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Feature Extraction of Thyroid Nodule US Images Using GLCM

Priti Shivaji Dhaygude[1], S. M. Handore[2]

[1]Trinity COE & Research, Pune, Maharashtra, India

[2]Trinity COE & Research, Pune, Maharashtra, India

Abstract: ***The Thyroid gland has a butterfly shape and is composed of two cone-like lobes. Thyroid gland belongs to the endocrine system. It is located in the neck just in front of the larynx. It controls the secretion of the thyroid hormone that regulates the temperature of the human body, and greatly affects childhood intelligence, growth, and adult metabolism. Too much or too little thyroid hormone (due to a thyroid that is too large or two small, respectively) causes pathological changes. Different methods that are used to identify and classify abnormalities of the thyroid gland include Ultrasound imaging (US), Computer Tomography (CT), Computer Aided Diagnosis (CAD), Magnetic Resonance Imaging (MRI). Ultrasound (US) imaging is mostly used popular diagnostic tool. It is inexpensive and easy to use also it may follow anatomical deformations in real time during biopsy and treatment as well as it is noninvasive and does not require ionizing radiation.***

Keywords: CAD, US, ANN, GLCM, FNAC, feature extraction, segmentation

1. Introduction

The thyroid keeps metabolism under control through the action of thyroid hormone. It produces harmones that performs regulation of growth and rate of function of many other systems. These harmones are named as triiodothyronine and thyroxine. There are various thyroid disorders like Hypothyroidism, Hyperthyroidism, goiter and thyroid nodules (benign/malignant). Medical image analysis plays an important role in many clinical procedures for detecting different types of human diseases. Thyroid medical images are utilized for the diagnosis process

Image processing is one of the type of signal processing which uses input as an image such as photograph or video frame and gives output as an image or parameters related to the image. Medical imaging is the technique used to create images of the human body for clinical purpose. Techniques to process US images are continuously being developed. Several methods for segmenting anatomical objects from US images have been presented, such as those for segmenting the prostate [18], [19], tumors in the breast [20], the carotid artery [21], [23] and the thyroid nodule [22]. Ultrasound provides a safe tool for disease surveillance [1] Medical imaging includes the study of normal anatomy and physiology. For diagnosing thyroid diseases, Ultrasound (US) . US imaging is inexpensive, non-invasive and easy to use. US images are often preferred due to their cost-effectiveness and portability in smaller hospitals. Ultrasound study of thyroid is preferred because of its superficial location, size and echogenicity obtaining the volumes of thyroid tissues to increase reliability as well as to reduce invasive operations like biopsy and Fine Needle Aspiration (FNA). Computerized system is a valuable and beneficial tool for feature extraction and classification of thyroid dule in order to eliminate operator dependence and to improve the diagnostic accuracy[16].

2. Proposed Methodology

Fig.1 represents the schematic of proposed method. First, US image of thyroid is taken which contains speckle noise. This noise must be removed before going to the next steps of the methodology.

Filtering-The noise in the image can be removed using linear as well as non-linear filters. Nonlinear filters are becoming more important in image processing applications. They are often better than linear filters at removing noise without distorting image features [2].It includes Median filtering as the most common method of clearing image noise. Median filter clears the noise in the image while retaining edges of an image [3].

Histogram Equalization-This process spreads out intensity values over the total range of values in order to achieve higher contrast. This process is mainly useful when we represent an by close contrast values like images in which both the background as well as foreground are bright at the same time or both are dark at the same time.

Normalization –It changes the range of pixel intensity values. The purpose of normalization is to bring the image in a range which is more familiar or normal to the senses.

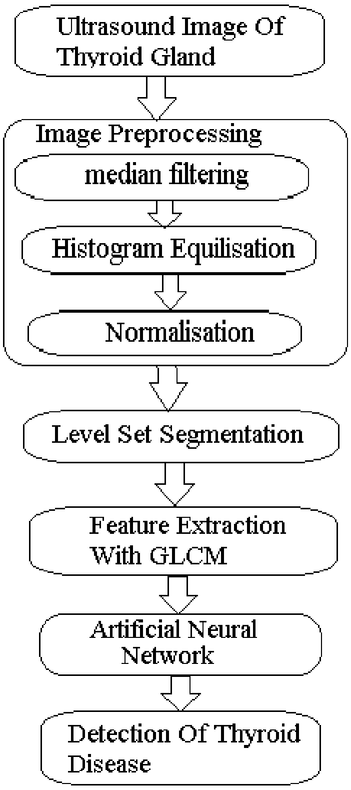

Figure 1: Schematic of Proposed Methodology

Segmentation-A process of partitioning a digital image into multiple segments is referred as image segmentation. In order to simplify and or change the representation of an image into something that is more meaningful as well as easy to analyze is the goal of segmentation[6].The level set methods have been documented to obtain good results from medical images having the boundary of the regions of interest usually have low curvature values [4][5]. With the help of level set method we can do segmentation even if there is intensity inhomogenity. Level Set Method gives numerical technique for tracking interfaces as well as shapes. The main advantages of level set method are that we can perform numerical computations including curves and surfaces [6].

Feature Extraction- It is the process of acquiring higher level information of an image like colour, shape, texture etc. Features contain the relevant information of an image. Features are divided into different classes based on the kind of properties they describe. Texture relates mostly to a specific and spatially repetitive structure of surfaces which is formed by repeating a particular element or some elements in different relative spatial positions. Texture is an important characteristic which is used in identifying regions of interest in an image. The earliest methods for texture feature Extraction is Grey Level Co-occurrence Matrices (GLCM) [7].GLCM characterize the texture of an image by calculating how often pairs of pixel with specific values and in a particular spatial relationship occur in an image. Then it creates a matrics and extracts statistical measures from this matrix.

