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EARLY STAGE DIAGNOSIS OF LUNG CANCER USING CT-SCAN IMAGES BASED ON CELLULAR LEARNING AUTOMATE

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Abstract—The early detection of lung cancer is a challenging problem due to the structure of the cancer cells, where most of the cells are overlapped with each other. This paper presents The project presents diagnosis of early stage lung cancer by making the image better and enhance it from noising, corruption or interference by using Gabor filtering and FIR filter to remove Gaussian noise. The noise removed image is given to two level histogram stage then given to Image Segmentation stage: to divide and segment the enhanced images by using canny edge detection algorithm. Then segmented image is Feature Extracted to obtain the general features of the enhanced segmented image using Binarization and Masking Approach. The proposed technique is efficient for segmentation principles to be a region of interest foundation for feature extraction obtaining. The proposed technique gives very promising results comparing with other used techniques. Relying on general features, a normality comparison is made. The main detected features for accurate images comparison are pixels percentage and mask-labelling with high accuracy and robust operation.

Keywords—Image preprocessing, Gabor filtering, Thresholding Technique, Cany edge detection, Image Segmentation, Feature extraction

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INTRODUCTION

Lung cancer is considered to be as the main cause of cancer death worldwide, and it is difficult to detect in its early stages because symptoms appear only at advanced stages causing the mortality rate to be the highest among all other types of cancer. More people die because of lung cancer than any other types of cancer such as: breast, colon, and prostate cancers. There is significant evidence indicating that the early detection of lung cancer will decrease the mortality rate. The most recent estimates according to the latest statistics provided by world health organization indicates that around 7.6 million deaths worldwide each year because of this type of cancer. Furthermore, mortality from cancer are expected to continue rising, to become around 17 million worldwide in 2030[1].

There are many techniques to diagnosis lung cancer, such as Chest Radiograph (x-ray), Computed Tomography (CT), Magnetic Resonance Imaging (MRI scan) and Sputum Cytology[2]. However, most of these techniques are expensive and time consuming. In other words, most of these techniques are detecting the lung cancer in its advanced stages, where the patient's chance of survival is very low. Therefore, there is a great need for a new technology to diagnose the lung cancer in its early stages. Image processing techniques provide a good quality tool for improving the manual analysis.

For this reason we attempt to use automatic diagnostic system for detecting lung cancer in its early stages based on the analysis of the sputum color images. In order to formulate a rule we have developed a thresholding technique for unsupervised segmentation of the sputum color image to divide the images into several meaningful sub regions. Image segmentation has been used as the first step in image classification and clustering. There are many algorithms which have been proposed in other articles for medical image segmentation, such as histogram analysis, regional growth, edge detection and Adaptive Thresholding[2]. A review of such image segmentation techniques can be found in[5]. Other authors have considered the use of color information as the key discriminating factor for cell segmentation for lung cancer diagnosis[7].The analysis of sputum images have been used in[8] for detecting tuberculosis; it consists of analyzing sputum images for detecting bacilli. They used analysis techniques and feature extraction for the enhancement of the images, such as edge detection, heuristic knowledge, region labeling and removing.

Thresholding has some benefits such as: fast processing, easy influence, resulting images do not keep weight space and another method is region growing. This algorithm starts from a pixel of an image and checks other pixels that are around start point. The non assigned pixel that are neighbors with region checked are similar to the region then the region growing frequently but if differences between neighbor pix and region is more than the threshold the process is stopped. [5] The region growing segmentation based thresholding is used on enhanced image.

I. IMAGE PREPROCESSING

GABOR FILTER

Image presentation based on Gabor function constitutes an excellent local and multi-scale decomposition in terms of logons that are simultaneously (and optimally) localization in space and frequency domains. A Gabor filter is a linear filter whose impulse response is defined by a harmonic function multiplied by a Gaussian function. Because of the multiplication-convolution property (Convolution theorem), the Fourier transform of a Gabor filter's impulse response is the convolution of the Fourier transform of the harmonic function and the Fourier transform of the Gaussian function.

