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Threshold Based Enhanced Segmentation Technique for Early Detection and Prediction of Lung Cancer

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***Abstract*— Lung cancer is one of the main causes of death in humans worldwide. The death rate due to lung cancer is highest among all other types of cancer. Early detection and correct diagnosis of the growing cancer cells can increase the survival rate. The present techniques like X-ray, MRI, CT scan and PET images are used for the diagnosis of the disease. For early detection and treatment stages, image processing techniques are widely used. With the help of expert physicians, images are examined and the stage of cancer is detected. Time factor plays very important role in the diagnosis of the abnormal cells as it is directly related to the survival rate. In this research work, we are using significant pattern tool for prediction of lung cancer. The proposed system will use Histogram Equalization for pre-processing followed by segmentation principles under adaptive segmentation algorithm and feature extraction processes. An enhanced region of the object of interest is obtained. On the basis of features obtained a normality comparison is made to check the state of the patient. If the detection of lung cancer is predicted in its early stages it will reduce the number of painful treatments and also reduce the surgery risk which will increase the survival rate. The effectiveness of the proposed system is validated through MATLAB environment which clearly verifies the pre-processing techniques of early detection and prediction of lung cancer**.

***Keywords*— Image Processing, Early Detection, Prediction, Lung Cancer, Segmentation, Feature Extraction.**

I. INTRODUCTION

Lung cancer is one of the most common causes of death in the whole world and the increase in a number of new cancer cases per year makes it most serious human body problem. As per American Cancer Society's estimation for May 2016 about 14% of new cancers are lung cancer, about 224,390 new cases of lung cancer (117,920 in men and 106,470 in women) and about 158,080 deaths from lung cancer (85,920 in men and 72, 160 in women). Lung cancer is a disease caused by uncontrolled growth of abnormal cells. Abnormal cells do not form healthy tissue, they grow rapidly and overlapped to form a tumor. These abnormalities of lung tissue are also known as lung nodules. These cells can travel from the lungs in blood or lymph. Lung cancer is prone to spread towards the center of the chest due to the natural flow of lymph. When a cancer tissue move from its place where it began and start growing at another place the process is called metastasis [2]. The purpose of this study is to propose a system that will produce promising results for lung cancer detection and prediction. These days image processing is widely used for improving the manual analysis in several areas like medical, military, space research and much more. In this study, CT scan images are used for the image processing. These images are collected from various hospitals and diagnosis centers. Pre-processing techniques are used to enhance the image interpretability and area of interest is separated. Histogram Equalization is used for pre-processing and feature extraction. Developing the algorithm for segmentation feature extraction like perimeter, area, and eccentricity of the tumor will be detected. Then on comparison with the normal values, it will be detected that whether the patient is suffering from cancer or not.

II. METHODOLOGY

Lung cancer diagnosis includes the following steps:

1. Image Capture
2. Image Enhancement
3. Image Segmentation
4. Feature Extraction
5. Diagnosis Result
6. Prediction Process

Figure 1 depicts the general steps followed in lung cancer detection system which contains four basic steps. The first stage is about the collection of CT (Computed Tomography) scan images (normal and abnormal) [3]. The second stage applies the several techniques of image enhancement to get better quality and clearness.

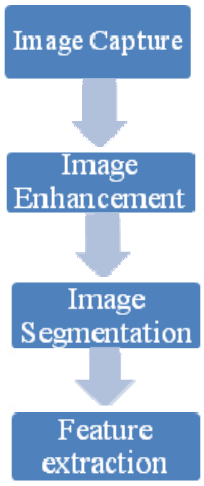

Fig.1 Image processing stages in lung cancer detection

The third stage implements the different segmentation algorithms which is one of most important step in image processing. Forth and the final stage obtains the general feature from the enhanced image which leads to a conclusion of normality or abnormality of the obtained image.

1. Image Capture/Image Collection

At first cancer and non-cancer patient, CT scan images of lungs are collected from different hospitals and diagnosis centers. These digital images are usually having 8bit resolution and DIACOM format. In this research work, CT scan images are being used because these images have low noise compared to X-ray and MRI images. Here CT scan images are collected from NIH/NCI Lung Image database Consortium (LIDC) dataset. Figure 2 shows a CT scan image of lung cancer for diagnosis. The collected image is in its raw form and requires pre-processing for better interpretation. For this technique like smoothing and image, enhancement is applied.

