Classification of Liver Disease Based on US Images

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Abstract - ***Liver disease is progressive, asymptotic and potentially fatal Diseases. In this study, an automatic hierarchical procedure to classify and stage liver disease using ultrasound images is described. The database for this work is the ultra sonographic images of liver disease along with the healthy conditions. Initially the contrast enhancement is applied to the input image that helps to identify the object, after that discrete wavelet transform is applied which helps to remove the speckle noise, then the approximate component is subjected to K-mean clustering which segments the image with respect to the minimum Euclidian distance. The classification strategy is performed using the classifier such as Neural Network. It is used to analyze the Liver disease which will be useful to doctors for the second opinion.***

Key Words: *Liver disease, contrast enhancement, Discrete wavelet Transform, Neural Network*

1. INTRODUCTION

This project work is exposes to automatic detection of Liver disease based on the ultrasound. Chronic liver disease is a important cause of morbidity in developed nations. It is normally caused by hepatitis and alcoholic abuse and metabolic of which may be liver fibrosis, cirrhosis, and/or hepatocarcinoma.

Typically, The initial stages of Liver Disease are usually asymptomatic like steatosis or hepatitis. Hepatitis is the inflammation of the liver, leading to liver cell damage and destruction. It is caused by hepatitis viruses, which may have many types, or by other factors. CLD is established with the presence of hepatitis which may evolve to the end-stage of every CLD - cirrhosis. In the cirrhosis stage there are two phases a compensated (asymptomatic) followed by the development of liver dysfunction, named decompensated cirrhosis.

Liver biopsy has a crucial role within the evaluation and staging of Liver disease. However, due to it's invasive nature and also the improved accuracy of noninvasive tests, its importance have diminished. In particularly, ultrasound as established to be an helpful diagnostic procedure for CLD.

Ultrasound is commonly used initial examination for identification of diffuse liver diseases due to its non radioactive, noninvasive and inexpensive nature. Cirrhosis is a diffused liver disease, most typically seen as a precursor to the development of hepatocarcinoma. experienced radiologists differentiate normal liver from cirrhotic liver by observing the echotexture that is generally homogeneous with medium echogenicity just in case of normal liver. The diagnosis of cirrhosis is generally done by observing the degree of nodularity present in heterogeneous echotexture. Variation in shape and size of liver is observed depending upon severity of the cirrhosis. The right lobe is generally affected by cirrhotic disorders.

2. LITERATURE SURVEY

In the review study presented in [1] it is shown that echogenicity, texture characterization and surface morphology of the liver parenchyma are effective features to diagnose the CLD. However, the analysis of those features is generally affected by the subjective assessment of the human operator. This factor could lead to significant errors in the identification and staging of CLD, since US liver images can show great variability. Therefore, new objective feature extraction and classification methodologies in a computer assisted identification framework are needed.

An experimental study was performed in [2] aiming at to discriminate the liver fibrosis from ultrasound images. They computed fractal features, entropy measures and concurrence data from ultrasound images to characterize the liver parenchyma type a textural point of view and therefore the classification results by using a Fisher linear classifier.

Other important work represented in [3] shows the ability of the wavelet coefficients, also computed from US images, to characterize the diffuse disease of the liver. Their goal was to discriminate normal, steatotic and cirrhotic conditions. A comparison results by using different classes of features, like co-occurrence information, Fourier descriptors and fractal measures, show that the wavelet based classifier outperforms the classifiers based on the other features.

In addition, the study in [4] proposes a quantitative tissue characterization to extend the quality fractal for evaluating the diffuse disease. In [5] it is referred that the pulse echo information from different grain types contain distinguishable statistical regularities.

In the study given in [6] a collection of a set from speckle and despeckled speckled image fields, computed from us images, to detect chronic liver disease. the most typical features represented in literature for the diagnosis of diffuse liver diseases include 1st order statistics, co-occurrence matrices, wavelet transform, attenuation and backscattering parameters.

In [7] mean and standard deviation texture descriptors evaluated from numerous sub-band feature images obtained by 2D-DWT, 2D-WPT and 2D-GWT are thought of for classification of normal and cirrhotic liver. it is documented that classifier designs which use regularisation like support vector machines are less susceptible to over fitting and obtain good generalisation performance to a particular extent even without feature space dimensionality reduction. For the this work SVM classifier is chosen for classification of normal and cirrhotic liver.

