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Lung Tumor Detection by Using Image Segmentation and Neural Network

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ABSTRACT

Nowadays cancer has become huge threat in human life. There are many types of cancer, Lung cancer is one of the common types causing very high mortality rate. The best way of protection from lung cancer is its early detection and diagnoses. With the fast development of the technology of computed tomography (CT) technology, medical test images become one of the most efficient examination methods to detect clinically the lung disease. The use of digital processing techniques like automatic segmentation for those images can help the Radiologist and the Surgeons to detect and remove lung tumors easily and efficiently. Early detection of cancer is the most promising way to enhance a patient's chance for survival. The back propagation is a systematic method of training multilayer neural networks in a supervised manner. The back propagation method, also known as the error back propagation algorithm, is based on the error-correction learning rule. The objective of our work is to take CT scan images and perform segmentation of their using OTSU's thresholding method and various shape parameters include optimal thresholding, area, energy, entropy etc. On the basis of their parameter back propagation network is trained to classify the tumor as per its extent. If the calculated parameter value above the threshold value then extent of cancer is high otherwise low. This work has been done on few CT images and results are analyzed graphically as well as numerically.

Keywords: OTSU's thresholding, CT images, Segmentation, Neural network, Back propagation.

1. INTRODUCTION

Imaging plays a vital role in the diagnosis of lung cancer. The most common modalities are Chest Radiography, Positron Emission Tomography (PET), Magnetic Resonance Imaging (MRI), Radionuclide Bone Scanning (RBS), and the X-ray computerized axial tomography (CT). In this work, author has used the CT images for the detection of the lung tumors, because it has the ability to determine the tumor in the presence of lymph node metastases. In fact, by the CT imaging one can easily distinguish between the tumor and normal tissues, especially when the pathology knowledge is present. Recent advances in Computed Tomography (CT) technology have enabled its use in diagnosing and identifying different diseases. Several lung diseases are diagnosed by investigating the patterns of lung tissue in pulmonary CT images, therefore segmentation and analysis is one of the important parts of CAD systems [7]. The image Pre-processing stage starts with image enhancement which tend to improve the interpretability or perception of information included in them for human viewers, or to provide better input for other automated image processing techniques. Image enhancement techniques can be divided into two broad categories: Spatial domain methods and frequency domain methods. Unfortunately, there is no general theory for determining what "good" image enhancement is when it comes to human perception. For lung cancer detection using image preprocessing as choose CT images have sizes 512×512 pixels, of 8-bits radiometric accuracy then converting the gray images into binary, using threshold (50< Th < 200),then labeling the binary image to define the number of objects. Extract the interested region of lung and calculate the labeled object's area, and sort them.

A. SEGMENTATION TECHNIQUE

Most of the image segmentation algorithms are based on one of the two basic properties of intensity values: discontinuity and similarity. Detecting discontinuities means to partition an image based on abrupt changes in intensity [10]. This includes image segmentation algorithms like edge detection. (Edge detection is based on abrupt change in intensity) and detecting similarities means to partition an image into regions that are similar according to a set of predefined criterion [10],this includes image segmentation algorithms like thresholding, region growing, region splitting and merging.

B. OTSU'S THRESHOLDING

Otsu's thresholding method based on a very simple idea Find the threshold that minimizes the weighted within-class variance. This turns out to be the same as maximizing the between-class variance. Operates directly on the gray level histogram [e.g. 256 numbers] so it's fast once the histogram is computed [16]. The total variance does not depend on threshold. For any given threshold, the total variance is the sum of the within-class variances (weighted) and the between class variance, which is the sum of weighted squared distances between the class means and the grand mean.
The number of pixels with gray level i is denoted fi, giving a probability of gray level i in an image of pi = fi / N.
It is based on the interclass variance maximization. Well thresholded classes have well discriminated intensity values.
M × N image histogram:
L intensity levels, [0. . . L − 1];
ni #pixels of intensity i :

$$\sum_{i=0}^{L-1} n\,i$$

Normalized histogram:

$$Pi= ni /MN$$

$$\sum_{i=0}^{L-1} p\,i = 1 \text{ , } \mathbf{pi>=0}$$

C. ARTIFICIAL NEURAL NETWORK

The neural can be used to extract patterns and detect that are too complex to be noticed by either humans or other computer techniques. Neural networks are typically performed in layers. Layers are made up of a number of interconnected with 'nodes' which contain an 'activation function'[3]. Patterns are presented to the network via the 'input layer' that communicates to one or more 'hidden layers 'where the actual processing is done via a system of weighted 'connections'. The hidden layers then connected to an 'output layer'. Both feed forward and feed forward back propagation neural networks are used for classification [6].

