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Determining Thyroid Nodules Using Texture Analysis

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Abstract - Ultrasonography (USG) is one of the best imaging modalities for early detection of malignancy in the thyroid gland. Computer Aided Diagnosis (CAD) plays an important role in classifying thyroid nodules. This paper proposes a classification of thyroid ultrasound images by using some texture features. Image processing is a technique that can be applied on medical images for detecting abnormalities such as tumors. Due to risk of malignancy, detecting and diagnosing of cold nodules in thyroid gland are important. Image Enhancement (forming colorful image in to gray image, Gaussian filter), Histogram Equalization and feature extraction to determine cold thyroid nodules automatically with high accuracy.

***Keywords:** Morphological operation, Gaussian Filter, Histogram equalization, GLCM, SVM classifier.*

I. INTRODUCTION

A thyroid is largest endocrine gland in the body, a butterfly shaped organ compose of the cone like lobes. It is located in the lower part of the neck below the Adam apple. The thyroid gland produces the T3 & T4 hormones that affects the heart rate, cholesterol level, body weight, energy level, mental state and controls a host of other body functions. Thus the function of thyroid is to regulate the body metabolism. The thyroid diseases are common worldwide. In India too, there is significant burden of thyroid diseases. The Ultrasonography (USG) usage increased the number of nodules detected. USG is the most implemented method for thyroid gland screening because of its low cost, short acquisition time, absence of radiations and sensitivity in ascertaining the size and number of nodules.

Moreover, USG also provides information about nodule structure, volume, number and size of nodules, characteristics, separates thyroid from no thyroidal masses. Image Enhancement (forming colorful image in to gray image, Gaussian filter), GLCM and Gabor filter for feature extraction and classifier by using support vector machine (SVM) features which recorded in the USG images by using texture analysis with statistical methods, to distinguish between nodules. GLCM and histogram are compared and combined to get the best accuracy.

II. METHOD

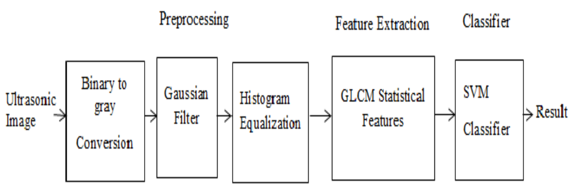

Fig.1. Block diagram of a system

A. Preprocessing:

1)Thyroid Ultrasonic Image: Ultrasonic Scan Images are collected for different types of problems of thyroid. One Image is taken for operation at a time.

2) Transform the images into gray scale: Binary Image is converted into Gray Scale. It requires less memory. We are converting image to gray scale because the intensity of the image gradually varies across the brightness spectrum. The intensity at any point is a whole number in range of [0,255]. Thus it can pick values from a pool of 256 different values. But in binary image intensity values greater than 127 change to 255 and if intensity values less than 127 change to 0.After this conversion small change in different part of image becomes visible.

3) Gaussian Filter: A Gaussian filter is a filter whose impulse response is a Gaussian function (or an approximation to it). Gaussian filters have the properties of having no overshoot to a step function input while minimizing the rise and fall time. This behavior is closely connected to the fact that the Gaussian filter has the minimum possible group delay. It is considered the ideal time domain filter as it is the ideal frequency domain filter.

4) Histogram Equalization The histogram equalization algorithm has been a conventional image enhancement algorithm for its simplicity and efficiency. It adjusts the gray level of an image according to the probability distribution function of the image and enlarges the dynamic range of the gray distribution to improve visual effects of the image. Histogram equalization creates an image with equally distributed brightness levels over the whole brightness scale. Histogram equalization is a technique to obtain a histogram that has uniformly distributed intensity in the image. The approach taken is to

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get broader levels of gray in the area that has many pixels and narrow levels of gray in the area that has few pixels. It can be used to improve overall contrast.