ANN Classifier-ANN is a parallel distributed processor that has a natural tendency for storing experiential knowledge The use of textural features in ANN helps to resolve misclassification. The main benefit of neural networks is that a model of the system can be built from the available data. Classification of image is done using neural networks is done by texture feature extraction and then applying the back propagation algorithm [8].

The remaining paper is organized as follows. Section 3 covers Texture feature extraction using GLCM, Section 4 gives experimental results, Section 5 presents the conclusion and in Section 6, the references are given.

3. Texture Feature Extraction Using GLCM

Texture is a most significant feature of an image is widely used in medical image analysis, automatic visual inspection, image classification and remote sensing[9][10][11]. Textures are complex visual patterns consisting of entities, or sub-patterns having characteristic brightness, color, slope, size, etc. A basic stage to obtain such features through texture analysis process is texture feature extraction. Texture features can be extracted with number of methods, using structural, statistical, model-based and transform information, in which a well-known method is using a Gray Level Co-occurrence Matrix (GLCM)[12]. GLCM contains the second-order statistical information of spatial relationship of image pixels. From GLCM, Haralick introduced 13 common statistical features, known as Haralick texture features. Texture is a visual pattern with properties of homogeneity which do not result from the presence of only a single color such as clouds and water [13]. Haralick suggested the use of gray level co-occurrence matrix. It always considers the relationship between two neighboring pixels, out of which the first pixel is known as a reference whereas the second is known as a neighbour pixel. GLCM matrix can be explained with the example illustrated in fig 2 for four different gray levels. Here we have used one pixel offset (a reference pixel and its immediate neighbour). When the window is large then using a larger offset is possible. In this case, the top left cell will be filled with the number of times the combination of 0, 0 occurs, i.e. how many times in the image area a pixel with grey level 0 (neighbour pixel) appears to the right of another pixel with grey level 0(reference pixel)[15]

neighbour pixel value ---> ref pixel value:	0	1	2	3
0	0,0	0,1	0,2	0,3
1	1,0	1,1	1,2	1,3
2	2,0	2,1	2,2	2,3
3	3,0	3,1	3,2	3,3

Figure 2: GLCM calculation

4. Experimental Results

Total 16 images were used amongst which 8 images were benign (non-cancerous) and 8 images were malignant (cancerous).Total 7 features were extracted using GLCM. According to features matrices there are seven type of features which is helpful to exacts the features of images or texture of images. These following features are calculated:

Table 1: Some features with their formulae

Features	Formula
AP	Area/Perimeter
compactness	$(\text{Perimeter})^2/\text{Area}$
Solidity	area/convex area
Eccentricity	Minor Axis Length / Major Axis Length

Table 2: Extracted Feature values of Benign Thyroid Images

US Image	Benign Measurement Indices			
	Area	Perimeter	AP	Compactness
Case 1	277.25	115	2.41	47.7006
Case 2	7.03E+03	1.03E+03	6.83	150.588
Case 3	136	55.5	2.45	22.648
Case 4	10093	1.62E+03	6.24	258.979
Case 5	2.18E+03	564	3.86	145.74
Case 6	440.75	142.5	3.09	46.072
Case 7	2.44E+03	4.73E+02	5.17	91.422
Case 8	1.21E+04	892.5	13.6	65.589

	Benign Measurement Indices		
US Image	Solidity	Eccentricity	Orientation
Case 1	0.6539	0.7626	17.8293
Case 2	0.5569	0.6992	13.966
Case 3	0.9306	0.6387	-53.6185
Case 4	0.6344	0.8986	-83.0916
Case 5	0.7745	0.7093	-6.6006
Case 6	0.8041	0.8323	11.6209
Case 7	0.7612	0.9918	14.7327
Case 8	0.7785	0.8434	9.4388

Table 4: Extracted Feature values of Malignant Thyroid Images

US Image	Malignant Measurement Indices			
	Area	Perimeter	AP	Compactness
Case 1	4.20E+03	773.75	5.43	142.472
Case 2	1.01E+04	1.19E+03	8.43	141.507
Case 3	1.47E+04	1318	11.17	117.936
Case 4	3614	669	5.402	123.84
Case 5	2.48E+03	670	3.703	180.907
Case 6	1.06E+04	2.11E+03	5.008	420.801
Case 7	928.125	275.875	3.364	82.0008
Case 8	977.375	240.875	4.057	59.3639

	Malignant Measurement Indices		
US Image	Solidity	Eccentricity	Orientation
Case 1	0.6729	0.9953	1.01E+04
Case 2	0.6984	0.9086	1.47E+04
Case 3	0.8167	0.961	6.1294
Case 4	0.7556	0.9794	-2.4143
Case 5	0.6747	0.9884	-7.7571
Case 6	0.4927	0.941	21.2408
Case 7	0.8079	0.9895	1.8912
Case 8	0.7935	0.9785	3.3308

The extracted features are given to the neural network to determine which type of nodule is present (malignant or benign).

5. Conclusion

Medical images are useful for clinical diagnosis. It is a time consuming for physicians to manually segment the thyroid nodule. From the experimental results, generation of more features may enhance the evaluation procedure accuracy. This work gives efficient platform for researchers and scientist.

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