学位報告 4

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主　論　文　の　要　旨

論文題目　Study on precise airway segmentation from chest CT volumes based on machine learning and local intensity analysis

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論　文　内　容　の　要　旨

Lung cancer has become one of the leading causes of cancer-related death, accounting for 1.6 million deaths. Therefore, early detection and diagnosis are necessary. In diagnosis and surgery on lung cancer, a physician always wants to obtain useful and precise information for the assessment of the lesion in the lung. With the development and improvement of the 3-D CT and the generation of high-resolution data, more accurate treatment of disease is feasible. Thus, the segmentation of airway trees in the 3D chest computerized tomography (CT) volume is an important step in the analysis of various pulmonary diseases like asthma and chronic bronchitis.

This work introduces several new approaches for airway segmentation which is a vital core component of computerized aided diagnosis. There are several proposed methods developed to segment the airway from the 3D CT volumes. One method is composed of three steps. First, Hessian analysis is utilized to enhance the tube-like structure in CT volumes, then an adaptive multiscale cavity-enhancement filter is employed to detect the cavity-like structure with different radii. In the second step, support vector machine (SVM) learning will be utilized to remove the false positive (FP) regions from the result obtained in the previous step. Finally, the graph-cut algorithm is used to refine the candidate voxels to form an integrated airway tree.

Second one is recognizing the airway regions from the trachea using the volume of interests (VOIs) to segment each branch. A VOI is placed to envelop the branch currently being processed. Then a cavity enhancement filter is performed only inside the current VOI so that each branch is extracted. At the same time, we perform a leakage detection scheme to avoid any leakage regions inside the VOI. Next the GVF magnitude map and a tubular-likeness function are computed in each VOI. This assists the predictions of both the position and direction of the next child VOIs to detect the next child branches to continue the tracking algorithm. Finally, we unify all of the extracted airway regions to form a complete airway tree. segmentation methods, our method can increase the detection rate by 5.6 while decreasing the false positives (FP) by 0.7 percentage points.

In the last work, we combine 3D deep learning with image-based tracking in order to automatically extract the airways. Our method is driven by adaptive cuboidal volume of interest (VOI) analysis using a 3D U-Net model. We track the airways along their centerlines and set VOIs according to the diameter and running direction of each airway. After setting a VOI, the 3D U-Net is utilized to extract the airway region inside the VOI. All extracted candidate airway regions are unified to form an integrated airway tree. We trained on 30 cases and tested our method on an additional 20 cases. Compared with other state-of-the-art airway tracking and segmentation methods, our method can increase the detection rate by 5.6 while decreasing the false positives (FP) by 0.7 percentage points.