3. METHODOLOGY

It is common practice to have the preprocessing of ultrasound images before it has been extracted and classified. The processing scheme consists of image database, image pre-processing includes image enhancement, discrete wavelet transform to remove the speckle noise from the ultrasound image and image segmentation where the image is segmented, feature extraction and classification. Finally the classification of liver disease is done in three stages:1)Normal liver 2)compensated cirrhosis 3)Decompensated cirrhosis. Fig 1 illustrates block diagram of proposed method.

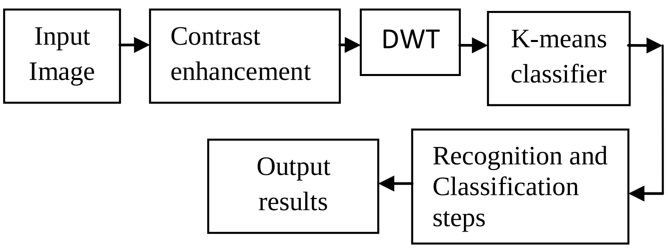

Fig -1: Block diagram for proposed method.

3.1 Contrast Enhancement

Contrast is the visual property of an object that separates it from other objects in an image. The contrast of objects against the background of an image is important for 2 functions: identifying an object and later tracking it. It improves the perceptibility of objects in the prospect by enhancing the intensity difference between objects and their background So as to have discernible objects that may each be properly recorded and tracked, correct contrast levels should be utilized to distinguish one object from another.

Contrast enhancements are generally performed as a contrast stretch followed by a tonal enhancement, although these might both be performed in one step. A contrast stretch improves the brightness differences uniformly across the dynamic range of the image, whereas tonal enhancements improve the brightness variations in the shadow (dark), midtone (grays), or highlight (bright) regions at the expense of the brightness differences in the alternative regions.

3.2 Discrete Wavelet Transform

The wavelet transform (WT) provides multiscale features from the US images. The decomposition is performed according to a sequence of low pass (G) and high-pass, (H),filtering operations followed by down-sampling the results, ↓2. This technique generates a pyramidal illustration of the original image with decreasing resolution comprising a lower resolution low-pass component (approximation component) (LL), and 3 high-pass components (detailed components) along the horizontal (HL), vertical (LH), and diagonal directions (HH). High-pass elements (H) contain image detailed information at completely different resolution scales along 3 directions, whereas low-pass versions (L) contain the approximation component.

Liver tissue characterization based on WT multiresolution analysis has been performed in many works. This approach is effective in the morphological characterization of the image from the approximation fields and at the same time in a textural characterization at several resolution scales from the detailed fields.

3.3 kNN Classifier

Instance-based classifier such as the kNN classifier operates on the premises that the classification of unknown instances are often done by relating the unknown to the familiar according to some distance/similarity function. The intuition is that 2 instances so much apart in the instance space defined by the suitable distance function are less probably than 2 closely situated instances to belong to the same category.

The purpose of the k Nearest Neighbours (kNN) algorithm is to use a database in which the data points are separated into many separate classes to predict the classification of new sample point.

The non-parametric kNN classifier is tested in this study. It classifies the test sample to a class according to the majority of the training neighbors in feature space by using the minimum euclidean distance criterion . The algorithm for the nearest neighbor rule is summarized as follows ; Given an unknown feature vector x and a distance measure, then:

• Out of N training vectors, identify the k nearest neighbors, regardless of class label.

• Out of those k samples, identify the number os vectors, ki, that belong to class Wi, i=1, 2, ..., M.

• Assign x to the category Wi with the maximum no. of ki of samples.

3.4 Database

For this experimental study a dataset is built up. The total image set of 55 US images has been collected for the work. Radiology experts confirmed the presence of liver disease by assessment criteria including:

1. Visual examination of features of sonographic images according to their expertise.

2.Follow-up the clinical history of the patient and other associated finding.

Database description
The database of this type is containing 3 classes which includes total of 55 image ultrasound. The total 55 images includes 25 of normal liver ultrasound image,20 compensated cirrhosis and 10 decompensated cirrhosis.

4. RESULTS AND DISCUSSION

In this section, results from the real data, as described in previous section are represented to validate the proposed technique. All the results are obtained with the MatLab for pattern recognition. For this initially the contrast enhancement is done on the input US image. Contrast enhancements improve the perceptibility of objects in the scene by enhancing the brightness difference between objects and their backgrounds.