Its impulse response is defined by a sinusoidal wave (a plane wave for 2D Gabor filters) multiplied by a Gaussian filter . Because of the multiplication-convolution property (convolution), the of a Gabor filter's impulse response is the convolution of the Fourier transform of the harmonic function and the Fourier transform of the Gaussian function. The filter has a real and an imaginary component representing orthogonal directions. The two components may be formed into a complex number or used individually.

In this equation, λrepresents the wavelength of the sinusoidal factor, θrepresents the orientation of the normal to the parallel stripes of a Gabor function, $\psi$is the phase offset, $\sigma$is the sigma/standard deviation of the Gaussian envelope and $\gamma$is the spatial aspect ratio, and specifies the ellipticity of the support of the Gabor function.

Complex

$$g(x,y;\lambda,\theta,\psi,\sigma,\gamma) = \exp\left(-\frac{x'^2+\gamma^2 y'^2}{2\sigma^2}\right)\exp\left(i\left(2\pi\frac{x'}{\lambda}+\psi\right)\right)$$

Real

$$g(x,y;\lambda,\theta,\psi,\sigma,\gamma) = \exp\left(-\frac{x'^2+\gamma^2 y'^2}{2\sigma^2}\right)\cos\left(2\pi\frac{x'}{\lambda}+\psi\right)$$

Imaginary

$$g(x,y;\lambda,\theta,\psi,\sigma,\gamma) = \exp\left(-\frac{x'^2+\gamma^2 y'^2}{2\sigma^2}\right)\sin\left(2\pi\frac{x'}{\lambda}+\psi\right)$$

where

$$x' = x\cos\theta + y\sin\theta$$

and

$$y' = -x\sin\theta + y\cos\theta$$

In this equation, λrepresents the wavelength of the sinusoidal factor, θrepresents the orientation of the normal to the parallel stripes of a Gabor function, $\psi$is the phase offset, $\sigma$is the sigma/standard deviation of the Gaussian envelope and $\gamma$is the spatial aspect ratio, and specifies the elasticity of the support of the Gabor function.

FAST FOURIER TRANSFORM

Fast Fourier Transform technique operates on Fourier transform of a given image. The frequency domain is a space in which each image value at image position F represents the amount that the intensity values in image "I" vary over a specific distance related to F. Fast Fourier Transform is used here in image filtering (enhancement).

In particular, many of the existing techniques for image description and recognition depend highly on the segmentation results. Segmentation divides the image into its constituent regions or objects. Segmentation of medical images in 2D, slice by slice has many useful applications for the medical professional such as: visualization and volume estimation of objects of interest, detection of abnormalities (e.g. tumors, polyps, etc.), tissue quantification and classification, and more . The goal of segmentation is to simplify and/or change the representation of the image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics.

The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image (edge detection). All pixels in a given region are similar with respect to some characteristic or computed property, such as color, intensity, or texture.

II. SEGMENTATION

HISTOGRAM THRESHOLDING

Thresholding is one of the most powerful tools for image segmentation. The segmented image obtained from thresholding has the advantages of smaller storage space, fast processing speed and ease in manipulation, compared with gray level image which usually contains 256 levels. Therefore, thresholding techniques have drawn a lot of attention during the past 20 years. Thresholding is a non-linear operation that converts a gray-scale image into a binary image where the two levels are assigned to pixels that are below or above the specified threshold value. In this research, Otsu's method that uses (gray thresh) function to compute global image threshold is used. Otsu's method is based on threshold selection by statistical criteria. Otsu suggested minimizing the weighted sum of within-class variances of the object and background pixels to establish an optimum threshold. Recalling that minimization of within-class variances is equivalent to maximization of between-class variance. This method gives satisfactory results for bimodal histogram images. Threshold values based on this method will be between 0 and 1, after achieving the threshold value; image will be segmented based on it

A. *Segmentation*

Marker-driven watershed segmentation technique extracts seeds that indicate the presence of objects or background at specific image locations. Marker locations are then set to be regional minima within the topological surface (typically, the gradient of the original input image), and the watershed algorithm is applied. Separating touching objects in an image is one of the most difficult image processing operations, where the watershed transform is often applied to such problem. Marker-controlled watershed approach has two types: External associated with the background and Internal associated with the objects of interest. Image Segmentation using the watershed transforms works well if we can identify or “mark” foreground objects and background locations, to find “catchment basins” and “watershed ridge lines” in an image by treating it as a surface where light pixels are high and dark pixels are low

B.Feature Extraction

Image features Extraction stage is an important stage that uses algorithms and techniques to detect and isolate various desired portions or shapes (features) of a given image. To predict the probability of lung cancer presence, the following two methods are used: binarization and masking, both methods are based on facts that strongly related to lung anatomy and information of lung CT imaging.

