

Deformable Image Registration for Pleural Photodynamic Therapy

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Abstract

Introduction: Deformable image registration is a form of medical image processing that can fuse images acquired by different modalities, and can provide insights into the development of phenomenon and variation in normal anatomical structure over time. Prior to post-operative pleural photodynamic therapy (PDT) performed at the University of Pennsylvania, a series of computed tomography (CT) scans of lungs will be acquired for each patient. During PDT treatment, an infrared (IR) navigation system is used to contour the lungs and provide real-time treatment guidance. The ultimate goal is to perform deformable registration of the CT images to the contour-based structure of lung. This manuscript shows some preliminary results of the deformable image registration model developed in COMSOL Multiphysics® using images and contoured structures of the lungs both acquired by CT scan.

Method: First, the Dicom CT images of lungs are read into MATLAB®, which creates intensity matrices. Second, image segmentation is performed to differentiate different tissue types such as bone, connective tissue, organs, and air in the lung. Third, the lung will be contoured via gradient edge-detection. These contours are then converted into solid geometries and imported to COMSOL. The structure contours of lungs acquired will be directly converted and imported to COMSOL. In the COMSOL model, the image registration will be performed via an Arbitrary Lagrangian-Eulerian (ALE) moving mesh method. ALE mesh is created in a reference image and deformed to match a target image. To accomplish this deformed mesh registration, the ALE method solves partial-differential equations (PDEs) for the mesh displacements to smooth mesh deformation.

Results: Figure 1 shows a representative slice of the original CT image of lung at the position of $z=90.5$ mm. Figure 2 shows the segmented CT image using K-means method. Figure 3 shows the CT structure scanned at the same location (i.e. $z=90.5$ mm). After the segmentation, lung in figure 2 was contoured and converted to solid geometry so that it can be imported into the COMSOL. Figure 4 shows the mesh of imported geometry. The results of the deformable image registration performed for five patients will be presented and discussed in this work in the near future.

Figures used in the abstract



Figure 1: CT image of lung at $z=90.5$ mm.

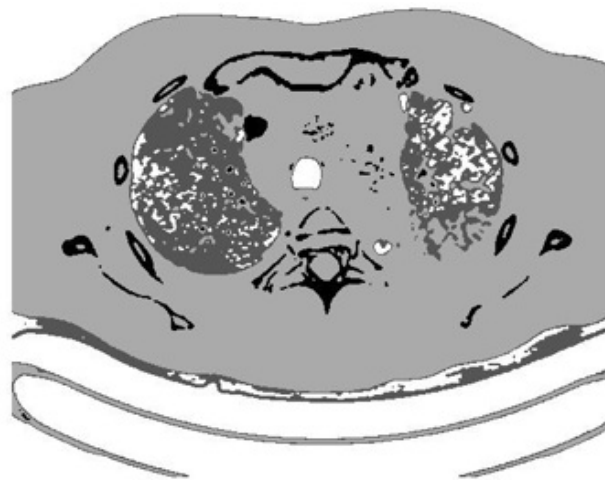


Figure 2: Segmentation of the CT image.

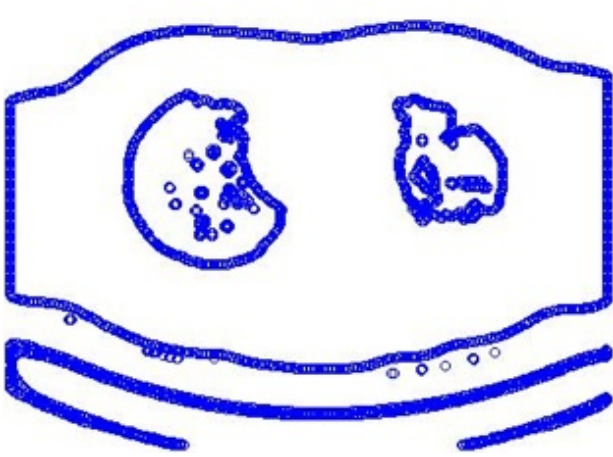


Figure 3: The structure of the lung.

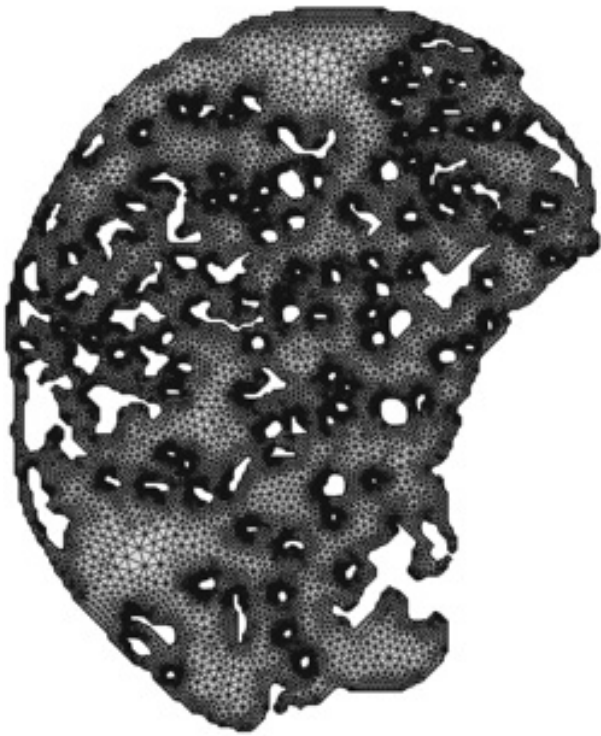


Figure 4: The meshed imported geometry of lung.