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Lung Cancer Detection from Computed Topography Images using Marker controlled Watershed

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Abstract:
The death count due to lung cancer is increasing day by day. According to the statistics calculated by world health organization (WHO), the estimated deaths are around 2,28,150 (116,440 in men and 111,710 in women). The statistics shows the lung cancer consists of about 14 percent among other cancers. It ranks second place in each woman and men. This research is carried out using lung cancer CT scan images as input data. In this research, the proposed methodology is implemented in three stages. In stage one, preprocessing is done using gaussian filter and Gabor filter. The image smoothing is accomplished with gaussian filter and image enhancement is carried out using Gabor filter. In stage two, image segmentation is done using marker-controlled watershed algorithm it segments the lung portion only. In stage three, binarization is used for detection and classification is carried out based on the black and white pixels. In the binarization method, if black pixel count is less than 17179, then lung cancer is detected. The adopted Navies Bayes classifier shows an accuracy of 94.6 percent. Gabor filter gives best in terms of texture analysis and intensity when compare with a gaussian filter. Gabor filter increases the contrast in nodule areas that are very helpful for cancer detection.

Keywords:*Binarization, CT images, Gaussian Filter, Gabor Filter, Marker controlled watershed.*

I. INTRODUCTION

Lung cancer is caused mainly due to life style changes. Eating tobacco, smoking, exposure to pollutants, family history and so on. Malicious cancer cells grow in the body parts such as chest wall, diaphragm, bronchus. Lung cancer or primary lung cancer deals with the growth of cancer cells in lung parts itself while Secondary lung cancer deals with spreading of cancer cells to lungs which are grown from other body part. Lung cancer can be categorized into two major types, among which first is Non-small lung cancer and the second is small cell lung cancer. The size of malicious cells starts growing rapidly and thereby increasing the cancer stages. NSCLC constitutes about 85 percent and the SCLC constitutes the remaining 15 percent [1]. More number of deaths happen due to lung tumor/lung cancer according WHO. The survival rate can be increased by early detection of the lung tumor. Various computer aided detection systems are available. In this research cancer images are taken from computer topography (CT). CT images are having high resolution and more clarity when compared to X-ray images and provides more productive output for analysis [2]. The research is carried out in four stages. In stage one, acquiring of CT images from cancer data base is accomplished from http://www.cancerimagearchieve.net. In stage two, the noise is removed from the acquired images using gaussian and Gabor filter. In this stage image enhancement and smoothing is also done. In stage three, image segmentation is done using marker watershed and thresholding for analysis on selected lung portion [3]. In stage four, detection and classification is done using binarization and Navies Bayes classifier. In binarization process, the total

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number of black color pixels and white color pixels are calculated using a set threshold value. If the black pixel count is above the threshold then the tumor is normal else if black pixels are below the threshold then the cancer tumor is detected. Finally, the accuracy is obtained using Navies Bayes classifier.

The flow chart for the steps followed in this paper is shown in Figure (1)

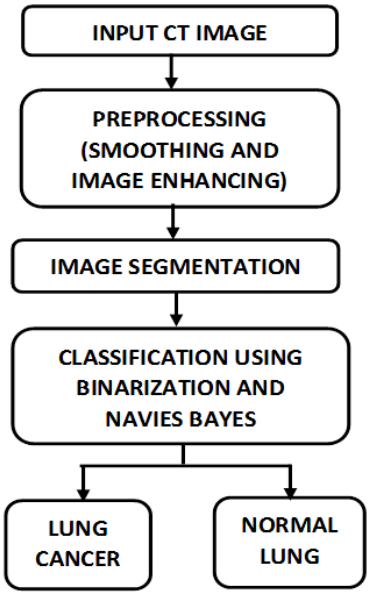

Figure 1. Flow chart

In this paper, we are going to discuss the techniques which can be helpful to detect cancer in early stages.

II. BACKGROUND

Suren Makaju[4],[17] proposed a method in which gaussian filter and median filter were implemented in pre-processing stage. Watershed algorithm was used for segmentation and other features such as centroid, diameter and pixel mean intensity were extracted.

Moffy Vas [5] detected lung cancer in which CT scan images were used as data. Image Preprocessing was carried out using the median filter and image segmentation was carried out using morphological methods. GLCM was used for image extraction and in final stage ANN was used as classifier.

Deep Prakash Kaucha [6],[15] presented an early and fast method for lung cancer detection. In its initial stage of detection, conversion of CT scan images was done. DWT (Discrete Waveform Transform) was used for image segmentation. GLCM was implemented for features extraction which were finally given to SVM classifier for detection.

Pooja R.Katre[7] implemented a methodology for cancer detection. The detection initially used median filter for noise removal present in taken input images. Marker controlled watershed was utilized for segmenting the image. Features were extracted and detection was done.

Bhagyarekha U. Dhaware [8] detected lung cancer cells by using the below methodology. Preprocessing was done using CLAHE. Features were extracted by implementing GLCM and Bayesian classifier was used.

