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A Survey on PET-CT Lung Tumor Delineation

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Abstract: Accurate parenchymal lung tumor delineation with PET-CT can be problematic given the inherent tumor heterogeneity and proximity / involvement of extra-parenchymal tissue. In this proposed method, we propose a tumor delineation approach that is based on new tumor–Ground truth method models for a given image. The ground truth method give more efficient result compared to other methods. Then this method extends to segmentation, region based graph methods (n-cut and a-cut) and another segmentation model is k-means algorithm is used. After the tumor detection part move on to classification part, this classification done by neural network based implementation has been used. The result computation is very fast the more efficiency. In background likelihood method not efficient compare other methods. The above model is processed in MATLAB tool and achieve high efficiency in the detection and classification model compared to previous one.

Key words: CT · Dicom · Ground truth · PET · Segmentation

INTRODUCTION

Lung cancer is the one of the most leading cause of cancer death in men and the second leading cause of women. Every year, nearly more than 90,000 men and 79,000 women are diagnosed because of cancer. Now coming to cancer statistics about 12.7 millions cancer cases and 7.6 million cancer deaths are estimated to have occurred in 2008. This result tells us one fourth of the population will be diagnosed with the cancer in their lifetime and one fifth of the cases will go to die from the lung tumor disease [1].

Most of them notice their disease when it's too late and the surgery will be tough to do. In 2011, lung cancer has been the main cause of death from cancers by 15%. Today, several types of techniques are used diagnosis of the disease, such as Computerized Tomography, Positron Emission Tomography, Chest Radiograph (x-ray), Magnetic Resonance Imaging (MRI scans).

These techniques can detect only in its advanced stages, but we need the technique to diagnose in its early stages. Different software tools are use diagnose the lung cancer, such as 3D-Doctor, Workstation, analyzes, 3dviewnix, 3D slicer. Some of these software tools as image support some visual formats like Dicom and analyze. Some tools provide features such as processing and visualization for instant registration, noise suppression, analyzing images for diagnostic purposes, applying conventional Thresholding methods and representing 2D and 3D data using visualization methods. Currently, the most effective image technique for early detection of lung cancers is PET-CT imaging technique and it is the most reliable tool [2].

Lung Tumor: Cancer is a group of diseases that are characterized by an abnormal and unregulated growth of cells. Those cells are we can see in Fig. 1. The main differences are that beginning tumor grows slowly and it will usually not come back if it is surgically removed. There are two groups of lung cancer, those are Small cell Lung cancer (SCLC) and the other one is Non-Small Cell Lung Cancer (NSCLC), which covers more than 85% of all cases. CT scans (Computed Tomography), PET scans (Positron Emission Tomography) and MRI (Magnetic Resonance Imaging) is the diagnosing methods are available to detect Lung cancer; [3].

We can calculate the lung tumor based on tumor size and we can give which stage it is also calculated. Now we will see stages of lung tumor.

This is an early stage of lung tumor; some symptoms gave clarity about lung cancer. Those symptoms are weight loss, chest infections, coughing up blood, difficult to take a breath, tired, lack of energy and shoulder pain. These are very early symptoms of lung cancer. There many reasons caused by to get a lung cancer. Those reasons we can see in Figure 3 [4].

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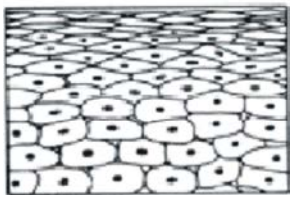
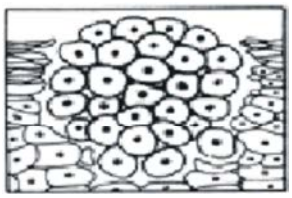