1) Feed Forward Neural Network

In a feed forward neural networks information always moves in one direction only, there is no any feedback. The information moves forward from input layer through hidden layer to the output layer. The networks are used are Hebb, Perception, Ada-line and Madaline networks in feed forward [26].

2) Feed Forward Back Propagation Neural Network

The back propagation is a systematic method of training multilayer neural networks in a supervised manner. The back propagation method, also known as the error back propagation algorithm, is based on the error-correction learning rule. The back propagation network consists of at least three layers of units: an input layer, at least one intermediate hidden layer and one output layer. An input pattern is forwarded to the output through input to hidden and hidden to output weights. The output of the network is the classification decision.

2. RELATED STUDY

Lung cancer is the leading cause of cancer deaths in United States, among both men and women. The major cause of lung cancer is the smoking. The risk of lung cancer increases with length of time and number of cigarettes a person smoke. If a person quit smoking even after smoking so many years, that person can significantly reduce chances of developing lung cancer is very leading cause of cancer deaths in both women and men. American cancer Society's estimates for lung cancer in the United States for 2013 are about 228,190 new cases of lung cancer (both small cell and non-small cell) and about 159,480 deaths from lung cancer.

Lung cancer is estimated that 1.3 million people are diagnosed with this disease every year (12.6% of the total number of cancer diagnosed), and about 1.3 million people are dying of this disease yearly (17.8% of the total cancer death) [1]. The survival and manage rate is higher if the cancer is detected at early stages. The early detection of lung cancer is not an easy task. About 81% patients are diagnosed correctly at the middle or advanced stage of cancer [2]. In order to detect it at its early stages, regular screening and watching is very important which can reduce the number of deaths due to lung cancer. Lung cancer patients cannot understand any symptoms at initial stages but it can lead to death if not detected and treated on timely [6]. A Computed Tomography (CT) scan is very good medical imaging technique especially in the field of thoracic radiology [16]. A small slice CT scan of the chest is an essential procedure for lung cancer diagnosis. Previous works have concentrated mostly on the analysis of CT-scan images to detect tumors and

other anomalies of the lungs. However, minimal work has been done in attempting to classify tumor classes based on these images for which new ground is broken here. Neural networks are important tools for cancer detection and monitoring. An initial diagnosis called early diagnosis is made based on the demo graphic and clinical data of the patient. About more than 30% cancer deaths are preventable. Curing cancer has been a major aim of medical researchers for decades. Artificial neural networks now are used in many fields. They have become well established as practical, multipurpose, strong computational methodologies with solid theoretic support and with strong potential to be effective in any discipline especially in medicine. Over the last two decades, a great amount of research work has been conducted for automated cancer diagnosis.

Mokhled S. ALTSRSWNEH,"Lung cancer detection using image processing technique" Leonardo electronic journal of practices and technologies (2012). Algorithm or techniques are enhancing a better image Gabor filter, auto enhancement algorithm FFT are used and segmentation of the enhanced image is done by thresholding approach and marker controlled watershed segmentation approach. Results are Image quality and accuracy by using Gabor filter based on Gaussian rules. Features are extracted by pixel comparison and mask labeling. Time factor is the main drawback of this research technique.

S.K. Vijai Anand," Segmentation coupled textual feature classification for lung tumor prediction" IEEE TRANSACTION (2010) Algorithm or technique are image processing techniques are coupled with neural network to predict the tumor is either benign or malignant, CT image is denoised with non-linear total variation algorithm and optimal thresholding is applied to the denoised. This system is able to find cancerous cells in less than 3 minutes. It is limited to small input image set. It can be enhanced for large image set.

Katrina Palmer Lee et.al (2012) [9] proposed iterative image restoration a method, implementation of efficient matrix vector multiplication, and linear system solves for preconditions can be a tedious and time consuming process. Different blurring functions and boundary conditions often require implementing different data structures and algorithms. A complex set of computational methods are needed, each likely having different input parameters and calling sequences. This paper describes a set of MATLAB tools that hide these complicated implementation details. Combining the powerful scientific computing and graphics capabilities in MATLAB, with the ability to do object oriented programming and operator overloading, results in a set of classes that is easy to use, and easily extensible.

Priti Aggarwal et.al (2013) [13] reviewed a result from a comparative study of Wiener based & IWD based Image restoration method is presented. The method uses five metrics such as average absolute difference, signal to noise ratio, peak signal to noise ratio, image fidelity & mean squared error value that measured the performance to compare and analyse the results. Principal components analysis (PCA) is used to improve the quality of restoration. The implementation of the IWD based image restoration obtains the higher PSNR value. The higher the PSNR value higher the quality of an image.