B. Feature Extraction

Texture Feature Extraction Methods:

Medical images possess a vast amount of texture information relevant to clinical practice. Histological alterations present in some illnesses may bring about texture changes in the US image that are amenable to quantification through texture analysis. This has been successfully applied to the classification of pathological tissues from the liver, thyroid, breasts, kidneys, prostate, heart, brain and lungs. The most commonly used texture features are Gray Level Histogram, Run-length matrix, Gray Level Co-occurrence matrix, contour let transform, Wavelets transform, Radon Transform, Local Binary Pattern, Fuzzy Local Binary Pattern, Fuzzy local Gray Histogram. These texture feature found in literature of texture analysis on ultrasound medical images of thyroid gland for detection of thyroid nodule as a benign or malignant tissue from normal one. In this paper, gray level co-occurrence matrix (GLCM) based texture feature extraction approach is fallowed which explain next in detail.

Histogram-texture: A simple method to get the texture. The frequency of occurrence of each level in an image represented by the histogram. To obtain a histogram-based on statistical characteristics, texture of an image can be calculated through the following features:

a) Mean: a feature to generate the average brightness of possessed objects in the image. Components of these features are calculated based on equation (1).

$$m = \sum_{i=0}^{L-1} i\, p(i) \qquad (1)$$

With *i* denoted the level of gray in the image, *p(i)* denoted as the probability of *i*, and *L* denote the highest gray level of the image.

b) Standard deviation: a feature that provides the size of the image contrast can be calculated with equation (2).

$$\sigma = \sqrt{\sum_{i=1}^{L-1} (i-m)^2 p(i)} \qquad (2)$$

c) Skweness: a feature that expressed asymmetry of the average intensity which expressed by the equation (3).

$$skweness = \sum_{i=1}^{L-1} (i-m)^3 p(i) \qquad (3)$$

d) Energy: is a measure the distribution of pixel intensities toward the reach gray level. The equation is as follows.

$$energy = \sum_{i=1}^{L-1} [p(i)]^2 \qquad (4)$$

Gray Level Co-Occurrence Matrix (GLCM): Using histograms in calculation will result in measures of texture that carry only information about distribution of intensities, but not about the relative position of pixels with respect to each other in that texture. Using a statistical approach such as co-occurrence matrix will help to provide valuable information about the relative position of the neighboring pixels in an image. GLCM using textures on second-order, by considering the relationship of the neighboring pixels. GLCM features, which are Angular Second Moment (ASM), contrast, Inverse Different Moment(IDM), entropy, and correlation .

a) Angular Second Moment (ASM): homogeneity relationship of an image, calculated in the equation (5).

$$ASM = \sum_{i=1}^{L} \sum_{j=1}^{L} \left(GLCM(i,j)\right)^2 \qquad (5)$$

b) Contrast: is a measure of the presence of variations of gray level image pixel, is defined by equation (6):

$$contrast = \sum_{n=1}^{L} n^2 \left\{ \sum_{|i-j|=n} GLCM(i,j) \right\} \qquad (6)$$

c) Inverse Different Moment (IDM): used to measure homogeneity. IDM is calculated by equation (7).

$$IDM = \sum_{i=1}^{L} \sum_{j=1}^{L} \frac{\left(GLCM(i,j)\right)^2}{1+(i-j)^2} \qquad (7)$$

d) Entropy: declare the irregularity of gray levels in the image, represent as equation (9).

$$Entropy = -\sum_{i=1}^{L} \sum_{j=1}^{L} \left(GLCM(i,j)\right) log(GLCM(i,j) \qquad (8)$$

e) Correlation: is a measure of linear dependence among the gray level values in the image, which explains by equation (10).

$$Correlation = \frac{\sum_{i=1}^{L} \sum_{j=1}^{L} (ij)\left(GLCM(i,j) - \mu_i{}' \mu_j{}'\right)}{\sigma_i{}' \sigma_j{}'} \qquad (9)$$

C. Classification

SVM Classifier: A Support Vector Machine (SVM) is a discriminative classifier formally defined by a separating hyper plane. It constructs a hyper plane or set of hyper planes in a high or infinite dimensional space, which used for classification, outliers detection. In classification of images Experimental result shows SVMs achieve higher search accuracy. An individual instance of an object is recognized.

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III. RESULT AND DISCUSSION

In this research, thyroid ultrasonic images are obtained from cimlaboratory.com/?lang=en&mod=software database with JPEG images.

The first step is to determine the region of interest (ROI) in Ultrasonic input image. Figure shows the image of the ROI.