1. Normal cells



2. Tumor effecting image

Fig. 1: Normal and Benign Cells

Fig. 2: Stage 1 of Small size tumor part

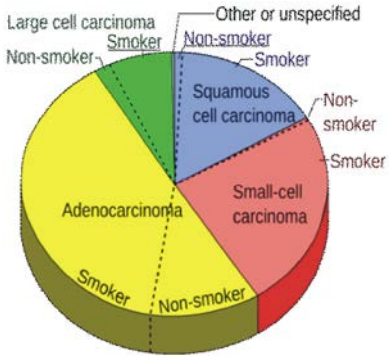


Fig. 3: Causes for lung cancer

Smoking is the most important risk factor for lung cancer. Death risk of lung cancer due smoking is 15 times higher than non-smokers. As a smoker, the risk of developing lung cancer is 1 in 10, similar to that if we increase smoking the risk factor will increase to 1 in 3. Below Figure 4 shows cancer stage 2. The next Figure 5 shows cancer stages 3 and 4.

Proposed Method

Input Image: The natural scene image for text detection we give as the input image. In imaging science, image processing is any form of signal processing for which the input is an image; it is in the form of a photograph or video frame. It is a Dicom image so we can't able to see clearly. The result of image processing may be either an image or a set of characteristics or parameters related to the image.

Preprocess: Pre-processing images commonly involve removing low-frequency background noise, removing reflections, the intensity of the individual particle images can be normalized and portions of image masking. Image preprocessing is the technique to enhance data and images prior to computational processing. Pre-processing deals with previous techniques for increasing contrast and detecting undesirable noises. In this proposed method Ground Truth Method is used for enhancement of the input PCT-CT images [5].

Ground Truth Method: The term "ground truth" refers to the accuracy of the training set's classification for supervised learning techniques. This technique applies on statistical models to prove or disprove research hypothesis. The term "ground truthing" refers to the process of gathering the proper objective data for this test. In Ground truth method Segmentation is one of the methods for some image requirements. In medical imaging, segmentation is important for image measurements, feature extraction and image display. In such a case of some applications, Segmentation may be useful to classify image pixels into anatomical regions, such as muscles, bones and blood vessels. While in other image pixels into pathological regions, such as cancer, tissue deformities. The purpose of the segmentation of the lung region in the CT image is to achieve a better orientation in the image. A lot of regions of articles can be found regarding segmentation in the lung region in CT images. By using automatic tools we may discuss the pixel regions growing and thresholding. Segmentation of pulmonary X-ray computed Tomography(CT) images as shown in Fig. 10 [6].

Actually, in this segmentation method having disadvantages.

- Low detection of tumor part.
- Complex to implement.
- In contrast to image not give exact output.

So this is the reason for proposing Ground Truth method. In this method we will get the binary image may have noise and we can reduce the noise in forthur proces and get exact lung DCM image will come.