Avinash. S [9] developed an image improvement algorithm for early detection. Gabor function was used in Image preprocessing stage and Marker driven watershed segmentation technique was used for segmentation and analysis was carried on.

Sayali Satish Kanitkar [10],[16] detected lung cancer whose methodology is explained below. Gaussian filter was utilized for removing noise. Watershed technique was used for Image segmentation. After segmentation, binarization was followed to detect cancer.

Anita Chaudhary [11] detected lung cancer by implementing a method with the use of CT images. The entire work was divided into three stages in which Gabor filter, FFT methods were used in first stage for image enhancement. Watershed and thresholding techniques were used in second stage for image segmentation. Features were extracted and classification was done.

Mokhled S. Tarawneh [12],[18] implemented a method to detect lung cancer which was divided into three stages. Gabor filter, FFT and auto enhancement algorithm were utilized in Image Enhancement stage. Thresholding and Marker-Controlled Watershed were utilized in Image Segmentation

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stage. Features were extracted using binarization and masking technique.

Anjali Kulkarni [13],[19] proposed a new strategy to classify lung cancer stages in which CT scan images were used. Median filter was used for image smoothing and enhancement was done with Gabor filter. Marker based watershed method was used and features such as area, perimeter, boundary were extracted.

III. PROPOSED METHODOLOGY

The methodology here is followed by four steps and then finally with the result. In brief explanation of these steps are being explained in further sections. Flowchart here provides the idea of the procedure which is followed:

A. Data collection

CT (Computer Tomography) images of non-cancerous and cancerous are taken from

http://cancerimagearchieve.net. Total 70 cancerous images and 30 non-cancerous images are taken for

analysis. All the input images taken are in DICOM format which is considered as the standard format for medical imaging [2].

B. Image preprocessing

The collected images may have some noise and in order to remove this, filters are used. In this paper, Gaussian and Gabor Filter are considered. The input image taken for detection is the binary image which is then applied with the filter.

Gaussian filter: Gaussian filter is a low pass filter it helps in removing the high frequency component in the image. This smoothing reduces the noise very effectively thereby giving accurate results [9].

The mathematical formula used for this filter is shown in equation (1) below

$$G(p,q)=\frac{1}{2\pi\sigma^2}e^{-\frac{p^2+q^2}{2\sigma^2}} \quad (1)$$

Where p = distance calculated from origin to a point on horizontal axis , q = distance calculated from origin to a point on vertical axis

σ= standard deviation of gaussian distribution Gaussian smoothing uses this 2-D distribution formula for smoothing purposes which can be achieved with the help of convolution technique.

Gabor filter: Image enhancement is done using filter. The purpose and necessity of enhancement here is to increase the quality of filtered image so that information available in the image can be easily visible or understandable to humans [9].

Equation (2) below represents the mathematical formula used for this filter.

$$g(x,y;\lambda,\theta,\psi,\sigma,\gamma) = \exp\left(-\frac{x_1^2+\gamma^2y_1^2}{2\sigma^2}\right)\exp\left(\mathrm{i}\left(2\pi\frac{x_1}{\lambda}+\psi\right)\right)$$

Where,

$$x1 = x\cos\theta + y\sin\theta$$
$$y1 = -x\sin\theta + y\cos\theta \quad (2)$$

C. Image segmentation

In this stage, thresholding and marker-controlled watershed techniques are utilized for segmentation of the filtered input image. Thresholding technique is used to separate pixels based on intensity into dark or light regions. It helps in creation of binary image from grayscale image by replacing each pixel of an image with black pixel.

To extract the minimum region value from the image watershed segmentation is used. In watershed transform over segmentation is occurring so to overcome this draw-back marker-controlled watershed techniques are applied in this research. Marker controlled watershed method is applied to segment boundaries from the filtered image. After segmentation is performed each object is separated from their respective neighbors.

The next step after segmentation is binarization. Binarization deals with counting the total number of black color and white color pixels in an image. The black pixel number count is compared with threshold and if it less than the threshold value, cancer is detected or if it is more than that of threshold value

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than the patient is normal. The threshold value used here is 17179.

D. Feature extraction:

Grey-Level Co-Occurrence Matrix: GLCM is purely statistical mathematical methodology in which texture features of images are being examined with the help of pixel values. These pixel values are extracted with the help of the intensity values of the images from which matrix is calculated [14].

IV. RESULTS & DISCUSSIONS

The image smoothing using gaussian filter is shown in Figure 2(a) here all the high frequency components are filtered from the image and noise is removed. The image enhancement using Gabor filter shown in figure 2(b) where the quality of image is highly improved for detection of lung cancer.