3. PROPOSED WORK

A. Existing system

I. Take digital chest radiograph contrast enhancement then removal of background information.

II. Perform SNA Identification (by shape) and SNA Separation Feature Extraction.

III. Comparison b/w normal and affected lung then Classify the tumor.

IV. Analysis of Results.

B. Need for research

Following steps are to be performed need for research in this proposed system.

1.) Edge detection- Edge detection is to be done on the required region of image. The image recovered will be fuzzy at the interface of normal and tumor region. If the region is blurred region then it will recognize as tumor for maximum possibility of correct diagnostic

2.) Image restoration- The recovered image after optimal threshold and <background removal>holes filling is further processed with efficient algorithm of image restoration starting from center of the ROI (region of interest) towards edges so that we could have clear image with least information loss.

3.) Image segmentation- The image of the lungs thus received will be segmented with area threshold of 1-1.5mm to get difference in non-affected and affected parts of the lung within the tumor.

4.) Image registration- Images of the lung taken at different angles of view will be stitched to make a round view of the tumor. This will help in actual visual of the size of tumor.

C. Objective

1.) To compare the features of the ROI (region of interest) with the normal lung images.
2.) To reduce the processing time and increase the accuracy.

The process is to study and analyze the various edge-detection techniques on CT images. Then apply the optimal thresholding technique to segment the lung region, we are using Otsu's thresholding method. Then apply the fuzzy logy BPN (Back Propagation Network) to the recovered image to find out the cancerous/non-cancerous tumor. At the end of research, make a comparison of all the techniques previously used related to this dissertation.

4. RESULTS & DISCUSSION

A. Input and output of Images: Lung tumor is leading cause of cancer in both men and women. Therefore detection of lung cancer is not easy task. Analysis process includes segmentation using OTSU's thresh holding technique and shape parameters optimal threshold, area, energy, entropy, area etc. Result methodology of program is given below. In this process author have segmented using OTSU's thresh holding technique and shape parameters such as optimal threshold, area, energy, entropy, area etc. In a table we set expected value if threshold value is less than 200 so it's less harmful if the same value is bigger than 200 so tumour is very harmful. Then we calculate area if value is less than 50.00 then we find out the tumour if area is more than 50.00 so tumour size is big. In this Comparison Graph shows our optimum results of proposed system over base values.

