Purpose:
The goal of our method is to reconstruct the 4D-CT from single 3D free-breathing image acquired at the treatment day, for improving accuracy in patient setup and dose delivery during radiotherapy of lung cancer.
Methods:
Our method consists of two steps. First, we propose a new spatiotemporal registration algorithm to build a 4D lung motion model by establishing temporal correspondences across different respiratory phase images of the 4D-CT acquired in the planning day. Second, we use the obtained 4D lung motion model to reconstruct a new 4D-CT for the treatment day, using just a free-breathing 3D-CT acquired in the treatment day. Specifically, in this step, we first de-interlace each slice of the free-breathing 3D-CT w.r.t. the optimal phase and couch position to obtain a sequence of incomplete 3D-CT images, each with image information only in certain slices. Then, we warp the 4D lung motion model (built in the planning day) to the sequence of incomplete 3D-CT images for reconstruction of a new complete 4D-CT for the treatment day.
Results:
The spatiotemporal registration algorithm in the first step was tested on five lung 4D-CT datasets with manual landmarks. Our algorithm achieves the best registration accuracy, compared to several other start-of-the-art deformable registration algorithms. The 4D-CT reconstruction algorithm in the second step was evaluated on a simulated free-breathing dataset. Our algorithm is able to reconstruct a high-quality 4D-CT with clear anatomical structures from single free-breathing 3D-CT.
Conclusions:
We have developed a novel two-step method to reconstruct a complete 4D-CT from single free-breathing 3D-CT acquired in the treatment day, by using a 4D lung motion model built from the 4D-CT acquired in the planning day. Promising results have been obtained in both simulated and real-patient datasets, indicating great potential of this method in improving the quality of image-guided lung radiotherapy.