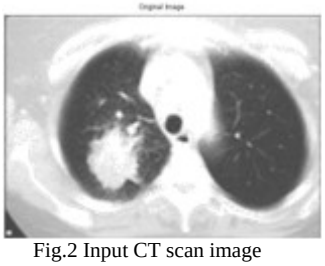

Fig.2 Input CT scan image

2. Image Enhancement

This process is done for making the image better understandable and noise free. There are set of processes to make an image more suitable for a particular application like sharpening an out of focus image, highlighting edges, improving image contrast etc. MATLAB is used in most of the stages of this research work. For smoothing of the raw image in pre-processing step, Median Filtering is used to remove noise from the image. It is a non-linear operation used to remove pepper and salt noise from the image. Figure 3 depicts the filtered image after median Filtering.

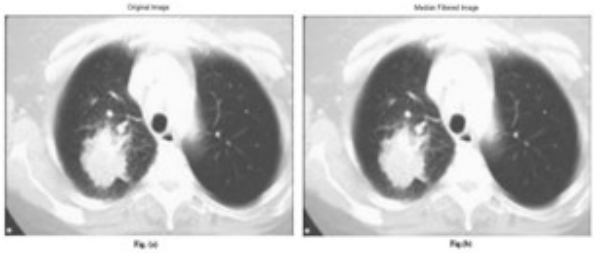

Fig.3 (a) Input image Fig.(b) Median filtered image

Image enhancement process can be divided into two large categories: Spatial domain methods and frequency domain methods. There is no theory that determines that which one is better when it comes to human perception. We are using Gabor Filter for image enhancement because it produces better results when compared to the auto enhancement and fast Fourier. Figure 4 shows enhanced the image in the orientation of the parallel stripes of the histogram.

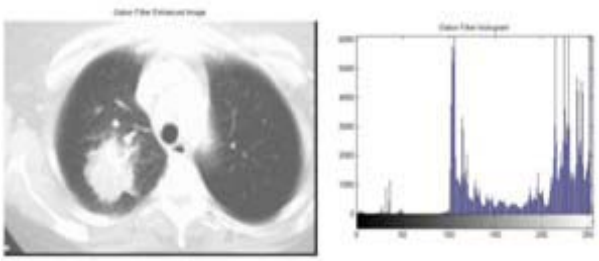

Fig.4 (a) Filtered image Fig. (b) histogram

3. Image Segmentation

It is a process of partitioning the pre-processed CT scan images. Segmentation is used to separate the pixel corresponding to the lung tissue from the surrounding anatomy. Partitioning of medical images in 2-D has useful applications for medical professionals like volume estimation, visualization, abnormality detection and much more. It aims to generalize the representation of an image into more human interpretable. The end result of the segmentation process is a segmented image that collectively covers the entire image. Figure 5 shows the segmented image for better interpretability.

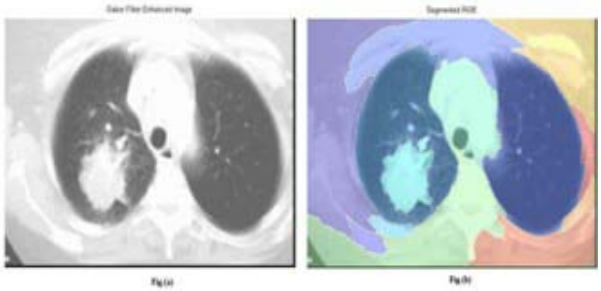

Fig.5 (a) Enhanced image Fig. (b) Segmented image

There are two basic properties of intensity values segmentation algorithms are based on Similarity and discontinuity. The first category on which we partition the image is on abrupt changes in intensity like an edge in the image and in the second category we segment the image on areas that are similar according to predefined criteria. Histogram thresholding comes under this category. Figure 6 shows the classification of the image segmentation algorithms.

Types of Image Segmentation Algorithms:

a) Edge-Based Segmentation Algorithms
b) Threshold Based Segmentation Algorithms
c) Region Based Segmentation Algorithms
d) Clustering Based Segmentation Algorithms
e) Graph-Based Segmentation Algorithms

In this research work, we are using adaptive thresholding under threshold based segmentation technique. As it is an effective tool to separate objects from the background and best suited for greyscale images. Algorithms come under Threshold Based Segmentation Technique divide the pixel with respect to their intensity level [4]. There are basically three types of thresholding:

3.1 Global Thresholding:

An appropriate value for T is set and this value will be constant for the whole image. On the basis of T output image q(x, y) can be obtained from the original image p(x, y).

$$q(x,y) = \begin{cases} 1, & p(x,y) > T \\ 0, & p(x,y) < T \end{cases}$$

3.2 *Variable Thresholding:*

In this type of thresholding, the value of the T can vary over the image and further grouped into two categories:

a) Local Threshold: In this, the value of T depends on the neighborhood of x and y.
b) Adaptive Threshold: The value of is a function of x and y.

