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A Survey of Different Types of Characterization Technique In Ultra Sonograms of the Thyroid Nodules

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Abstract - Thyroid is one of the endocrine Gland. Thyroid can be classified into normal, nodule and cancers thyroid. The characterization of the thyroid tissue in digital image processing techniques offer's the texture description and using the ultrasound images. In this paper describe the various type of feature extraction techniques characterization and classification method. The texture characterization in medical images plays an important role as it helps into characterized the type of images, directions and extracting the features. This survey focuses on three types of characterization technique and methods that classify the thyroid nodule medical imaging. Result shows that comparatively analysis of these characterization techniques

Keywords-Texture feature; Thyroid nodule; gray level co-occurrence matrix(GLCM); CBIR; SVM classifier; LBP; KNN classifier; K-Mean classifier ; Radon domain.

I. INTRODUCTION

Thyroid gland is a butterfly shaped organ and is compose of two cone-like lobes. Thyroid gland is one of the largest endocrine gland and is located below the skin and muscles at the front of the neck, just at the spot where a bow tie would rest. It manufactures the hormones that help control metabolism and growth. Too much or too little thyroid hormone causes pathological changes causing hyperthyroid or hypothyroidism. Therefore, physicians often diagnose abnormal symptoms of thyroid gland from medical images. Thyroid gland is characterized as normal, hypo or hyperechogenic. In modern medicine, various medical images- Ultrasound, CT, Scintigraphy, SPECT, MR, PET, X-ray etc play an important role in process of disease diagnosing and treating and have become major evidence to ensure disease.

All these medical images contain speckle noise; SPECT images contain stochastic noise [5]. So the pre-processing of these medical images in an initial step. These medical images are required by physicians to detect the thyroid nodule. Various approaches have been proposed for Ultrasound images from thyroid, breast and prostate, even the most popular of them. Ultrasonography is the most well accepted imaging modality for the diagnosis of thyroid nodules [6].

The ultrasound images include mobility and low cost and ability to providing detailed information. A

thyroid nodule is abnormal growth of cells within the thyroid gland and can be non-cancerous (benign) or cancerous (malignant). The most of the thyroid nodules are benign and not cancerous. Digital image processing techniques offer the opportunity for texture description. The thyroid nodule can be characterized by texture description and quantifying properties such as smoothness, coarseness and regularity [1]. The thyroid texture characterization based on statistical parameters could provide an objective diagnostic tool and contribute to the use of computer assisted applications in thyroid disorders.

The most famous feature extraction techniques are presented based on grey-level co-occurrence matrix (GLCM) [1], linear binary pattern (LBP)[2], Radon domain[3] and fuzzy theory provides noise resistant local binary pattern (FLBP) [4]. Image retrieval is based on the text-based image retrieval (TBIR) [5].

Thyroid classifications methods into nodular and normal thyroid have been present based on The SVM [6], K-Mean cluster classifier, KNN classifiers.

The present study concentrates on all thyroid classification approaches and texture characterization approaches. Every year, new thyroid characterization and thyroid classifications algorithms are published. This survey describes different thyroid feature extraction and thyroid classification methods used in medical images.

This paper is organized as follows. Section II discusses various methods and techniques for thyroid feature extraction techniques And thyroid classification methods. Section III comparatively analysis study. Section IV concludes this survey.

II. Techniques and methods for thyroid texture characterization and classification

The purpose of this study the thyroid can be classified into normal and nodular. Thyroid nodules can be further classified as benign (normal) and malignant (cancerous). The basic three types of methods for thyroid characterization are:

A. Texture Characterization in ultasonograms.

In this method Maria E. Lyra et al [1]. Proposed a method to characterize the thyroid in ultrasound images. The authors have used GLCM (Gray-level co-occurrence matrix) to characterize the thyroid as normal or hypoechogenic. GLCM is tabulation of how often difference combination of pixels brightness values occur in an image. This proposed method by Maria et al used first order and co-occurrence features and multifactor analysis is used to find optimal subset of parameters for thyroid texture. The co-occurrence matrix was determined from the brightness relationship between reference pixel and pixel with a specific positional relationship to the reference pixel. Standard deviation and mean of grey levels of image were computed as first order statistic. The (GLCM) is the 2-D matrix of joint probabilities between pairs of pixels, separated by a distance, d, in a direction. The co-occurrence parameters are computed from the corresponding GLCM. There are two element (i,j) in the matrix describes the probability that two pixels in the image with a given separation, and gray levels i, j. the separation is defined by the linear distance and angle θ . GLCM, the mathematical terms are :

$$\Phi(d,\theta)= [f(i, j) d, \theta]$$

The statistical analysis produce the new classification of the US according to their texture. Principal component analysis (PCA) is applied in order to the reduce the num of feature and to calculate a linear combination of texture features.

