Lung Nodular Pattern for Interstitial Lung Diseases Using Neural Network Classification

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Abstract - Lung nodules is a circle or oval that is often found on chest radiograph (X-ray) or computed tomography (CT) scan. Lung nodules usually do not cause a symptom, usually found incidentally on chest X-ray or CT. Diagnosis process performed by observing CT Scan. The further process by taking a sample of tissue in the lungs and perform laboratory tests. This procedure is not effective. The aim of this study was develop software to detect lumps on pulmonary CT scan images are nodules or artery. This study consists of five steps. The first step is to build user interface. The second is to develop software for lung segmentation using Active Shape Model. The third is to develop software for candidate pulmonary nodules segmentation using mathematical morphology. The fourth is detection of pulmonary nodules using Support Vector Machine (SVM). The fifth is a 3-D visualization of pulmonary nodules using volume rendering.

Keywords -ASM, Mathematical Morphology, NN

I. INTRODUCTION:

Currently, cancer is still a serious problem in the world. World Cancer 2014 International Agency for Research on Cancer (IARC) at the World Health Organization that in 2012 there were approximately 14 million new cases of cancer occur. Lung cancer is the most common cause of death with an estimated 8.2 million deaths. According to IARC, about 70 percent of cancer deaths occur in Africa, Asia, Central and South America [1] [2]. Lung cancer is a disease caused by lung cell division that is uncontrolled. If left untreated, the growth of lung cells to grow and spread beyond the lungs [3]. Lung nodules are a circle or oval that is often found on chest radiograph (X-ray) or computed tomography (CT) scan [4]. At one of the 500 reading chest X-ray can be found a nodule. Benign nodules or benign when found in people who are still aged under 40 years. Causes Tumor and Lung Nodules are still not very clear, but in general there is a problem with inflammation due to infections histoplasmosis, coccidioidomycosis, Cryptococcus's, oraspergillosis. The possibility of inflammation is not caused by an infection, but a result of rheumatoid arthritis, Wegener's granulomatosisSarcoidosis. Among other causes are congenital anomalies (birth defects) as cystic lung and

pulmonary malformations [5]. If there is a suspicion of lung cancer, it will be diagnosed in more advanced with chest X-ray and CT Scan. In the X-ray will reveal a picture of a tumor or a liquid, while the CT scan, you will see a tumor, fluid or lymph node enlargement.

Furthermore, to ensure nodules or not to be held laboratory tests of samples of sputum and phlegm. It is also taken of lung tissue or gland, for laboratory test. Diagnostic process as above is not effective. Therefore we need software that can automatically detect lung nodules. Several studies relating to the detection of nodules automatically among others [6] - [11]. The aim of this study is to develop pulmonary nodule detection software. This study consists of five steps. The first step is to build user interface. The second is to develop software for segmentation of lung using Active Shape Model (ASM). The third is, to develop software for segmentation candidate pulmonary nodules using mathematical morphology. The fourth is detection of pulmonary nodules using NN. The fifth is a 3-D visualization of pulmonary nodules. The end result is a software that can detect an existing image in CT lung nodule or artery

II. MATERIALS

The data used in this study is the CT images of 30 patients. Image sliced in axial CT scan. Image size of 505x427 pixels, and a thickness of 0.5 - 10 mm
In this method we have applied median filtering onto the input image directly if it is in grayscale, otherwise we have to convert the input image into grayscale before applying median filtering.this approach is subtraction of median filtered image from input image (in case of the input image is in grayscale form) or subtraction of median filtered image from grayscale form on input image (in case of the input image is in RGB form). Image subtraction is used to find changes between two images of same scene. Thresholding is one of the most useful and easy to implement technique for image segmentation. If in an image consists of light objects on a dark background, in such a way that object and background pixels have intensity values grouped into dominant modes, then we can extract light objects from background using thresholding operation. Depends on the value of thresholding parameter (T). For the

proposed method we have used dynamic thresholdingtechnique discussed . The value of thresholding parameter is calculated using the formulae discussed below to each pixel and it'sneighborhoodpixel. Thethersholding values we are getting low specification value.
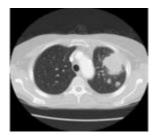

