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Texture Characterization in Ultrasonograms of the Thyroid Gland

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The advantages of using ultrasonic imaging for the diagnosis and follow-up of thyroid disorders include its mobility and low cost as well as the ability to measure the dimensions of the gland, and evaluate the structure and echogenicity of the parenchyma. However, in making an overall evaluation of a sonogram a physician uses his clinical experience without giving any quantifiable indices.

Scope

This study tries a quantitative characterization of the thyroid tissue as far as homogeneity and echogenicity are concerned, to quantitatively evaluate thyroid texture. Digital image processing techniques offer the opportunity for texture description. Although there is no formal definition of texture, this particular method of description can quantify properties such as smoothness, coarseness and regularity. First-order and co-occurrence features are quantified and multi factor analysis is used to evaluate the optimal subset of parameters for thyroid texture.

Methods and Materials

Thyroid ultrasonograms of 40 patients were used for further image processing. The thyroid ultrasonograms were converted to DICOM format by the SIEMENS sonographic imaging system with an amplitude resolution of 8bits (256 gray levels) and a matrix of 800×600 pixels. MATLAB software was used for the analysis of the images A manual delineation of a rectangular ROI enclosing the thyroid was used (Fig.1, Fig.2).

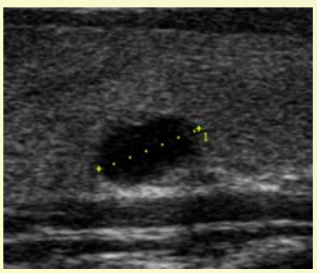

Fig.1. *Thyroid ultrasonogram. An hypoechoic region is included.*

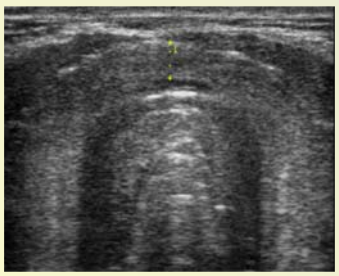

Fig.2. *Thyroid ultrasonogram image. An echogenic region is selected*

Conclusion

- In this study second order statistical features were calculated as potential texture descriptors.
- The constructed model was 100% successful in classifying correctly normal and hypoechogenic thyroid parenchyma.
- The results show the potential of this method to be used in computer assisted applications of thyroid disorders.

Gray-level co-occurrence matrix (GLCM) is the two dimensional matrix of joint probabilities between pairs of pixels, separated by a distance, d, in a given direction. It is popular in texture description and base on the repeated occurrence of some gray level configuration in the texture. This configuration varies fast with distance in fine texture but tardily in coarse textures. The first order statistics computed are the mean and standard deviation of the gray levels of the image. The co-occurrence parameters were computed from the corresponding gray-level co-occurrence matrices (Fig.3, Fig.4).

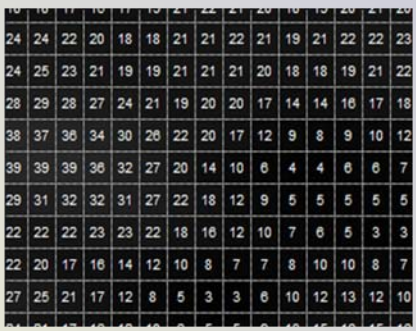

Fig.3*. Matrix of pixel values of the image in Fig.1, from the hypoechoic region.*

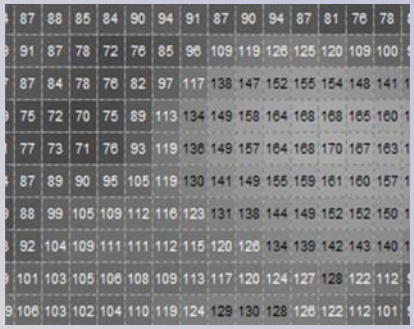

Fig.4*. Matrix of pixel values of the image in Fig.2, from an echogenic region*

This matrix results from an image through statistical, paired comparisons of the pixels' gray levels. Each element (i,j) in the matrix describes the probability that two pixels in the image with a given separation, have gray levels i and j. The separation is defined by the linear distance d and the angle θ.

$$GLCM, \quad \Phi(d,\theta) = \left[\hat{f}(i,j|d,\theta)\right]$$

Results

The elements of the GLCM are not separately used for texture characterization. Many parameters have been extracted and proposed as texture descriptors. Four widely used parameters that are calculated in this study are: **Energy**, **Homogeneity**, **Correlation** and **Contrast** (Fig.5)

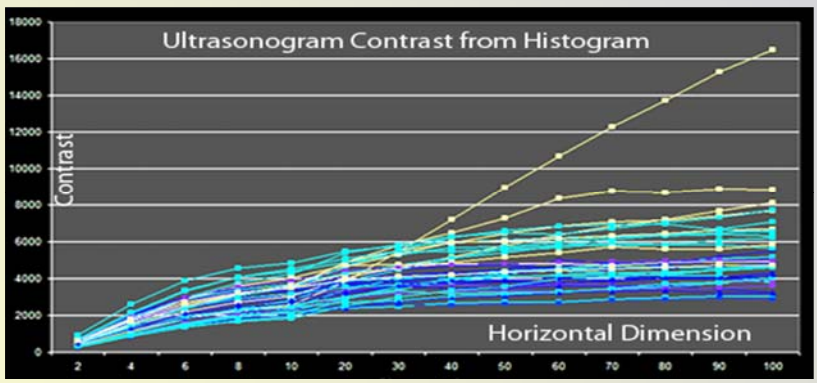

Fig.5*.Images Contrast calculated to the horizontal dimension. Contrast is highly correlated*