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Segmentation of Lung Tumor Using GLCM Technique

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Abstract:- Cancer is the critical health problem worldwide. Lung cancer is the main cause of cancer death for both men and women. A pulmonary nodule is the common sign of lung cancer. The proposed system efficiently predicts lung tumor (nodule) from Computed Tomography (CT) images through image processing techniques. To enhance a patient's chance for survival of lung cancer early detection is very important. In image processing procedures, process such as extraction of lung region from chest computer tomography images, segmentation of lung region, feature extraction from the segmented region. For image denoisingtotal variation based denoising is used, and then segmentation is done using thresholding and morphological operation. Gray level co-occurrence matrix (GLCM) is used for extracting texture features from lung nodule. The proposed system has yielded promising results that would supplement in the diagnosis of lung cancer.

Keywords:- Total variation, Optical thresholding, Morphology, GLCM(Graylevel co-occurrence matrix).

I. INTRODUCTION

Lung Cancer is uncontrolled cell growth in tissues of the lung. If left untreated, this growth can spread beyond the lung by the process of metastasis into nearby tissue or other parts of the body. Tumors can either be benign or malignant.Lung cancer is also called carcinoma. Carcinoma is type of malignant. Lung nodules (tumor) are small masses of tissue in the lung. They appear as round, white shadows on a chest X-ray or computerized tomography (CT) scan [10].

Most cancers that start in the lung, known as primary lung cancers, are carcinomas.A cancerous (malignant) tumor consists of cancer cells which have the ability to spread beyond the original site. Sometimes cells break away from the original (primary) cancer and spread to other organs in the body by traveling in the bloodstream or lymphatic system. When these cells reach a new area of the body they may go on dividing and form a new tumor, often referred to as a "secondary" or a "metastasis". The two main types are small-cell lung carcinoma (SCLC) and non-small-celllung carcinoma (NSCLC).The three main subtypes of NSCLC are adenocarcinoma, squamous-cell carcinoma and large-cell carcinoma. Lung cancer staging is an assessment of the degree of spread of the cancer from its original source [11]. NSCLC have four stages and SCLC have two stages.

The most common symptoms are coughing (including coughing up blood), weight loss, shortness of breath, and chest pains. The vast majority (85%) of cases of lung cancer are due to long-term tobacco smoking. About 10–15% of cases occur in people who have never smoked. These cases are often caused by a combination of genetic factors and exposure to radon gas, asbestos, second-hand smoke, or other forms of air pollution. Lung cancer is a deadly disease and has chances to spread to other parts of the body, e.g. the brain, liver, bone and bone marrow [12].

Medical imaging allows looking inside the body, without resorting to invasive methods. Not only more comfortable and safe for the patient, imaging also allows views of anatomy and physiology that cannot be obtained by anyother means. Medical imaging plays an important role in early tumor (nodule) detection and treatment of cancer. It also guides the physician with information for efficient and effective diagnosis.The various scan techniques are available like CT scan, MRI, PET. The proposed system usesComputed Tomography (CT),because it is one of the best imaging techniques for soft tissue imaging behind bone structures. ACT image has high spatial resolution, minimizes artifacts and provides excellent visualization of anatomical features for analysis. In earlier stages, lung cancer is most commonlynoticeable in CT images.

For removing noise in the image different techniques are used like Linear smoothing, Median filtering, Denoising using local statistical, Total variation, Wiener filter, Anisotropic diffusion, Bilateral filtering Fields of expert [13]. The Total denoising method is used in proposed system. Different techniques areGlobal thresholding, Automatic thresholding, optimal thresholding, Otsu method for converting graylevel image into binary image [15]. Optical thresholding is used in proposed system. Segmentation methods can be broadly classified in four categories, namely, edge based, region based, data clustering and matching [14]. The proposed system uses morphological operations for segmentation. For extracting features from image different techniques are used like Gabor, Gabor Wavelet, Wevelet, GLCM (Gray level co-occurance Matrix). GLCM (Gray level co-occurance Matrix) is used in proposed system.

II. SYSTEM ARCHITECTURE

The proposed system for extraction of lung tumor is shown in Fig. 1. The proposed system uses image processing techniques are total variation denoising, optimal thresholding, morphological operations forsegmentation,gray-level co-occurrence matrix feature extraction (GLCM).

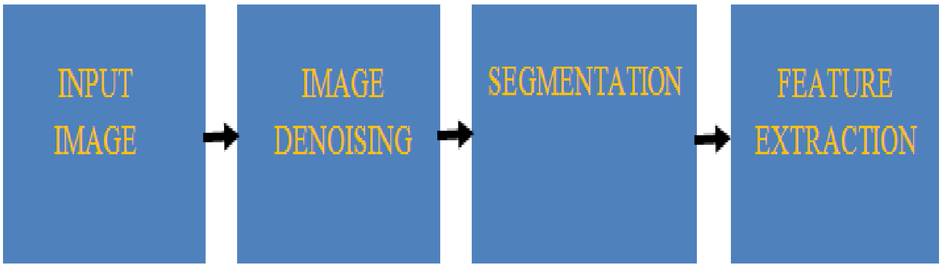


Fig. 1: Block diagram of proposed system

A. Input Image

Computed Tomography (CT) imaging, also known as “CAT scanning” (Computed Axial Tomography), combines the use of a digital computer together with a rotating X-ray device to create detailed cross sectional images or “slices” of the different organs and body parts such as the lungs, liver, kidneys, pancreas, pelvis, extremities Brain, spine, and blood vessels. CT machines were the first imaging devices for detailed visualization of the internal three-dimensional anatomy of living creatures [3].