Then later discrete wavelet transform is applied to the image.Then after taking the DWT, the approximate component subjected to classifier i.e k mean, which segments the image with respect to the minimum euclidian distance. results are generated from the preprocessing procedures. The red shows third level liver disease. Yellow shows second level,while blue shows first level liver disease.

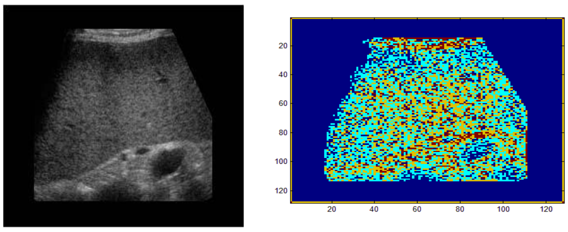

Fig -2: (a) input image ultrasound (b) preprocessed image.

4.1 ANN Approach for Classification

Neural networks have come forward as a major tool for classification. Neural networks are data driven self-adaptive methods in which they can fine-tune themselves to the data exclusive of any clear specification of functional form for the distinctive model and they are universal functional approximators in which neural networks can approximate whichever function with random accuracy. Neural networks are nonlinear models, that makes them suitable in modelling real world intricate relationships. Neural networks are able to approximate the subsequent probabilities, which provides the basis for setting up classification rule and performing statistical analysis. Results for training testing and validation for the neural network for the proposed methodology are as shown below:

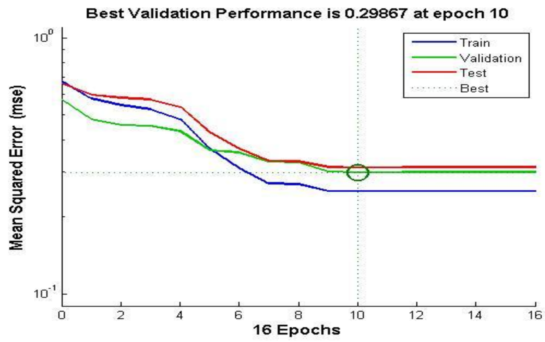

Fig -3: (a) Plot of Validation Performance is 0.29067 at epoch 10

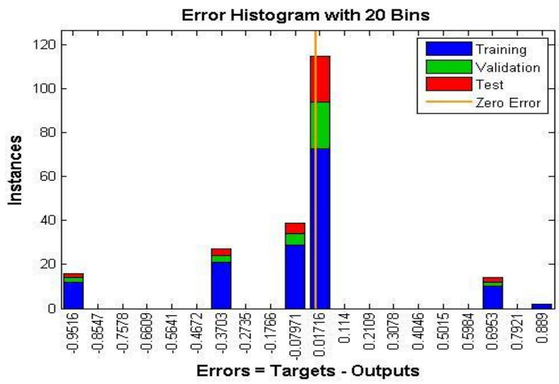

Fig -4: Error Histogram

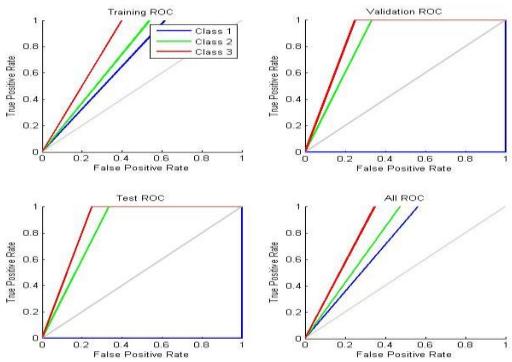

Fig -5: Training, Validation & Test ROC plots

5. CONCLUSIONS

In this paper the classification strategy for the liver disease based on the USG of liver has been demonstrated. The input image undergoes preprocessing that includes Contrast Enhancement, Discrete wavelet transform and Segmentation using kNN classifier. The classification and recognition is based on Neural Network. The performance is evaluated using error histogram, validation plot, and ROC plot. The best validation performance is 0.29867 at epoch 10 .The main goal of method is to provide a useful diagnosis tool which may reduce, but does not replace, liver biopsy and it is useful for the doctors for the second openion. In future work, the proposed multifeature approach will be expanded to incorporate more textural and morphological features. Moreover future work will also investigate classifier combination techniques.

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BIOGRAPHIES

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