Chapter 36
A Hybrid Approach for 3D Lung Segmentation in CT Images Using Active Contour and Morphological Operation

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ABSTRACT

Lung segmentation is the initial step for detection and diagnosis for lung-related abnormalities and disease. In CAD system for lung cancer, this step traces the boundary for the pulmonary region from thorax in CT images. It decreases the overhead for a further step in CAD system by reducing the space for finding the ROIs. The major issue and challenging task for the segmentation is the inclusion of juxtapleural nodules in the segmented lungs. The chapter attempts 3D lung segmentation of CT images using active contour and morphological operations. The major steps in the proposed approach contain: preprocessing through various techniques, Otsu's thresholding for the binarizing the image; morphological operations are applied for elimination of undesired region and, finally, active contour for the segmentation of the lungs in 3D. For experiment, 10 subjects are taken from the public dataset of LIDC-IDRI. The proposed method achieved accuracies 0.979 Jaccard's similarity index value, 0.989 Dice similarity coefficient, and 0.073 volume overlap error when compared to ground truth.

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INTRODUCTION

According to different statistics and survey by various organizations the lung disease has been observed as most common cancer growth worldwide. International Agency for Research on Cancer (IARC) had given the statistical data in 2008 for occurrence and mortality rate from 27 cancers in the series of GLOBOCON for 182 nations (Ferlay et al, 2010). In that survey it was approximated that 12.7 million cases observed as incidence of new lung cancer and 7.6 million cases of mortality rate in 2008.In GLOBOCON 2012 v 1.0 approximately 1.8 million new lung cancer (malignant growth) cases as the incidence rate were evaluated (Ferlay et al, 2013). It was about 13% for cases listed and in area of death rate because of malignant growth its commitment was 19%, announced by GLOBOCAN (IARC) in the module of Cancer Surveillance. Lung disease is seen to be the real reason for death in male populaces. Among females, lung malignant growth is the main source of death in growing nations, and the second driving reason for death in growing nations (Torre et al, 2015). In 2015, European Union, the mortality rate due to malignancy in lungs in men is approximated as 6% compared with the year of 2009, similarly the figure for women is 7% (Malvezzi et al, 2015). American Cancer Society, Facts and Figures for Cancer statistics 2019 reveals the estimated incidence rate and mortality rate from lung cancer will be 228,150 and 142,670 respectively, and the 5-year survival rate is only 19% (DeSantis et al, 2017). In India, the severity of lung cancer is approximately 6.9% incidence rate and 9.3% death rate as compared to all cancer related deaths in both genders with the highest occurrence in the state of Mizoram ("NCRP Annual Reports…", 2013).

The most common factor for lung cancer is cigarette smoking. As per statistics (DeSantis et al, 2017) 81% of death from lung cancer in US is due to smoking. The risk for cancer is related to quantity and duration of smoking habit. The other causes for this cancer are cigar and pipe smoking, passive smoking, exposure to radon gas, asbestos, etc. Computer-aided diagnosis (CAD) system is now becoming very popular for the detection of lung cancer. This is considered to be an assistive tool for radiologist as well as second opinion for the detection and diagnosis lung nodules. The two forms of computer-aided system are available in medical field for the detection and diagnosis namely CADe (Computer-aided detection) and CADx (Computer-aided diagnosis) respectively for lung cancer.

RELATED WORK

Lung segmentation has been a keen research area for various authors in current decades. The advancement of latest modality like CT, PET (Positron Emission Tomography), MRI (Magnetic Resonance Imaging), etc. facilitate the 3D segmentation for lungs for better visualization and accuracies in further diagnosis. Silva et al. (Nery et al, 2012) had given method based on 3D Gaussian filter to reduce some noise. In this technique, the initial lung lobes are extracted through thresholding followed by sequential erosion for separation of two lung regions. The inferior and superior border of lungs is obtained and morphological operation is applied for border correction subsequently subtracting with original generates the final region. A hybrid method using automatic 3D region growing and morphological operation and multiatlas segmentation had been proposed by Rikxoort et al. (Van et al, 2009). The procedure for lung segmentation given by Da Nobrega et al. (Da et al, 2017) follows: image addition, locating the trachea, lungs (with respiratory track) segmentation, trachea segmentation and volume subtraction. Yim et al. (Yim et al, 2005) proposed a procedure using inverse seeded region growing and connected component