CT has the unique ability to image a combination of soft tissue, bone, and blood vessels among the various imaging techniques such as MRI and X-ray. For example, conventional x-ray imaging of the head can only show the dense bone structures. Magnetic resonance (MR) imaging does an excellent job of showing soft tissue and blood vessels, but MR does not give as much detail of bony structures.

B. Image Dnoising

For accurate analysis and diagnosis, it is required to reduce the image noise. To enhance the fidelity of an image which actually means removing the random and uncorrelated structures and retaining the resolution is the main of the any noise reduction algorithm [4].

1) **Total Variation:** Random noise is present in CT images. The non-linear total variation based on partially differential equation algorithm proposed by Leonid et at. is chosen because it effectively removes random noise present and also smoothens the image [8]. The input to the denoising module is a 2D lung CT image in JPEG format of size 512 x 512. Let the observed intensity function $u_o(x, y)$ denote the pixel values of a noisy image. Let $u(x, y)$ denote the desired clean image, and n be the additive noise, is represented in (1).

$$u_o(x,y)=u(x,y)+n(x,y) \qquad (1)$$

The total variation of the image is minimized subject to constraints involving the statistics of the noise. The constraints are imposed using Lagrange multipliers as in (2). The solution is obtained using the gradient-projection method with time as a parameter [1].

C. Segmentation

In proposed system to extract tumorfirst segments the area of interest (lung) and then analyse the separately obtained area for nodule detection. For normal lung, segmentation can be performed by making use of excellent contrast between air and surrounding tissues.

1) ***Thresholding:***Most widely used method for image segmentation is Thresholding. It discriminatesforeground from the background. Otsu’s method [2] is one of the best global thresholding methods. It works well with dearly scanned images, but it performs unsatisfactorily for those poor quality images that have low contrast and non-uniform illumination [7]. The pre-processed lung CT consists of high intensity pixels in the body and low intensity pixels in the lung and surrounding air.

To segregate the body and non-body pixels through an iterative procedure,Optimal thresholding proposed by Shiying et al., is applied on the pre-processed lung image. The initial threshold T^o is average between minimum and maximum intensity in the image. T^i is the segmentation threshold at step i.To choose a new segmentation threshold, segment the image with the current threshold to separate body and non-body pixels of the image. The mean gray-level of the body pixels and non-body pixels aftersegmentationare denoted as μ_b and μ_n. The new threshold $T^{i+1}$is determined using equation (2).

$$\boldsymbol{T^{i+1}} = \frac{\boldsymbol{\mu_b+\mu_n}}{\boldsymbol{2}} \quad (2)$$

Repeat steps 3-5 until there is no significant difference between threshold values in successive iterations (T^{i+1} = T).The lung image after segmentation with optimal threshold value contains non-body pixels such as the air surrounding the lungs, using morphological operation body and other low-density regions within the image is removed [1].

2) ***Morphology:*** Lung nodules are the small masses of tissue in the lung [2] .They appear approximately round and white in CT scan or X-ray images. In the proposed method our region of interest is lung nodule.In proposed method 4- connected labeling algorithm is used.

Overview of 4- connectedlabeling algorithm is explained as taken a binary image, then find negative of the image. Check the north and west pixel for every pixels. If the pixel to the west or north has the same intensity value, the pixel belongs to same region. Assign the same label to the current pixel.If the pixel to the west has a different value and the pixel to the north has the same value, assign the north pixel's label to current pixel.If the north and west neighbors of pixel have different pixel values, create a new label and assign that label to the current pixel.Do this recursively for all pixels that have a 4-connectivity [2].

All pixels above the threshold that have a 4-connectivity will get the same number and thereby each region a unique label. Find the centroid of each label, if centroid of label is not present at significant height and width considering our region of interest eliminates that label. In this way we will get desired lung region.The objects are expanded in dilation operation, thus small holes probably are filled and disjoint objects are connected. The objects are diminished in erosion operation with etching away (eroding) their boundaries [9].

