Pulmonary lobar segmentation from computed tomography scans based on a statistical finite element analysis of lobe shape

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Automatic identification of pulmonary lobes from imaging is important in lung disease assessment and treatment planning. However, the pulmonary lobar fissure can be difficult to detect automatically, as it is thin, usually of fuzzy appearance and incomplete, and can be obscured by or confused with features of disease. Traditional anatomical knowledge-based methods rely heavily on anatomic knowledge and largely ignore individual variability, which may result in failure in pathological lungs. In this study, we aim to overcome difficulties in identifying pulmonary fissures by using a statistical finite element shape model of lobes to guide lobar segmentation. By deforming a principle component analysis based statistical shape model onto an individual’s lung shape, we predict the likely region of fissure locations, to initialize the search region for fissures. Then, an eigenvalue of Hessian matrix analysis and a connected component eigenvector based analysis are used to determine a set of fissure-like candidate points. A smooth multi-level B-spline curve is fitted to the most fissure-like points (those with high fissure probability) and the fitted fissure plane is extrapolated to the lung boundaries. The method was tested on 20 inspiratory and expiratory CT scans, and the results show that the algorithm performs well both in healthy young subjects and older subjects with idiopathic pulmonary fibrosis. The method was able to estimate the fissure location in 100% of cases, whereas two other segmentation softwares which use anatomy-based method tested for comparison were unable to segment 7/20 and 9/20 subjects respectively.