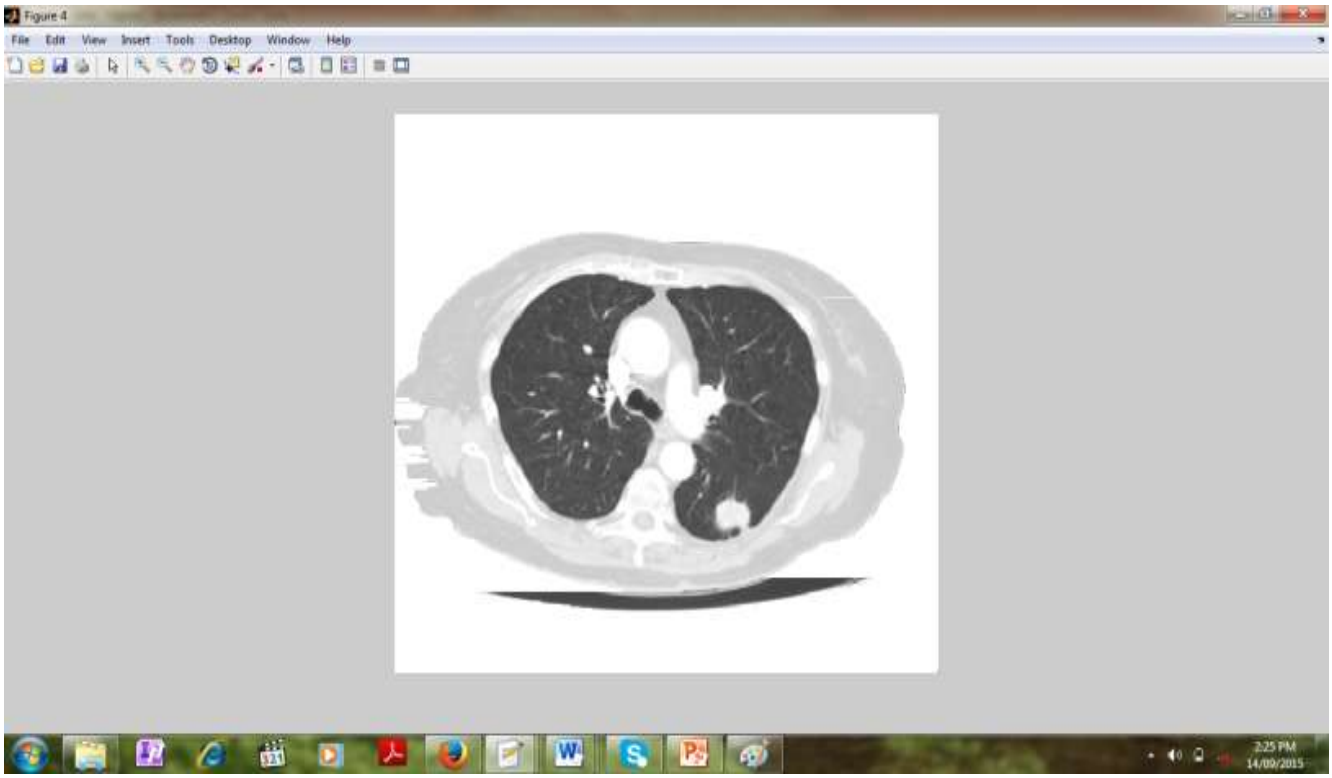

Figure 1: MATLAB Shows Input Result Image1

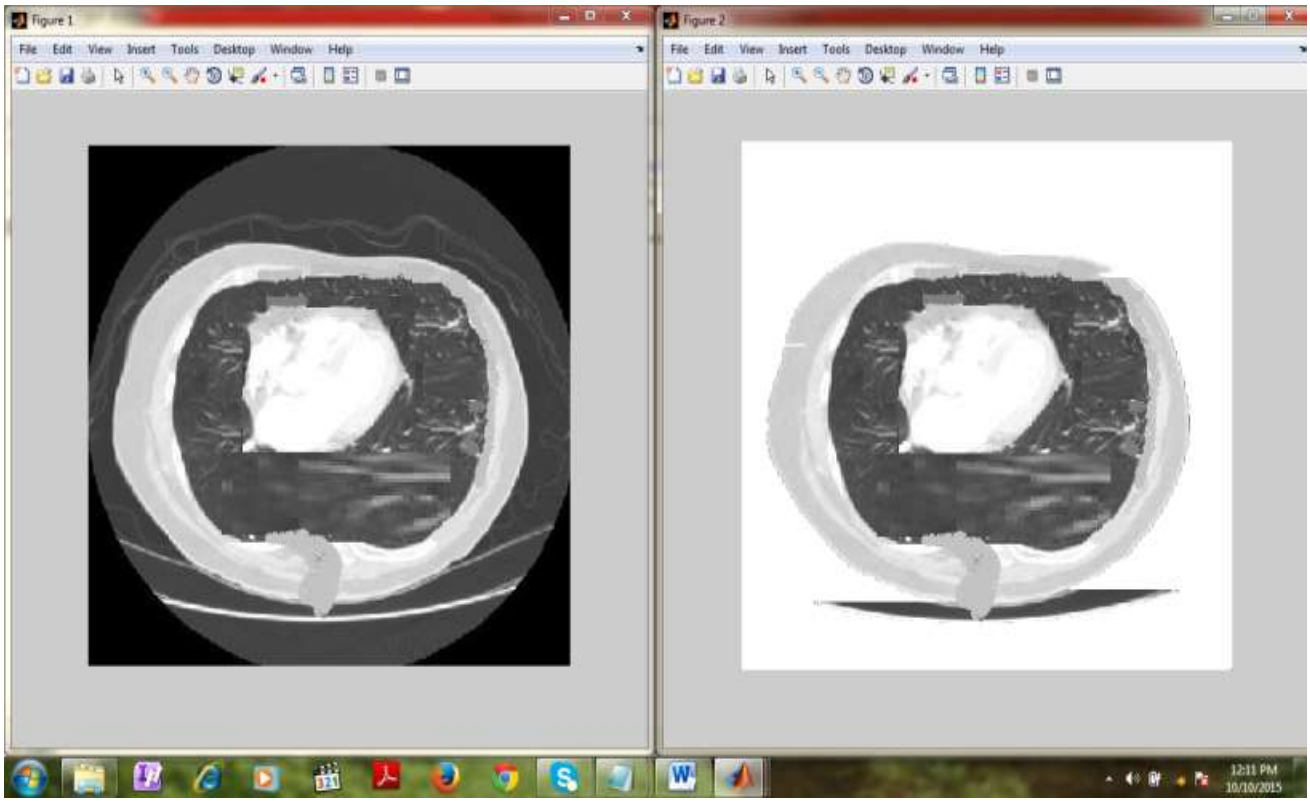

Figure 2: MATLAB Shows Input Result image 2

In this process author have segmented using OTSU's thresh holding technique and shape parameters such as optimal threshold, area, energy, entropy, area etc. In a table we set expected value if threshold value is less than 200 so it's less harmful if the same value is bigger than 200 so tumour is very harmful. Then we calculate area if value is less than 50.00 then we find out the tumour if area is more than 50.00 so tumour size is big. In this Comparison Graph shows our optimum results of proposed system over base values.

