ULTRASONOGRAPHY KIDNEY IMAGE CLASSIFICATION BASED ON BACK-PROPAGATION NEURAL NETWORKS

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Abstract: Ultrasonography is one of the cheapest and protective approaches in medical imaging. This research aims at classification of medical ultrasound images of kidney as normal and abnormal kidney images In this work, the wiener filter is used to reduce the noise present in the image The gray-level co-occurrence matrix (GLCM) is used for examining the texture. It is used to find texture properties of an image by calculating the frequency of occurrence of pixel pairs with specific values and in a specified spatial relationship. Further, the Back-propagation Neural Network is used to classify the images as normal or abnormal kidney images. We got a better accuracy of 99%. The obtained result is then compared with the previous works.

***IndexTerms* – Classification, Noise, Pixel, Texture.**

I. INTRODUCTION

Medical tools are mounting day by day with superior sorts. In this aspect diagnosing medical problems is a prominent one. In recent years huge advancements have been made in automated systems for recognizing kidney diseases with the help of ultrasonic systems. UltraSound (US) imaging uses the faster and more accurate procedures in medical diagnosis. This enables quality of information to be extracted during imaging the patients. Classification techniques such as feature extraction, image analysis and pattern recognition are most important for the evaluation of renal disorders. This research describes an automated system for analyzing and classifying ultrasound kidney images. The system starts with capturing ultrasound kidney image and identifying the region of interest. Image processing techniques are employed to improve the image quality and reduce noise. Classification is done with help of Back Propagation Neural Network (BPNN).

II. LITERATURE SURVEY

Many researchers introduce computer aided systems for medical image classification and diagnosis. Neural network based classification method provides accurate classification compared to other classification methods. Prema T. Akkasaligar et al. [1] proposed a method for the classification of medical ultrasound images of kidney as normal and cystic images. The Gray Level Co-occurrence Matrix features and run length texture features are extracted. Further, the k-nearest neighbor classifier (k-NN) is used to classify the images as normal and cystic kidney images. They obtained an accuracy of 84%. Mariam Wagih Attia et al. [2] discussed a computer-aided system for automatic classification of Ultrasound Kidney diseases. Images of five classes: Normal, Cyst, Stone, Tumor and Failure were considered. Principal Component Analysis (PCA) was performed to reduce the number of features. The author obtained a best accuracy of 97%. R.I. Heaven Rose et al. [3] proposed Association rule based classification is given for making more accurate decision and bringing more confidence to the diagnosis of medical images. A new associative classification technique named CHiSAR (Classification Based on Highly Strong Association Rule) was employed. Chang Won Kim et al. [4] proposed a system for quantifying the hepatorenal index difference between the liver and the kidney with respect to the multiple severity status of hepatic steatosis. Self organising maps is designed to establish characteristic clusters form the image and the distribution of hepatorenal index values with respect to different levels of fatty liver. Samson Isaac et al. [5] proposed a system to provide most significant content descriptive parameters to identify and classify the kidney stone with ultrasound scan. Fuzzy c means clustering is used for unsupervised image segmentation. The statistical features are extracted by decomposing the kidney stone images into different frequency sub bands using wavelet transform. The ability of these features in classifying kidney stone is done using back propagation neural network.

III. PROPOSED METHODOLOGY

The main objective of this research is to classify normal and abnormal conditions of kidney from the ultrasonic kidney images using ANNs. Different views of ultrasound kidney images are considered for this work. The image sets consists of normal and abnormal kidney images. The methodology is divided into three main steps.