D. Feature Extraction

Textural features from the spatial distribution can be used to characterize images. To describe the texture of an image Gray Level Co-occurrence Matrix (GLCM) is one of the most popular way texture [2].GLCM is defined as a matrix of relative frequencies p (i, j) calculated as how often a pixel with the intensity i occurs in a specific spatial relationship to pixel with value j.
The features are defined as follows:

- **Area**: It is a scalar value that gives the actual number of pixels in the ROI.
- **Convex Area**: It is a scalar value that gives the number of pixels in convex image of the ROI which is a binary image with all pixels within the hull filled in.
- **Equivalent Diameter**: It is the diameter of a circle with the same area as the ROI as defined in below.

  $$\text{Equiv Diameter} = \frac{\sqrt{4*Area}}{\sqrt{\pi}} \quad (3)$$
- **Solidity**: It is the proportion of the pixels in the convex hull that are also in the ROI.

  $$\text{Solidity} = \frac{\text{Area}}{\text{Convex Area}} \quad (4)$$
- **Energy**: It is the summation of squared elements in the GLCM and its value range between 0 and 1

  $$\text{Energy} = \sum_{k=0}^{n} p^2\,(i,j) \quad (5)$$
- **Contrast**: It is the measure of contrast between an intensity of pixel and its neighboring pixels over the whole ROI, where N is the number of different gray levels.

  $$\text{Contrast} = \sum_{i}^{N} \sum_{j}^{N} (i-j)^2\; p(i,j) \quad (6)$$
- **Homogeneity**: It is the measure of closeness of the distribution of elements in the GLCM to the GLCM of each ROI and its Value ranges between 0 and 1.

  $$\text{Homogeneity} = \sum_{i,j} \frac{p(i,j)}{1+|i-j|} \quad (7)$$
- **Correlation**: It is the measure correlation of pixel to its neighbor over the ROI.

$$\text{Correlation} = \sum_{i}^{N}\sum_{j}^{N}\frac{p(i,j)-\mu r\ \mu c}{\sigma r\ \sigma c}(8)$$

- **Eccentricity**: The eccentricity is the ratio of the distance between the foci of the ellipse and its major axis length. After feature extraction, it then applies classification technique to predict the lung tumor as either benign or malignant [1].

III. Result

The lung image set used for study of the proposed system consist of diseased lung CT JPEG images of size 512x512.

Fig.2: Original Noisy Image

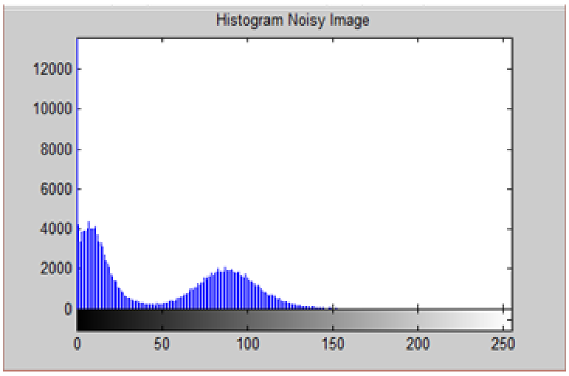


Fig.3: Histogram of noisy Image

Fig.3: Denoised Image

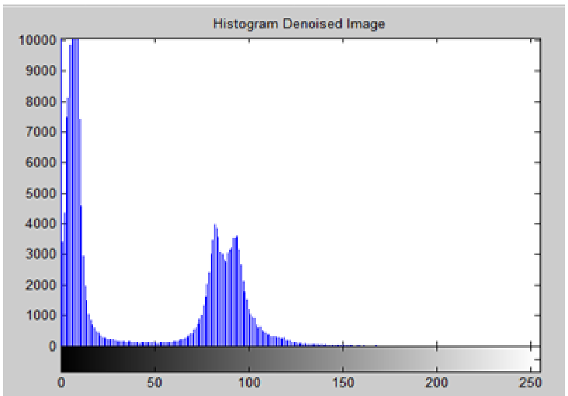
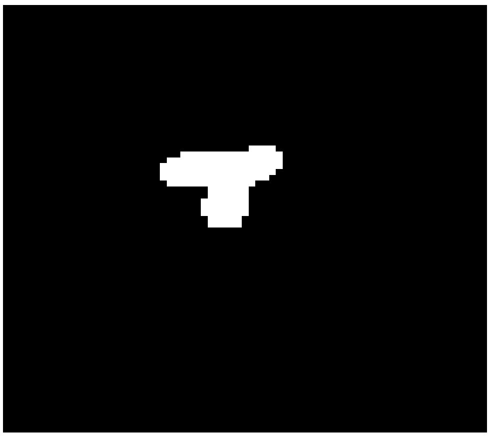


Fig.4: Histogram of Denoised Image

Table I: Features of Extracted Image



FEATURES	VALUES
Tumor Area	428
Tumorconvex area	517
Equivdiameter	23.3441
Tumor Convex Eccentricity	0.5232
Tumor Convex Solidity	0.8279
Image contrast	325.616
Image correlation	0.9112
Image Energy	0.0577
Image Homogeneity	0.3478

Fig.5: Tumor Image

IV. CONCLUSIONS

Proposed system helps physician to extract the tumor region. The computer tomography image is used. 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. In the first phase the image is denoised. In second phase lung region is separated from surrounding anatomy. In next phase ROI is extracted, after ROI extraction features extraction is performed by GLCM. The proposed system implemented on MATLAB takes less than 3 minutes of processing time and has yielded promising results that would supplement in the diagnosis of lung cancer.

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