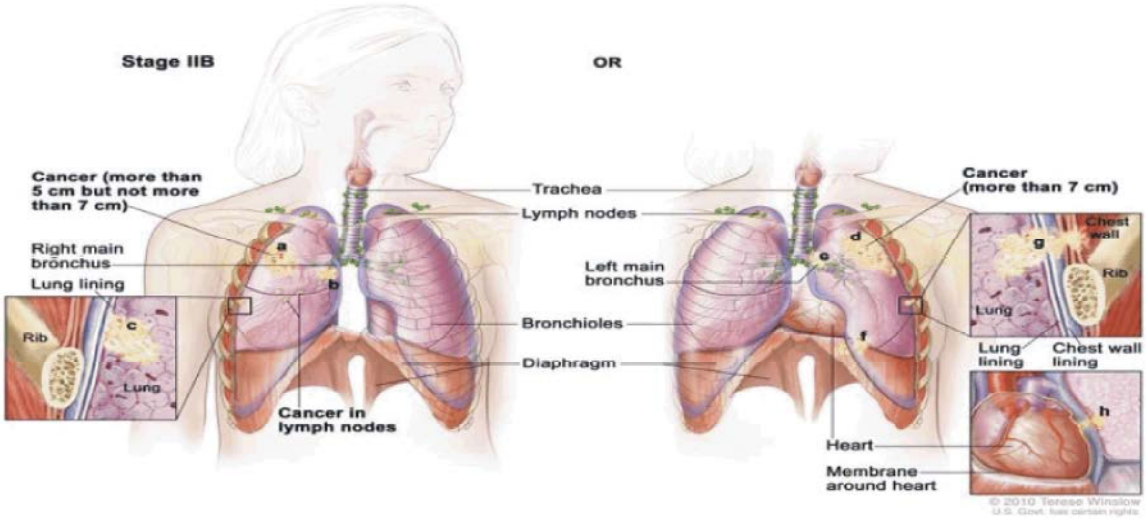


Fig. 4: Stage 2 of lung cancer

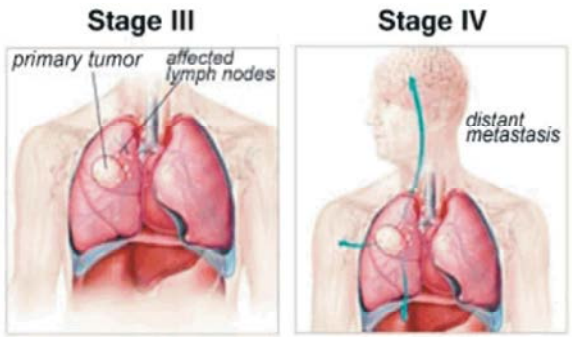


Fig. 5: Stage 3 &4 of lung cancer

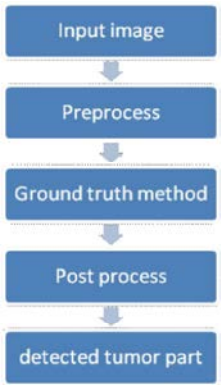


Fig. 6: Block diagram of PET-CT lung delineation based on Ground truth method

Post Process: Post process enhances the quality of output image, to prepare it for publication and distribution, includes techniques to clean up images to make them visually clearer as well as the application of filters and other treatments to change the look and feel of a picture [7].

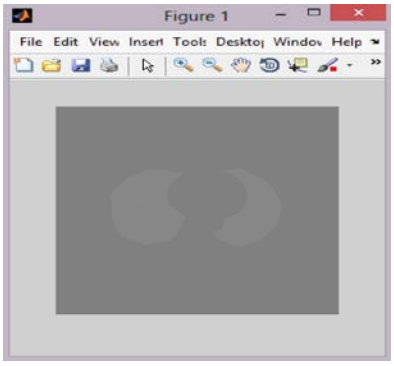


Fig. 7: DICOM image

Tumor Detecting Part: After the post processing session the segmented part may analyze where the actual pixel rate is varied and these features satisfy the tumor concept, end of these segmentation the given image diagnose whether it is effected or not.

Literature Survey: Tumor Segmentation Based on New Tumor-Background Likelihood Models.

Potesil: Potesil reported a tumor segmentation approach using a joint likelihood ratio test where a mode-seeking region growing in the PET images was firstly carried out using a threshold of 40% maximum SUV. To avoid segmentation leakage to adjacent organs with high FDG uptake, the authors restricted the process to exclude pre-segmented structures, such as the heart and other hot spots. Then on the basis of the initial PET segmentation, region a likelihood model in CT was defined using a sigmoidal function.