The constructed model was 100% successful in classifying correctly normal and hypo echogenic thyroid.

B. Characterization in Radon Domain

Characterization of thyroid tissue in radon domain was proposed by Maroulis et al[2]. It was based on the hypothesis that tissue in thyroid Ultrasound images can be differentiated by directionality patterns. These patterns may not be dominant image noise. This method is capable of characterizing the thyroid nodule

into normal nodular thyroid tissue and into benign and malignant. The 2D Radon Transform denoted as $R_u(\rho, \theta)$ is given by:

$$R_u(\rho, \theta) = \int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} u(x, y) \delta(\rho - x \cos \theta - y \sin \theta) dx dy \tag{1}$$

Where ρ the perpendicular is distance of a line from the origin and θ is the angle formed by the distance vector.

Table 1: Comparative results :

Method	KNN classifier K=5 classification accuracy
Radon-based approach	84.1%
Co-occurrence-based approach	71.2%

The SVM classifier the overall classification accuracy which is improved the 90.9% for radon-based approach. Further differentiating of nodular tissues with malignancy risk (high-risk or low risk).

Table 2: Classification accuracy are:

Method	KNN classifier K=5 Classification accuracy
Radon-based approach	86.3%
Co-occurrence-based approach	74.2%

The overall classification accuracy provide the maximum classification accuracy 89.4% using the SVM classifier.

C. Texture representation via noise resistant image feature.

The robustness of textural features on speckle noise is of vital importance for ultra sound imaging. Maroulis et al [3] proposed a method for texture representation of thyroid for noise resistant image features. The proposed scheme is based on FLBP i.e. Fuzzy Local Binary pattern. Fuzzy theory excels in producing exact results from imprecise data. The incorporation of fuzzy logic in the LBP approach includes the transformation of the input variables to respective fuzzy variables, according to a set of fuzzy rules. The rules are:

Rule 0 : The more negative Δp_i is , the greater the certainty that d_i is 0.

Rule 1 : The more positive Δp_i is , the greater the certainty that d_i is 1.

To represent the formation of a texture image, the LBP approach, models 3×3 textons. This consists of set of nine element, $p = \{p_{center}, p_0, p_1, \dots, p_7\}$,

where p_c represents the intensity value of the central pixel and p_i ($0 \leq i \leq 7$) represents the intensity value of the peripheral pixels.

Each texon then, can be characterized by a set of binary values d_i ($0 \leq i \leq 7$), where.

$$d_i = \begin{cases} 1, & \text{if } \Delta p_i \geq 0 \\ 0, & \text{if } \Delta p_i < 0 \end{cases} \quad (1)$$

where $\Delta p_i = p_i - p_{\text{center}}$

Further, for classification SVM classifier was used to classify the thyroid as normal or nodular.

The comparative result was both extraction technique co-occurrence 33% of classification error and sensitivity 96%, specification 58% and radon domain 23% of classification error and sensitivity 62%, specification was 72% analysis.

Table 3: Comparison of various types of characterization techniques

S.No	Methods	Advantages	Disadvantages
1.	GLCM(gray level co-occurrence matrix)	1.) It is a good approach for characterizing the texture and feature extraction techniques. 2.) Easy to implement and give exact texture of the US images.	1) It can take very large number of possible texture calculation Just because of image complexity and noisy images. 2) It can be difficult to find the various parameters of GLCM matrixes.
2.	LBP(local binary pattern)	1.) It is a powerful feature for texture classification (give higher classification performance in thyroid US images) 2.) It improves the detection performance in some datasets It is a good representation for noise resistant image features.	1.) Some time the LBP can miss the local structure as they don,t consider the effect of the center pixel. 2.) The binary data produced by them are sensitive to noise.
3.	Radon domain	1.) Easy to encode the directionality patterns in thyroid ultrasound images. 2.) It gives the higher classification accuracy then co-occurrence matrix.	Difficult to classified the thyroid US image performance as compare to LBP and very time consuming task.

IV. CONCLUSION

This survey mainly focuses on the study of thyroid classification and thyroid characterization on medical images that include ultrasound images, scintigraphy and SPECT images. Among all the methods discussed for thyroid classification, fuzzy local binary pattern (FLBP) provides higher classification performance as compared to radon based approach and GLCM approach, in terms of classification error, specificity and sensitivity. GLCM approach estimate for specificity and sensitivity was 58% and 96% for radon based approach the estimate for specificity and sensitivity was 92% and 76%.

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