure.