AbstractID: 14012 Title: 3D-3D deformable registration based on bifurcations of tubular organs for the 4D computed tomography (4DCT) image sets

Purpose: To develop an accurate feature based 3D-3D deformable registration method for patient-specific motion model used in external beam radiation treatment of lung cancers based on a 4D computed tomography (4DCT) image set by utilizing unique features of the bifurcations of tubular organs.

Method and Materials: Each 4DCT set consisted of 10 phases of 3DCT volumes during one breath cycle. A 3D tubular organ segmentation was first performed on each of the phases to extract the centerlines of bronchial trees, estimate radius of bronchial trees and automatically detect the bifurcation points by applying learning algorithm with specially designed filters. A novel deformable registration method was applied to minimize the distances of the corresponding bifurcation points between a target phase and a reference phase (e.g., between 0% phase and 50% phase) to capture the transformation between different phases. The results were evaluated by using volume and distance based estimators.

Results: The learning method was trained and tested with positive and negative examples. The generalization error of the learning method was estimated using bootstrapping with the mean error rate 4.6%. The detailed quantitative and qualitative registration results are shown in the supporting materials. The mean distance estimator yielded results ranging from 1.93 mm to 4.46 mm between the corresponding points between the 0% phase images and the 50% phase images after the deformable registration. The root-mean-square error ranged from 1.99 mm to 5.13 mm.

Conclusions: A novel and accurate 3D-3D registration method based on the bifurcations of the tubular organs was developed to capture the transformation between the 3D CT images in the 4D computed tomography (4DCT) image sets. These preliminary results show that the proposed method is robust, fast and accurate for the deformable registration of the tubular organ in the lung.