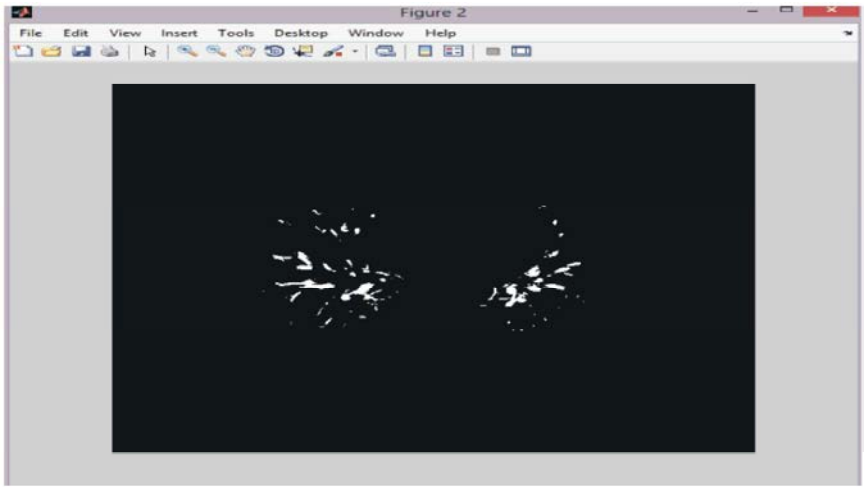


Fig. 8: Output of input image having low frequency background noise

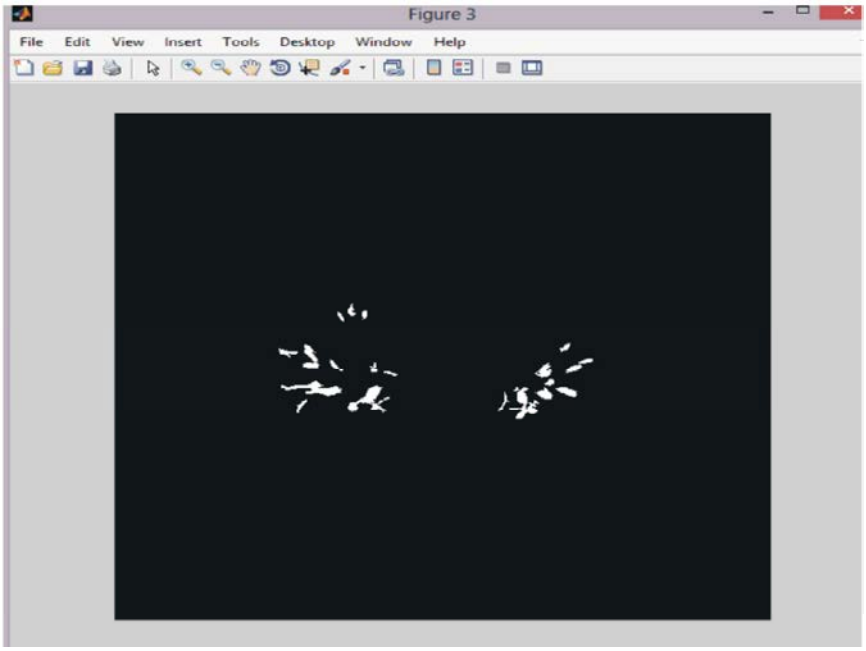


Fig. 9: Output of Preprocess image without low frequency background noise

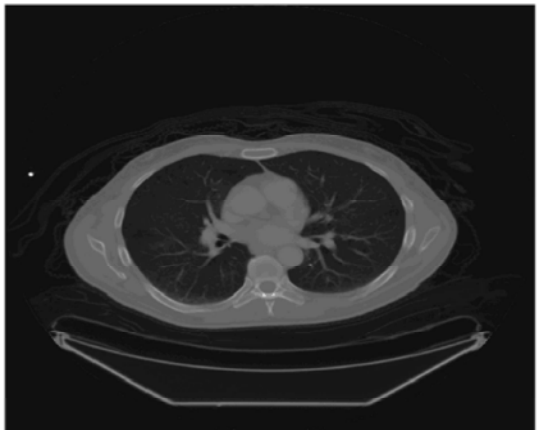


Fig. 10: The lung region, which is to segment the lung seen as the dark region in the body