3.3 Multiple Thresholding:

In this method there are multiple threshold values like T0 and T1 by these images can be computed as

$$q(x,y) = \begin{cases} m \text{ if } p(x,y) > T1 \\ m \text{ if } p(x,y) \leq T1 \\ m \text{ if } p(x,y) \leq T0 \end{cases}$$

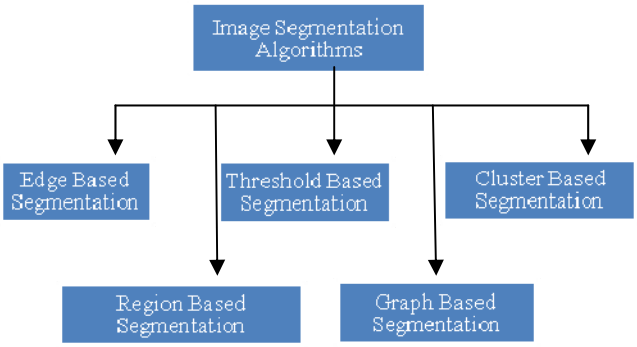

Fig.6 Image segmentation algorithms

4. Feature Extraction

Image feature extraction is an important stage which uses different algorithm and techniques to detect and separate intended portion of a given image [6]. Two methods are used for the prediction of lung cancer: binarization and masking, both are based on lung anatomy and information about the lung CT imaging.

4.1 Binarization Approach:

It is based on the fact that the number of black pixels is much greater than white pixels in the normal CT scan Images which are presented in Figure 7. On counting the black pixels for normal and abnormal images we get an average that can be used as a threshold. In this study, binarization check approach will be used which is realized by Figure 8.

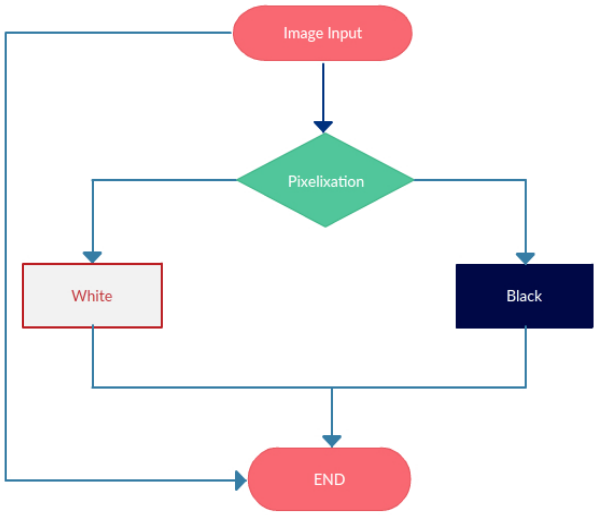

Fig.7 Binarization method procedure

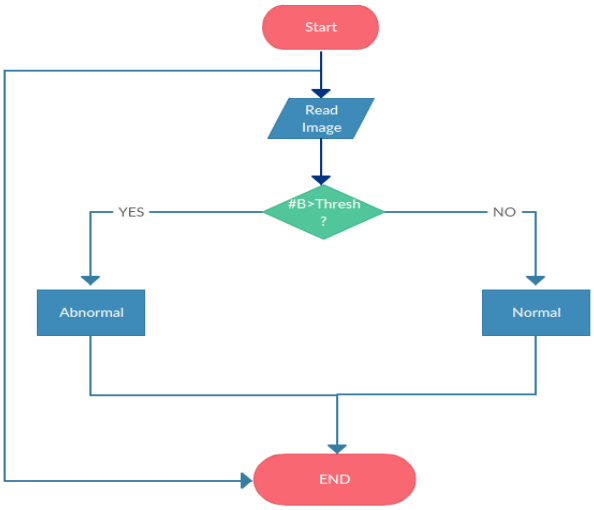

Fig.8 Binarization check method flowchart

5. Diagnosis Report

After completion of the feature extraction process system will show whether the image is normal or having some flaws.

III. Conclusions

An improved technique is developed for early detection and treatment stages. The time factor is very crucial for the detection of abnormality of the cells. We are intended to propose more enhanced human interpretable and accurate diagnosis result. The proposed system will be much more easy to use, cost-effective and time-saving. On the basis of general features, normality comparison is done and the result is produced.

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