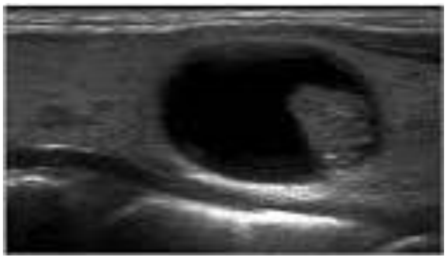

Fig.2. Image ROI

Input Image is then converted to gray scale. Figure shows the image after gray scale conversion.

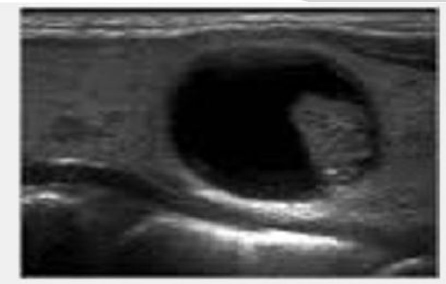

Fig.3. Gray image

After that we apply Gaussian Filter. Figure below shows the image after Gaussian Filter.

Fig.4. Image after Gaussian Filter

After applying Gaussian Filter we do Histogram Equalization. Figure below shows Original and Enhanced Image using Histogram Equalization.

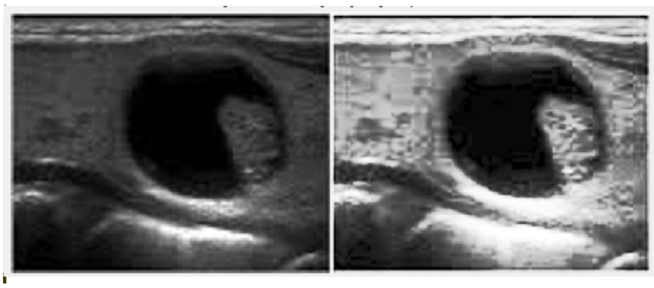

Fig.5. Original and Enhanced Image using Histogram Equalization

Histogram of original Image and Histogram of Image after Histogram Equalization shown in figures below.

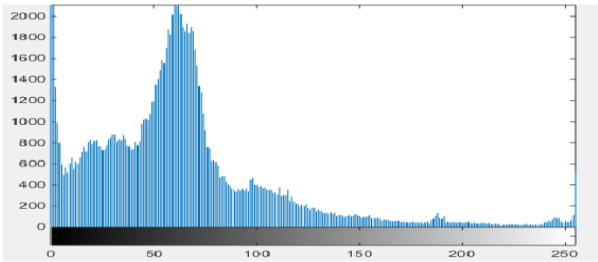

Fig.6. Histogram of Original Image

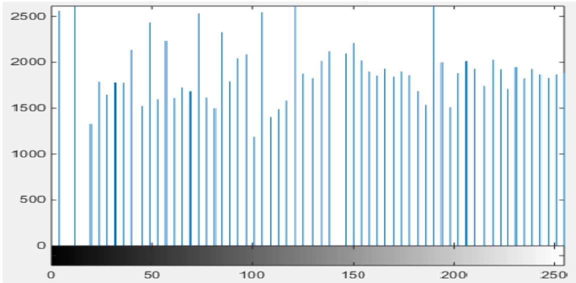

Fig.7. Histogram of Image after Histogram Equalization

After feature extraction we use SVM classifier. The final result is shown in figure below.

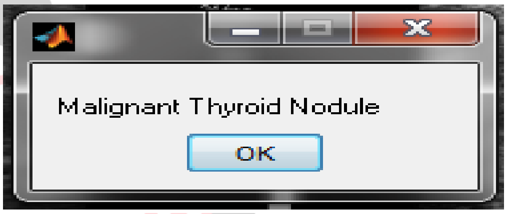

Fig.8. Final Result

IV. CONCLUSION

In this paper we mentioned how much detecting and diagnosing of cold nodules is important since it has high risk of thyroid cancer. These ultrasound images contained some of abnormal images having benign thyroid nodule (non-cancerous) and malignant thyroid nodule (cancerous). This paper proposes a method of thyroid cancer nodules classification based on texture analysis. The proposed method consists of preprocessing, Image Enhancement, Histogram Equalization, feature extraction, and classification. It successfully classifies the thyroid nodules in USG images. Computer added decision support systems are providing very nice services to support the doctors during diagnosis process and to save the patients from miss-diagnosis.

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