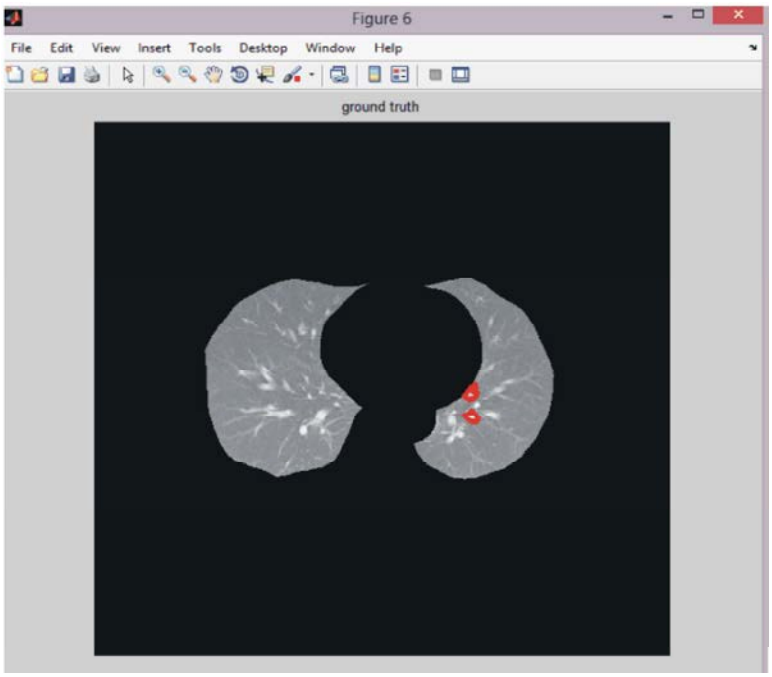


Fig. 11: Detected tumor part

Posteriori–Markov Random Field (MAP-MRF) to Lung Tumor Segmentation -- Gribben: Gribben reported the application of the maximum a posteriori–Markov random field (MAP-MRF) to lung tumor segmentation. This technique assumed that the tumors in PET-CT images were isolated within a box. It improved upon the Thresholding approach and the MAP-MRF approach when only the PET data were used.

An Efficient Visualization and Segmentation of Lung CT Scan Images for Early Diagnosis of Cancer: PET with 18F-FDG has been used in radiation treatment planning for non–small cell lung cancer (NSCLC). Thresholds of 15%–50% the maximum standardized uptake value (SUVmax) have been used for gross tumor volume (GTV) delineation by PET (PETGTV), with 40% being the most commonly used value. Recent studies indicated that 15%–20% may be more appropriate. The purposes of this study were to determine which threshold generates the best volumetric match to GTV delineation by CT (CTGTV) for peripheral NSCLC and to determine whether that threshold can be generalized to tumors of various sizes.

Mass Detection in Lung CT Images Using Region Growing Segmentation -and Decision Making Based on Fuzzy Inference System and Artificial Neural Network by Atiyeh Hashemi

According to estimates from the International Agency for Research on Cancer (IARC), there were 12.7 million new cancer cases in 2008 worldwide, of which 5.6 million occured in economically developed countries and 7.1 million in economically developing countries (Figure 1). The corresponding estimates for total cancer deaths in 2008 were 7.6 million (about 21,000 cancer deaths a day), 2.8 million in economically developed countries and 4.8 million in economically developing countries. By 2030, the global burden is expected to grow to 21.4 million new cancer cases and 13.2 million cancer deaths simply due to the growth and aging of the population, as well as reductions in childhood mortality and deaths from infectious diseases in developing countries.

Radiation therapy is one of the pillars of modern cancer treatment and plays a central role in the management of a wide range of potentially curable malignancies, either as the sole treatment or in combination with other modalities, such as chemotherapy or surgery. To be cured by radiation therapy, a tumor must be entirely contained within a volume of tissue treated to a tumouricidal dose. Patients selected for curative or ‘radical’ radiation therapy must have disease confined to a region that can be safely treated with the chosen tumouricidal dose. An optimum radiation therapy plan will deliver a sufficiently high dose of radiation to attain durable local tumor control while delivering the least possible dose to the smallest possible volume of critical normal tissues.

CONCLUSION

We propose PET-CT lung delineation based on Ground truth modal. The method quantatively validated on 25 studies and theoretically performed by MATLAB tool. Our method outperformed 3 other reported approaches and our lung delineation results may show a slight improvement compared to other approaches. Our future research includes classification of detected tumor part by using neural network based implementation.

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