Fig.1: Lung CT scan image with axial sices

III.   METHODS

Software development for the detection of pulmonary nodules can be explained by using Data Flow Diagrams (DFD) as in Figure 2. Data Flow Diagrams (DFD) level 1 illustrates the flow of information and transformation which is applied when the data is moved from input to output. At the DFD level 1 detection system of pulmonary nodules present, there is only one entity that is friendly, and there are five processes, namely the process of making the user interface, the process of segmenting the lung, pulmonary nodule segmentation process, the process of detection of pulmonary nodules and pulmonary nodule visualization process
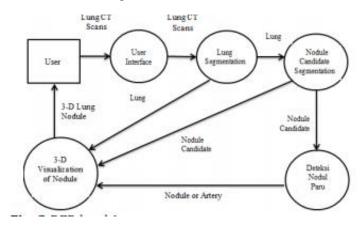

Fig.2: DFD level 1

Nodule Candidates Segmentation

Method used for segmentation of nodule candidate is mathematical morphology [14] - [16]. Step-by-step process of segmentation candidate pulmonary nodules using mathematical morphology can be explained as follows:

a. Subtraction among lung image with negative lung image Subtraction is done with the following steps: Image of lung segmentation results with ASM done complement process, which would result in a negative image of lungs. Process of complement in binary image, a value of zero to one and vice versa. Complement of intensity or RGB image, obtained from Subtraction of maximum pixel value (255) minus value of image. Output of complement of an image is if the dark image areas become light, and vice versa. Subtraction of lung image with a negative lung image. Results subtraction will be carried out Mathematical morphological processes.

b. Edge Detection
Edge detection of objects is an operation to detect significant changes in gray level of an image. Changes in the levelof intensity is measured by a gradient image. For example, an image f (x, y) is a two-dimensional function, the gradient vector of x and y, respectively, are a first derivative with respect to x and y that can be written in the form of an equation

c. Threshold
Thresholding is a process of separation of the pixels based on its degree of gray. Pixels that have a gray level less than the prescribed limit will be given a value of 0, while gray pixels that have a greater degree than the limit will be changed to value 1.

d. Dilation
Dilatation function is added for each pixel on the outskirts of a binary object that is an area that has a value of 1. Where dilatation added 8 pixels interconnected to the surrounding objects. And dilation is a process of combining the dots background (0) become part of the object (1). The use of dilation is put the pivot point S at point A. Give the number 1 for all points (x, y) that is exposed to or affected by the structure of S in that position. Dilation equation shown in Equation

$$D(A,S)=A+S \text{ (8)}$$

e. Fill Images Area To fill image area used algorithms based on morphological reconstruction. Definition of the image area is an area of dark pixels surrounded by lighter pixels. After the image location is determined, the next operation is to fill location (image area) using four neighboring connection background for the image of input 2-D and 6-connected background neighbors for 3-D input. Output of this process is an area surrounded by brightly colored pixels will have a value of one.

f. Erosion
Erosion function is to eliminate 8 pixels of the binary object associated with the periphery of the object. Erosion is the elimination of the object point (1) become part of the background (0). The use of erosion is place the pivot point S at point A is. If any part of S which are beyond the pivot point A deleted or used as background. Erosion is shown with equation

$$E(A,S)=AxS$$

g. Multiplication

Image multiplication performed to obtain the final image of the candidate nodules. Image multiplication can be done by multiplying each pixel with a certain value. Mathematically modeled using equation

$$\forall f(x,y): Nf(x,y) = f(x,y) * Th$$
$$\forall Nf(x,y); if \ Nf(x,y) > 255 \ Then \ Nf(x,y) = 255$$

(11) withTh $\geq$ 1 F(x,y) is the original image, and Nf (x, y) is image of multiplication of intensity of the original image with a value of Th. In this study, process of multiplication is a multiplication of image of the mask candidate nodules result of erosion process results, with image results in a reduction of complement. Results of candidate nodule segmentation using mathematical morphology can be seen.
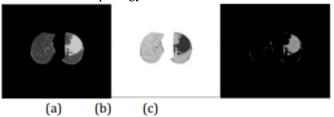