1. Image Acquisition
2. Noise Reduction.
3. Feature Extraction.
4. Classification

Ultrasound kidney images were obtained from a Scan centre at Marthandam, India. The database consist of 25 US kidney images. In which 15 are normal kidney image and 10 are abnormal kidney image with multiple kinds of diseases. It is very necessary to remove the speckle noise from the US kidney image without loss of pixel information from the original image. In the research, the wiener filter is used to reduce the noise present in the image. Wiener filter inverts the blurring and removes the additive noise simultaneously by performing an optimal trade off between inverse filtering and noise smoothing. Wiener filtering is optimal in terms of the mean square error, where it minimizes the overall mean square error in the process of inverse filtering and noise smoothing. Wiener filtering is also a linear estimation of the original image.

$$W(f_1,f_2) = \frac{H^*(f_1,f_2)\, S_{xx}(f_1,f_2)}{|H(f_1,f_2)|^2\, S_{xx}(f_1,f_2)+S_{\eta\eta}(f_1,f_2)}$$

Where S_{xx} (f_1, f2), $S_{\eta\eta}$ (f_1, f2) are respectively power spectra of the original image and the additive noise, and H (f_1, f2) is the blurring filter.

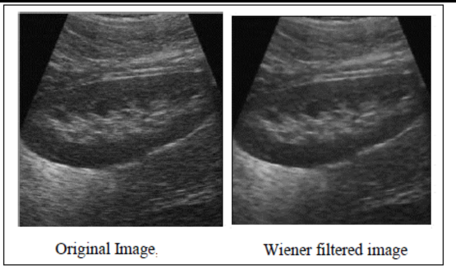

Figure 1: Filtered Image

An image texture is a set of metrics, calculated in image processing, designed to quantify the perceived texture of an image. It gives us information about the spatial arrangement of color or intensities in an image or selected region of an image. Texture is one of the important characteristics used in identifying objects or images. The gray-level co-occurrence matrix (GLCM) is used in the research for examining the texture. The GLCM functions are used for finding texture properties of an image by calculating the frequency of occurrence of pixel pairs with specific values and in a specified spatial relationship. It is calculated on square matrix of relative frequencies in which two neighboring pixels separated by distance d at orientation q occur in the image, at two different gray levels. This results into a square matrix having the size of the largest pixel value in the image. Here the features such as contrast, correlation, energy and homogeneity are calculated. The contrast measures the intensity contrast between a pixel and its neighbor on the entire image. The correlation is used to find a measure of how a pixel is correlated to its neighbor over the whole image. The energy is using the homogeneous region from non-homogeneous regions. It is expected to be high if the frequency of repeated pixel pairs is high. The normalized co-occurrence matrix is denoted by total number of the occurrence of two neighboring pixels between gray-intensity at vertical direction and angle. The homogeneity measures the closeness of the distribution of elements in the GLCM to the GLCM diagonal. The feature extraction algorithm for the US kidney image is given below.

1. Input the US kidney image.
2. Obtain the Region of Interest(ROI) of kidney
3. Apply log transform to cropped image.
4. Perform despeckling of log transformed image
5. Perform histogram equalization on despeckled image (P).
6. Find the run length features namely, Mean, Variance, Range, Energy, Homogeneity, Maximum Probability, Inverse Difference Moment (IDM).
7. Store the values obtained to in 5 as a feature vector.
8. Find gray-level co-occurrence matrices in four directions (0°, 45°,90°,135°)
9. For each matrix calculate contrast, correlation, energy and homogeneity separately
10. Store the combined feature vector by using the feature sets in 5 and 8

Artificial Neural Network (ANN) is an adaptive system that changes its structure based on external or internal information that flows through the network during the learning phase. Artificial neural network architecture has three layers in its structure. The three layers are input, hidden and output layer.

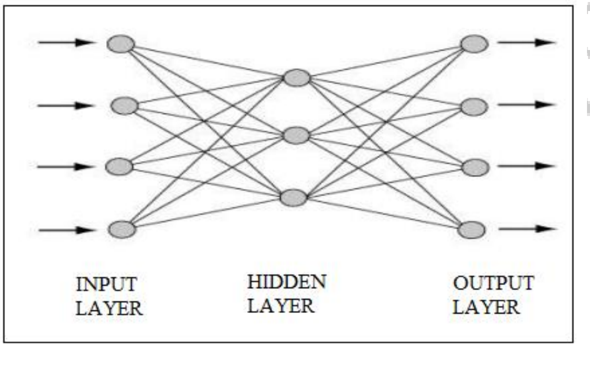

Figure 2: Structure of ANN

The input layer corresponds to a single attribute. The output layers of a network contain the solution to a problem. The hidden layers are between the input and output neurons and correspondingly a large number of weights. The weights are the key elements in an artificial neural network. They express the relative strength of the input data. The summation function computes the weighted sums of all the input elements entering each processing element. A summation function multiplies each input value by its weight and totals the values for a weighted sum Y. The formula for n inputs is

