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Inter-Subject Lung Respiratory Motion Modeling with Motion Artifacts Reduction

Ciliang Shao[1], Hejia Zhang[1], Jingjing He[1], Yang Ye[1], Kunpeng Wang[1]
[1]Sichuan University-Pittsburgh Institute,
Sichuan University, Chengdu, China
2021141520227@stu.edu.scu.cn; 2020141520183@stu.edu.scu.cn; 2022141520044@stu.edu.scu.cn;
2022141520102@stu.edu.scu.cn; kunpeng.wang@scu.edu.cn

Extended Abstract

Background: The lung cancer has become a severe health issue in the current world. Lung cancer accounts for 11.7% of global cancer deaths [3]. In clinical operations, image-guided percutaneous biopsy and intervention are commonly employed for diagnosis and treatment. The motion of the lung can be studied through 4D CT images that are recorded in multiple time phases. However, distortions of the lung shape may exist in the images and certain mitigation can lead to an accurate motion reconstruction.

Objectives: We propose a systematic mechanism to model lung respiratory motion based on 4D CT image data from multiple patients through landmark labeling and diffeomorphism simulation. This mechanism produces the deformation fields of lung tissue during breathing by extracting key landmark points and establishing the corresponding deformation vector field based on the refined 4D CT images. The derived mathematical model of the lung motion will then be compared with the existing motion model. A generalized model based on the parameters of multiple patients will then be presented.

Sope of the work: Motion artifacts in 4D CT scans can severely affect the accuracy of the motion modeling [4]. The motion artifacts generally arise from two main reasons: 1) the subtle movement of the patient during the CT scan and 2) the improper reconstruction of the CT images from the slice. Data cleansing was applied to remove the observable distorted image data due to artifacts. A reconstruction of the slices of the 3D CT images at different time is employed to ease the effect of the possible artifacts. Noise reduction and intensity rescaling are employed in the reconstruction of 3D CT images at different time. Landmarks are extracted from the reconstructed slices based on the centroids of the shapes of bronchi in each refined slice. Correlation of the landmarks at different time are examined to mitigate the potential artifacts and verify the validity of the labeling. The nonlinear Gauss Newton method is employed to formulate the motion of lung between consecutive time phases. Then a lung respiratory motion model represented by deformation fields is established upon the obtained motions following the diffeomorphic registration methods presented in [1]. The deformation field acting on the point cloud data extracted from the lung CT images will describe the lung motion at each time. Demonstration of our patient specific vector field will be conducted via comparison with the current results presented in [2,5].

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