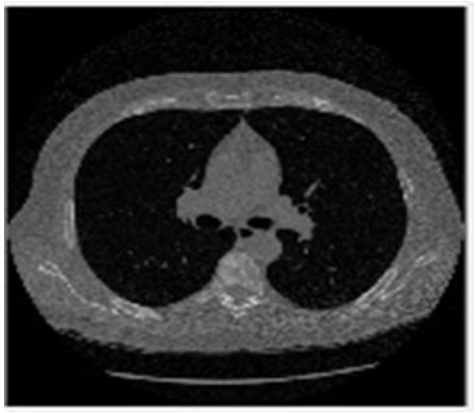

Figure 2(a) Image filtered using Gaussian filter

Figure 2(b) Image enhancement using Gabor filter

The segmentation is done using watershed and marker-controlled watershed techniques. In watershed transformation over segmentation occurred as shown in Figure 3(a). This over segmentation is reduced using markers watershed transform shown in Figure 3(b).

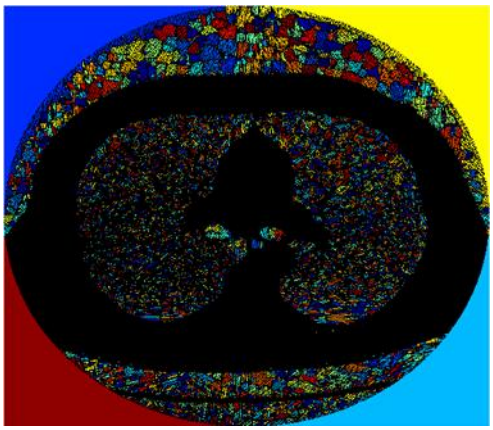

Figure 3(a) Over segmentation

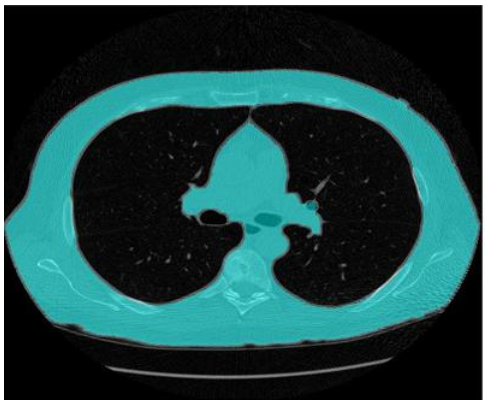

Figure 3(b) Marker controlled watershed

The binarization is applied for counting number of black and white pixels. This iteration is carried for 1200 times shown in Figure 4(a). In the final segmented image if the black pixels are less than 17179 then cancer symptoms are observed and it is considered as abnormal image shown in Figure 4(b).

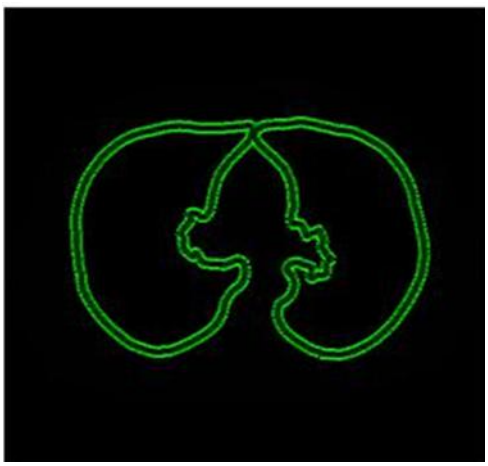

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Figure 4(a): 1200 Iterations

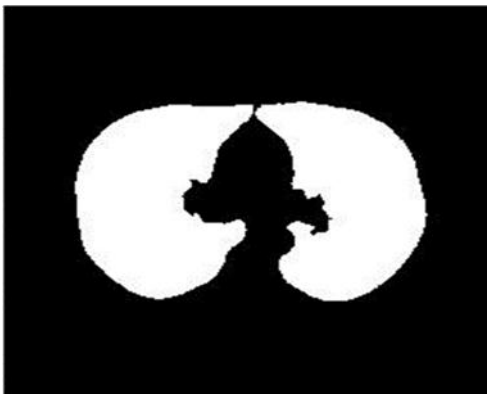

Figure 4(b): Segmented image

GLCM is applied for extracting numbers and the obtained result is as shown in the Table 1.

Table 1. Features obtained for the taken input image.

Feature	Value obtained
Contrast	2.897
Correlation	9.099
Energy	4.2073
Homogenity	8.9457

V. CONCLUSION

In this paper,an improved technique is proposed for early detection of lung cancer.The proposed methodology is carried out in three stages: image pre-processing,image segmentation and finally binarization.In implementation of image processing techniques,the properties of the images needs to be preserved properly. Inorder to enhance and smoothen the images,Gaussian and Gabor filters are implemented here which performs better when compared to other filters.The filtered images are then segmented for easy counting of the pixels which are used in further classification stage.Marker controlled watershed segmentation is proposed as it overcomes the problem of over-segmentation issue.After performing iterations of about 1200 the pixel count is generated which is then compared to the set threshold value.The proposed method classified the image based on the pixel count,if the pixel count is less than 17179 then the input image is considered as cancerous image. Binarization method proved to be the best and accurate method in early classification of lung cancer.

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