C.Binarization Approach

Binarization approach depends on the fact that the number of black pixels is much greater than white pixels in normal lung images, so we started to count the black pixels for normal and abnormal images to get an average that can be used later as a threshold, if the Leonardo Electronic Journal of Practices and Technologies number of the black pixels of a new image is greater that the threshold, then it indicates that the image is normal, otherwise, if the number of the black pixels is less than the threshold, it indicates that the image in abnormal.

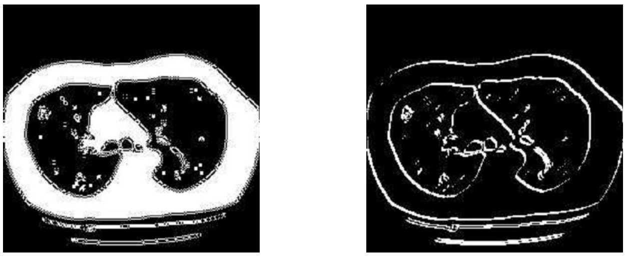
D.Masking Approach

Masking approach depends on the fact that the masses are appeared as white connected areas inside ROI (lungs), as they increase the percent of cancer presence increase. The appearance of solid blue color indicates normal case while appearance of RGB masses indicates the presence of cancer

III. RESULTS AND DISCUSSION

The experimental image is selected as the lung CT Image, whose size is 256×256 as shown in the figure (1). In this subsection, the proposed edge detection methods for detection of lung cancer are applied and results are shown in the figures 2-6

Figure(1) : Original image



(a) (b)

Figure (2): Results obtained after applying FFT(a) and one level thresholding(b)

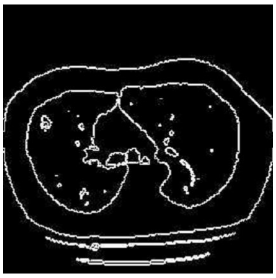


Figure (3): Results obtained after applying 2nd level thresholding

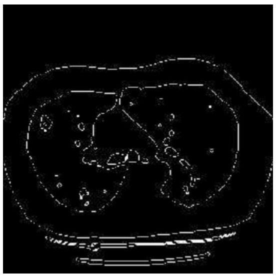


Figure (4): Results obtained after applying Binerization

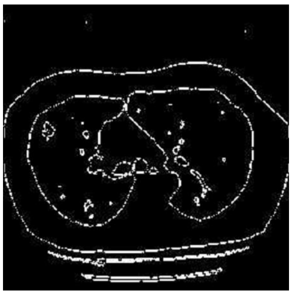


Figure (5): Results obtained after applying Masking

4. CONCLUSION

An image improvement technique is developing for earlier disease detection and treatment stages; the time factor was taken in account to discover the abnormality issues in target images. Image quality and accuracy is the core factors of this research, image quality assessment as well as enhancement stage where were adopted on low pre-processing techniques based on Gabor filter within Gaussian rules. The proposed technique is efficient for segmentation principles to be a region of interest foundation for feature extraction obtaining. The proposed technique gives very promising results comparing with other used techniques. Relying on general features, a normality comparison is made; features for accurate images comparison are pixels percentage and mask-labeling with high accuracy and robust operation.

5. FUTURE SCOPE

The two level thresholding, canny edge detection and features extraction technique shows promising result. The system diagnosis capability can be enhanced by archiving images and patient records. The archives should be available for free to the trained engineers and open source communities. The trained doctors and engineers working together need discover some new features for better classification and prognosis of cancer in early stages. The above techniques can be applied on images from X-ray or MRI for comparison of result. The images which give better result should be considered. The full automation of the system can be achieved by integrating diagnosis of cancer stage with best possible oncological treatment.

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