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Computerized System For Lung Nodule Detection in CT Scan Images by using Matlab

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Abstract— In this paper, proposed a method for detection and diagnosis of lung nodules (malignant & benign) on Computed Tomography (CT) images , the detection stage divided into two stages , getting the lung image from CT-scan image of the chest region ,and it depends mainly on the formation of lungs mask using Connected component Labeling algorithm(CCL) and number of morphological processes, and getting the lung nodules using landmarks and shape Features (geometric properties) of lung nodules .
The diagnosis of lung nodules (distinguish benign and malignant nodules) depending on the characteristics of the edges of the nodules has been detected.

MATLAB have been used through every procedures made. In image processing procedures, In image processing toolbox, process such as image pre-processing, segmentation and feature extraction have been discussed in detail, more accurate results by using various enhancement and feature selection techniques are getting.

Keywords— **Lung nodule detection, Thresholding , Morphological Processing), Feature extraction for nodule, Metastasis**,

I. INTRODUCTION

Lung cancer is a disease of abnormal cells multiplying and growing into a tumor. The mortality rate of lung cancer is the highest among all other types of cancer[1]. Lung cancer is one of the most serious cancers in the world, with the smallest survival rate after the diagnosis, Approximately 20% of cases with lung nodules represent lung cancers. therefore, the identification of potentially malignant lung nodules is essential for the screening and diagnosis of lung cancer[4].

Computed tomography (CT) is the most accurate imaging modality to obtain anatomical information about lung nodules and the surrounding structures [2]. In current clinical practice, however, interpretation of CT images is challenging for radiologists due to the large number of cases. This manual reading can be error-prone and the reader may miss nodules and thus a potential cancer. Computer-aided diagnosis (CAD) systems would be helpful for radiologists by offering initial screening or second opinions to classify lung nodules [3].

CAD provide depiction by automatically computing quantitative measures, and are capable of analyzing the large number of small nodules identified by CT scans[3].

The aim of this project was a detect feature for an accurate of images comparison and pixels percentage of mask-labelling and early detection of lung nodule and lung cancer.

The objective of this paper detection of Lung nodule using image processing based on the number of descriptors shape in order to distinguish between them and the surrounding tissue located within the lung or especially vessels that have the same rounded shape, then work on the diagnosis based on our knowledge of a malignant forked tumor, a variant of benign who have a regular shape.

II. METHODOLOGY

Overall, there are three main processes used throughout the report; processing, feature extraction and finally the classification process. MATLAB is used in every process made throughout the project. Process involved in the lung nodule detection system for the project can be view in Figure (1).

First step is to acquire the CT scan image of lung cancer patient. The lung CT images are having low noise when compared to X-ray and MRI images; hence they are considered for developing the technique. The main advantage of using computed tomography images is that, it gives better clarity and less distortion. For research work, the CT images are showing in Figure (2), Lung acquired from NIH/NCI Lung Image Database Consortium (LIDC) dataset [4].

First stage : lungs extraction from Input CT scan Image

1. image auto Thresholding:

The threshold was obtained by using Otsu's method [4], and applied it on the input image, by following equation:

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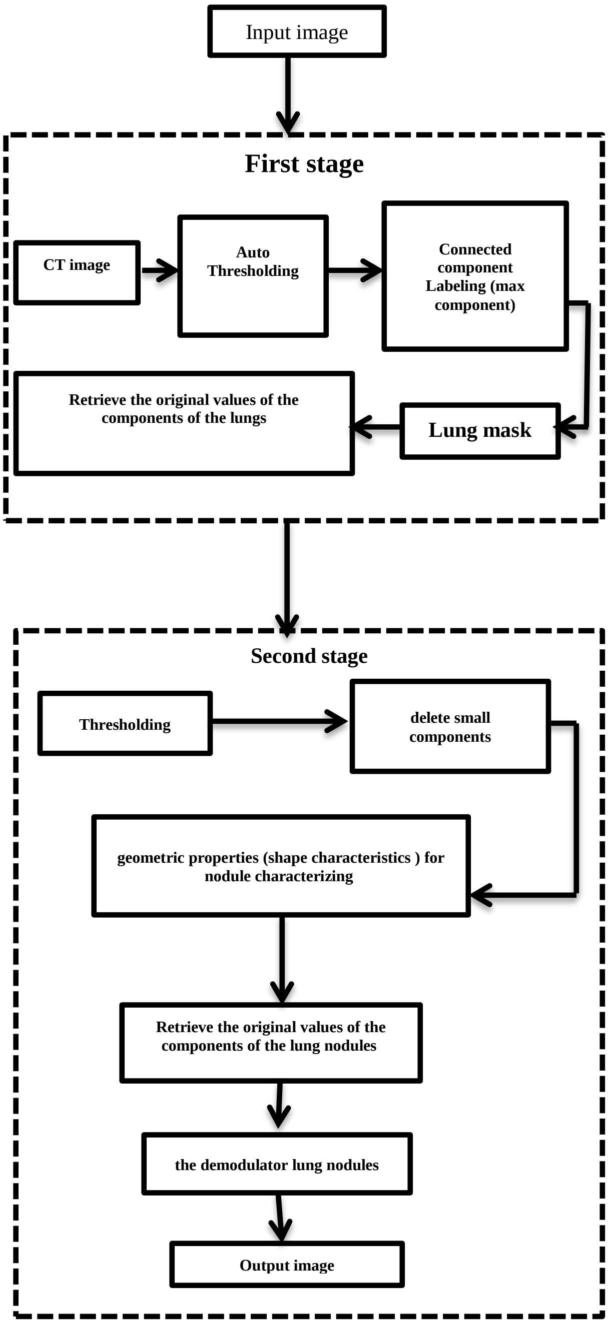


Figure (1) Nodules Detection System

(a)

(b)

Figure 2: Input CT scan Image(a), and the image after threshold (b)

$$f(x,y) = \begin{cases} 0 & if\ f_0(x,y) < T \\ 1 & if\ f_0(x,y) \geq T \end{cases} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots..(1)$$

Where:

$f(x,y)$ the image after threshold.

$f_0(x,y)$ Input CT scan Image **.**

T the used threshold.

2.Connected component Labeling and taking larger component:

By using the Connected component Labeling algorithm (CCL), the area of all components and select the component of the maximum area which represents the area surrounding the lungs was calculated, Figure (3), obtained the output image of lager component selection .

3. obtaining the lungs mask:

The lungs mask takes two steps:

- fill eyelets process , to obtain the external boundaries of object as showed in Figure (3) .

(a)

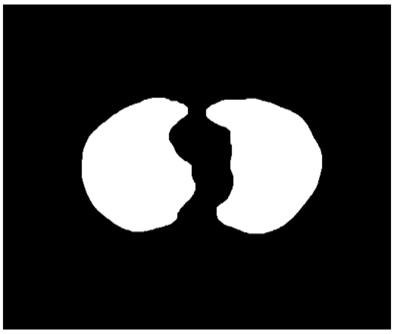
(b)

Figure 3: output image of lager component selection (a) fill eyelets process on last image(b)

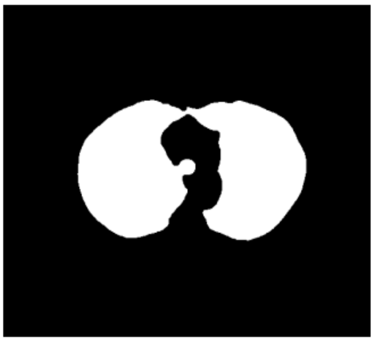
Figure (4) depicted the forming the lungs mask by multiplying previous image to the resulting from step (2).

4. get rid of the other members that appears next to lungs:

get rid of the areas surrounding the lungs or realism between them using morphological opening process followed the morphological closing process, where the structuring element circle with radius 10, Figure(4), shows the result of apple morphological processes(opening & closing).



(a)



(b)

Figure 4: : lungs mask image(a), the result of apple morphological processes(opening & closing), (b)

5.Retrieve the original values of the components of the lungs:

Retrieve the original values of lunges image accordance with the following equation:

$$f_1(x,y) = \begin{cases} f_0(x,y) & if \quad f(x,y) = 1 \\ 0 \quad if & f(x,y) = 0 \end{cases} \quad \dots\dots..(2)$$

Where:

$f(x,y)$ lungs mask image.