$$Y = \sum_{i=1}^{n} X_i w_i$$

Back Propagation networks are fully connected, layered, feed forward networks, in which activations flow from the input layer through the hidden layer(s) and then to the output layer. Back propagation uses supervised learning in which the network is trained using data for which inputs as well as desired outputs are known. In order to train a neural network to perform some task, the weight of each unit must be adjusted, in such a way that the error between the desired output and the actual output is reduced. The US kidney classification algorithm is given below.

Input: *1. US Kidney Image Data set (D)*
2. Learning Rate (l)
3. Network and a multilayer feed-forward network
Output: *A trained neural network*

Initialize all weights and biases in network

While terminating condition is not satisfied {

For each training tuple **X** in D {

Propagate the inputs forward

For each input layer unit j {

O j = I j

For each hidden or output layer unit j {

$I_j = \sum_i W_{ij} O_i + \theta_j$

$O_j = \frac{1}{1+e^{-1}j}$

Back propagate the errors

For each unit j in the output layer

$Err_j = O_j - O_j T_j - O_j$

For each unit j in the hidden layers, from the last to the first hidden layer

$Err_j = -\sum_k Err_j O_j O_j Err w_{jkk}$

For each weight w_{ij} in network {

$\Delta w_{ij} = (l) Err_j O_i$

$w_{ij} = w_{ij} + \Delta w_{ij}$

For each bias θ j in network {

$\Delta\theta_j = (I) Err_j$

$\theta j = \theta_j + \Delta\theta_j$

} }

IV. RESULT ANALYSIS

We have tested our proposed work with the ultra sound kidney images obtained from a scan centre at Nagercoil; India.we used various types of US kidney images such as normal, cyst, renal diseases for experimentation. The research work is implemented on Intel core i3 processor using Dotnet2012.The performance analysis exploits statistical measures, to compute the accuracy of the kidney classification. We got a better accuracy of 99%. The obtained result is then compared with the existing works.

Table 4.1 Comparison of Accuracy with Existing Methods

Work	Method	Accuracy
Prema T. Akkasaligar et al. [1]	k-NN	84%
Mariam Wagih Attia et al. [2]	PCA	97%
Proposed Method	BPNN	99%

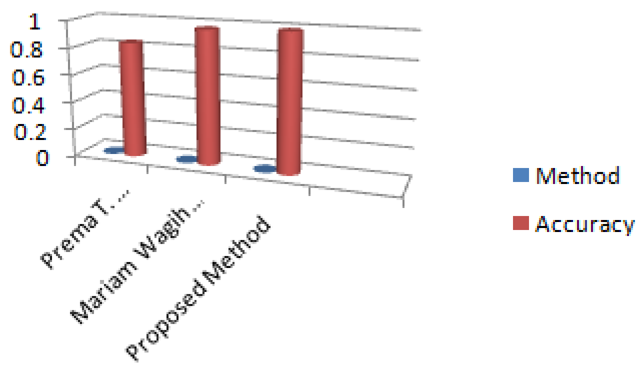

Figure 3: Comparison of Proposed Method with Existing Methods

V. CONCLUSION

An efficient ultrasound kidney image classification system using ANN classifiers is presented. Texture features are extracted and put in a training database. An efficient method gray-level co-occurrence matrix (GLCM) is applied for analyzing the texture. The features such as contrast, correlation, energy and homogeneity are obtained during the texture examination. The back-propagation algorithm is used to classify the kidney image into normal and cystic kidney image. We achieved a better accuracy of 99%. The results are encouraging and promising. Further work is required to apply the suggested technologies to a larger data set with a wide spectrum of kidneys disorders and to develop a complete intelligent system that can be used as an assistant tool in automatic classification of ultrasound kidney images.

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