B. Comparison of results: Compare the result of both images.

Table 1: Result Table

Description	**Consolidate Value [1]**	**Consolidate value[2]**
Optimal threshold	212.51160	207.8271
Area	52.611	43.787
Energy	2.4170	2.1522
Solidity	96.3184	80.1637

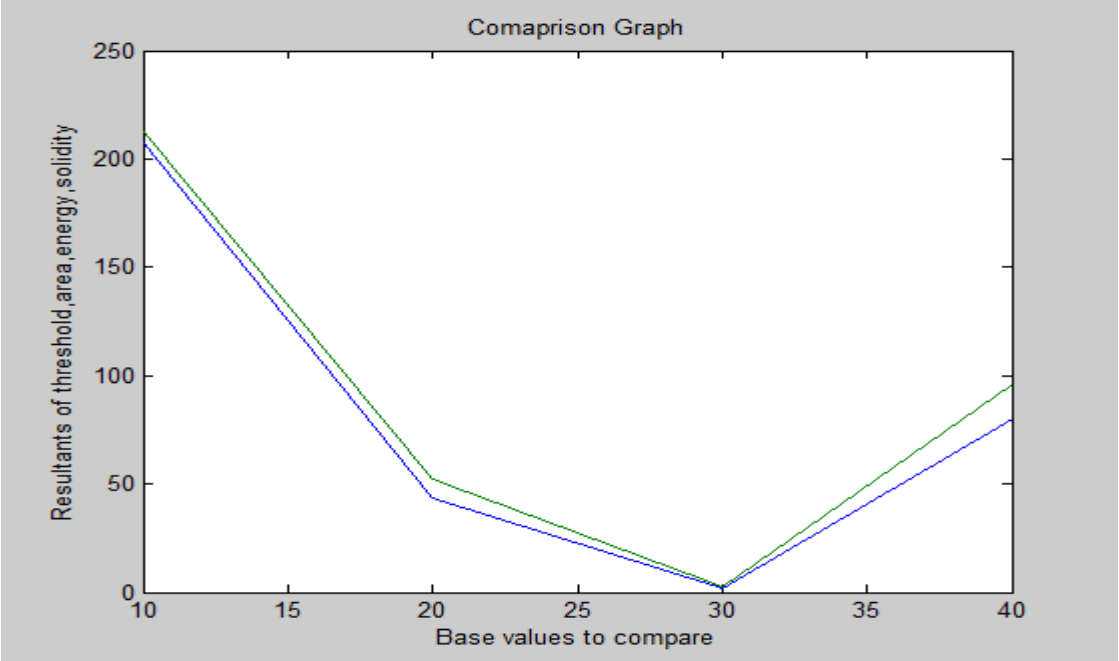

Figure 3: Comparison Graph

In the Figure 5 comparison graph, green line shows the consolidate value [1] of proposed system. In the Figure 3 comparison graph, blue line shows the consolidate value [2] from the previous research on the detection of the lung cancer. In this graph outcomes of consolidate value [1] over the consolidate value [2] of previous result.

CONCLUSION

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-labeling with high accuracy and robust operation. In this paper, the author developed lung cancer detection system for early detection of lung cancer by studying a number of steps. The approach starts by extracting the lung regions from lung CT image using several image processing techniques in MATLAB including binary image, erosion, Gaussian filter and start with binary image including of threshold technique that is used in the initial steps in the extraction process to convert CT image into binary image, which is faster and user-independent. After the extraction step, the region growing segmentation algorithm is applied on extracted lung regions. Then the shape of nodule is calculated using shape formula with the help of area and perimeter of nodule. Finally, the extracted features help to find the cancerous and non-cancerous candidate in CT images. To differentiate the cancerous nodules from other suspected nodule area from CT images, an artificial neural network using back propagation is developed. This consists of classifying the suspicious regions of pulmonary nodules. The principal advantages of artificial neural network are their ability to discover the preferred information in data. The paper suggests the best ANN technique with algorithm used for classification of lung cancer nodules in CT images. This system facilitates the radiologist and physician to recognize the suspicious nodules that increase the sensitivity of the diagnosis.

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