$f_0(x,y)$ Input CT scan Image **.**

$f_1(x,y)$ the extracted lungs image , which the result of first stage.

Figure (5), the extracted lungs image from input image CT

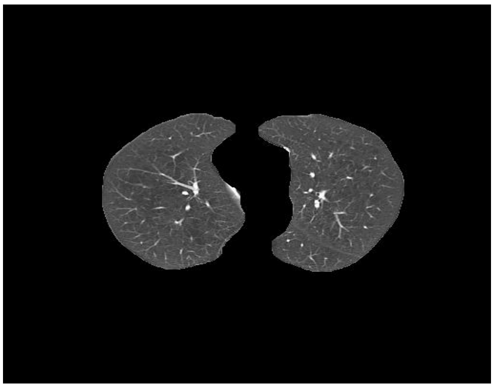


Figure 5: the extracted lungs image from input image CT

Second stage: lung nodules extraction from lunges image:

1.image thresholding:

From the image histogram Figure (6), we detect image elements which represent the lungs smaller than 150,so we select this threshold, accordance with the following equation, the detections is showing in Figure (7), result image after Thresholding:

$$f(x,y) = \begin{cases} 0 & if\ f_1(x,y) < 150 \\ 1 & if\ f_1(x,y) \geq 150 \end{cases} \ldots\ldots\ldots\ldots\ldots\ldots. (3)$$

Where:

$f(x,y)$ the image after threshold.

$f_1(x,y)$ Input CT scan Image **.**

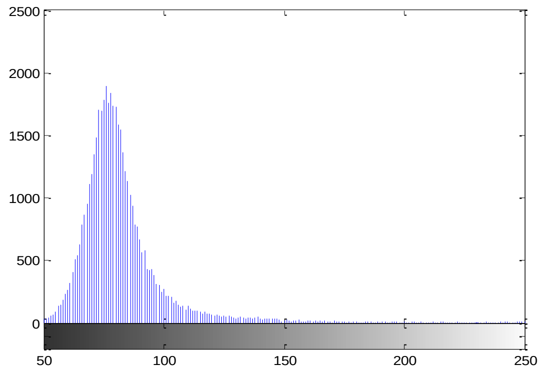


Figure 6:histogram of lungs image

Figure 7:result image after Thresholding

2. deleting the small components:

In this step , the components was deleted, figure (8) , which have area small than 15.

Figure 8:result image after deleting the small components

3.use the geometric properties (shape Features) for nodule selection:

Lungs nodules has shape next to the circle ,the several shape characteristics is used:

$$form\ factor = \frac{4\pi * Area}{perimeter}$$

$$roundness = \frac{4 * Area}{\pi * maxdiameter^2}$$

$$aspect\ ratio = \frac{maxdiameter}{mindiameter}$$

$$solidity = \frac{Area}{convexArea}$$

$$extent = \frac{TotalArea}{AreaBounding\ Rectangle}$$

$$comactness = \frac{\sqrt{(4 * Area)/\pi}}{maxdiameter}$$

The characteristics of lung nodules in following domains:

S1=[0.44-1.25] , S2=[183-9035], S3=[0.68-1], S4=[0.5-0.86], S5=[13.5-95.1], S6=[1-1.6]

Then delete all connected components, that do not meet the previous geometric characteristics . Figure (9), the :result image after deleting the connected components

Figure 9:result image after deleting the connected components

4.Retrieve the original values of the components of the lung nodules:

$$f_1(x,y) = \begin{cases} f_0(x,y) & if \quad f(x,y) = 1 \\ 0 & if \quad f(x,y) = 0 \end{cases} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where:

$f(x,y)$ result image of last stage.

$f_0(x,y)$ result Image of first stage **.**

$f_1(x,y)$ the extracted lung nodules image , which the result of second stage.

Following to the figure **(10),** shows image of extracted lung nodules regions.

