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A hybrid accurate lung segmentation method for quantification of diffuse interstitial lung disease in high-resolution computed tomography

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PURPOSE: Accurate lung segmentation in diffuse interstitial lung disease(DILD) at HRCT images is a challenge since the intensity distribution of lung parenchyma has the wide range of variations according to the progress and kinds of DILD. The purpose is to develop accurate lung segmentation from DILD at HRCT images.

MATERIALS AND METHODS: HRCT scans of fifty four DILD patients with a section thickness of 10 mm were performed. At first, the airway and colon were segmented and excluded by thresholding with –974 HU and connected component analysis. Second, rough left and right lungs were identified by thresholding with –474 HU and connected component analysis. Third, shape propagations inward and outward the initial lung boundary using level set algorithm were used to make a lung surface smooth and filled. Fourth, ribs were detected and reconstructed into a 3d surface as a lung boundary with a free-form surface fitting method. Last, the surface points of rib confronting a lung are extracted by ray tracing from the center of mass of a half lung. The distance map from the lung boundary was used to select only surface points within the limited distance. These points were used for surface fitting algorithm. The level-set based lung segmentation within this fitted surface was performed. The segmentation result was quantitatively compared with the segmented result, manually delineated by an expert. Various accuracy evaluation metrics were used including 1 minus volumetric overlap, relative absolute volume difference, average symmetric absolute surface distance, and symmetric RMS surface distance.

RESULTS: The average value of 1 minus volumetric overlap, relative absolute volume difference, average symmetric absolute surface distance, and symmetric RMS surface distance were 3.25 $\pm$ 2.64%, 2.32 $\pm$ 1.71%, 0.33 $\pm$ 0.45 mm, and 1.58 $\pm$ 2.65 mm respectively. The surface of the rib cage was also segmented.

CONCLUSION: We have proposed the accurate DILD lung segmentation method at HRCT. The lung boundaries of DILD dataset were more accurately detected by additional 3d surface of rib cage.

CLINICAL RELEVANCE/APPLICATION: Our method would be useful in determining the lung parenchyma, even though the lung has DILD, which is the essential step for the automatic classification and quantification of DILD.