Fig.3: Subtraction process of image (a) Lung Image, (b) Negative Image, (c) Subtraction Results Between a and b image.
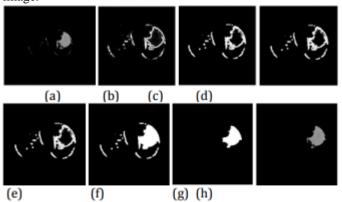

Fig.4: Morphology Process Of Nodules Candidate (a) image of subtraction results, (b) results of edge detection with convolution prewitt, (c) image of threshold

Lung parenchyma field segmentation

Some radiologists of Postgraduate Institute of Medical Education & Research (PGIMER), Chandigarh, INDIA suggested to remove the mediastinum part (central Part) from lung images as it is difficult to determine the malignancy at that place even for medical professionals. To view the same, the lung parenchyma fields are separated. The process of lung parenchyma field's segmentation is according to the following steps

Optimal Thresholding: The image is thresholded to extract low-density tissue region (e.g. Lung parenchymas) from fat area.

Background removal: The surrounding air, identified as low–density tissue, is removed. 3. Cleaning: It is performed to fill the holes in the binary image.

Lung mask: To extract lungs from background, lung mask is created.

Lung Extraction: Output of step 4 is subtracted from the original image to provide separated lung parenchymas for further processing.

Local binary pattern formulation

After obtaining lung parenchyma's from the preprocessing step, the LBPV operator is applied on lung data set and nodule templates. Ojala et al. 4 first introduced the LBP operator for rotation invariant texture classification. The LBP is very efficient texture descriptor due to its discriminative power and computational simplicity. Given an image I of size n $\times$ m grayscale pixels and we denote with I() gray level of the pixel of the image I, the LBP operator is calculated at each pixel by evaluating the binary differences of the values of a small circular neighborhood(with radius R) around the value of a central pixel . Mathematically, the LBP value of current pixel is given:

$$LBP_{P,R} = \sum_{p=0}^{P-1} s(g_p - g_c)2^p,$$
$$s(x) = \begin{cases} 1, & if \ x \geq 0; \\ 0, & otherwise; \end{cases}$$

Where
gc: gray value of the center pixel
gp: gray values of the circularly symmetric neighborhood
gp (p= 0, . . .,P-1).
P: Image Pixels in the circle of radius R(R > 0) that form a circularly symmetric neighbor set respectively 2p: binomial factor for each sign s(gp- gc)
A histogram is generated to represent the texture image after finding the LBP code of each pixel in the image. LBP derivation with example using 3x3 neighborhood. In this, each LBP is regarded as a micro-texton4 . Local textons include spots, flat areas, edges, line ends and corners. the different texture primitives detected by the uniform patterns of LBP. In the figure 4, gray circle indicates center pixel, Black and white circles correspond to bit values of 0 and 1 in the different patterns of the operator.

Neural Networks

The network classifies input vector into a specific class because that class has the maximum probability to be correct. In this paper, the PNN has three layers: the Input Layer, Radial Basis Layer and the Competitive layer. Radial Basis Layer evaluates vector distances between input vector and row weight vectors in weight matrix. These distances are scaled by Radial Basis Function nonlinearly. Competitive Layer finds

the shortest distance among them, and thus finds the training pattern closest to the input pattern based on their distance.
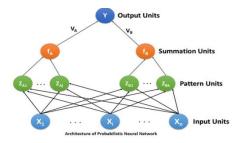

Fig.5: neural network analsis on retina

Analysis:

Accuracy:- Accuracy is also used as a statistical measure of how well a binary classification test correctly identifies or excludes a condition. among the total number of cases examined. To make the context clear by the semantics, it is often referred to as the "rand accuracy. It is a parameter of the test.it shows in the command window..

$$Acc=(Tp+Tn)/(Tp+Tn+Fp+Fn)$$

Sensitivity: In medical diagnosis, test sensitivity is the ability of a test to correctly identify those with the disease (true positive rate).

Sensitivity $=Tp/(Tp+Fn)$.

Specificity:-Whereas test specificity is the ability of the test to correctly identify those without the disease (true negative rate).

Specificity $=Tn/(Tn+Fp)$.

IV. CONCLUSION

Based on the tests, it can be concluded that software detection of pulmonary nodules by using neural networks proved capable of being used as a model for the detection of lung nodules.

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