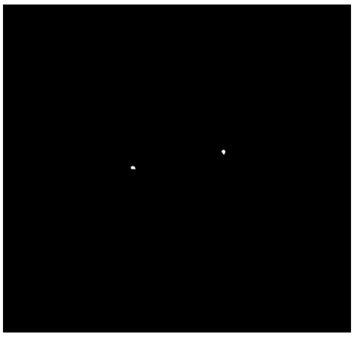


Figure 10: extracted lung nodules

3 Automatic diagnosis of lung nodules:

The concept of lung nodules diagnosis is a featuring(distinguishing) of benign nodules and malignant nodules. for lung nodules diagnosis we depends on nodule shape, where the malignant nodules perimeter is not uniformed while benign nodules has a uniformed perimeter.

calculation of the shape characteristics for lung nodules:

$$\boldsymbol{z} = \frac{\boldsymbol{perimeter}}{\boldsymbol{minor\ axes\ length}}$$

Where z is discrimination descriptor of nodules.

discrimination of benign nodules from malignant nodules:

After calculation of the descriptor (z) for a detected nodules , we concluded malignant nodules meet the following condition:

$z > 3.5$

And benign nodules meet the following condition:

$z \leq 3.5$

figure(11) shows the result of diagnosis.

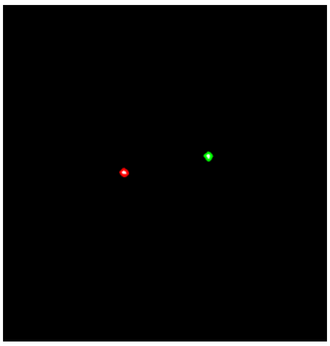
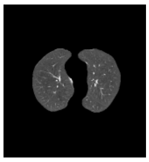
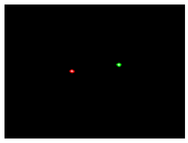
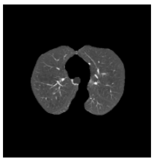
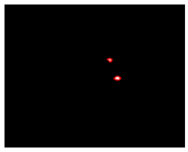
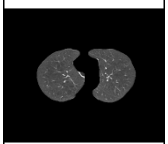
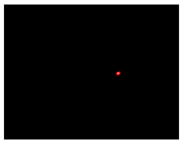
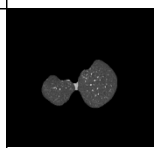
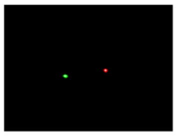
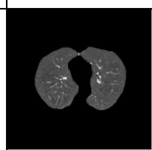
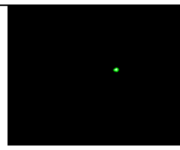
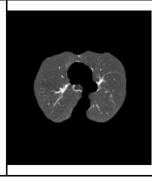
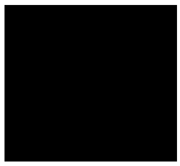


Figure 11 result of lung nodules diagnosis

Where the circled malignant lung nodules by red color , and benign lung nodules by green color, and now the table(1) contain all results of lung nodules diagnosis used in this study:

Table(1) some of CT scan image and it is image processing

No	Lungs image	Diagnosis result	explaining of case
1			Infected image
2			Infected image
3			Infected image
4			Infected image
5			Infected image
6			Intact image

I. Conclusion

Lung cancer is one of the most dangerous diseases in the world. Correct Diagnosis and early detection of lung cancer can increase the survival rate. The present techniques include study of X-ray, CT scan, MRI, PET images. The expert physicians diagnose the lung nodules by experience. The nodules is formed when some patients as a result of the causes of inflammatory or bacterial or tumor. The treatment includes surgery, chemotherapy, radiation therapy and targeted therapy. These treatments are lengthy, costly .hence, in this study we are trying to help the doctor to automatic diagnosis for lung nodules, where the doctors depends on the size of nodule and grow with the time as well as the patient's age and being smoker or not .but study depended on the shape of nodule for discrimination of benign nodules from malignant nodules. consequently, the diagnosis resulting from this algorithm as indicative index for the doctor , where at least one lung nodule detection will prompt the doctor to reconsider the image for accurate and fast diagnosis.

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