Evaluation Performance of GLCM and Pixel Intensity Matrix for Liver Cirrhosis

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ABSTRACT

Mainly due to liver diseases 216,865 people around the world die, which is about 2.44% of total deaths in the world. Cirrhosis is the one most dangerous liver disorder which adds up to this huge number. Cirrhosis is a condition where liver slowly deteriorates with formation of scar tissue and cannot function normally due to long lasting or chronic injury. In this paper we have used novel methods GLCM (Gray Level Co-occurrence Matrix) and Pixel Intensity Matrix after obtaining CT scan images (Computed Tomography) of healthy liver and cirrhosis affected liver. Performance Evaluation of both matrices is carried out to analyze cirrhosis liver.

Keywords -**Cirrhosis, CT scan, GLCM, Liver Disease, Pixel Intensity Matrix,**

I. INTRODUCTION

Cirrhosis is ranked 61 in the world for cause of death having an annual death rate of about 216,865. As of now we understand cirrhosis as a dynamic process and look through the current therapeutic methods for prevention and treatment for complications of cirrhosis. Early detection of cirrhosis can be made using liver biopsy whereas long lasting or chronic conditions use conventional imaging processing such as CT, MRI, Ultrasound, etc. which helps in prescribing apt treatment. One of the major challenges related to liver is liver transplantation in patients with cirrhosis. Cirrhosis result from stage called fibrogenesis and may lead to necro inflammation. Cirrhosis is mainly caused due to alcoholic liver diseases and Chronic Hepatitis C. In this condition liver deteriorates and cannot function normally as scar tissue replaces healthy tissue and partially blocks blood flow through the liver. Liver can regenerate most of its damaged cells also it is one of the most vital organs of the body and is essential for maintaining overall health. If injury to liver is severe or long lasting regeneration cannot be completely achieved. Fibrosis which is scaring of liver leads to cirrhosis.

During this condition liver becomes lumpy and stiff preventing blood flow inside the liver resulting in excess pressure on portal vein which supplies blood to the liver. This intense condition which occurs due to excessive pressure on portal vein is called portal hyper tension which causes blood to accumulate in the spleen. As a result, spleen gets bigger in size and destroys more platelet cells than usual leading to liver cancer or hepatocellular carcinoma.

Common causes for this condition are: excessive alcohol abuse chronic viral hepatitis (B or C), fat and copper accumulation in liver, Hemochromatosis (iron accumulation in body),cystic fibrosis, poor formation of bile ducts, inherited sugar metabolism disorders, genetic disorders, destruction or hardening or scarring of bile ducts and infections. Complications occur when blood pressure in veins supplying the liver is high, swollen legs and abdomen, spleen enlargement, bleeding, infections, malnutrition, toxin accumulation in brain, bone diseases, liver cancer and acute liver failure.

II. METHODOLOGY

For this method the images undergo two preprocessing stages:

(1) Enhancement *of* image and removal of blur regions.
(2) Filtering by median filter to remove salt and pepper noise

Region of interest is selected from CT scan images where we consider a set of images of both normal and cirrhosis liver. Later these images are analyzed using GLCM and Pixel Intensity parameters.

GLCM analysis

GLCM is a statistical method of examining texture that considers the spatial relationship of pixels in consideration. The GLCM functions indicate the texture of an image by calculating how often pairs of pixel with specific values and in a specified spatial relationship occur in an image. Later these functions create a GLCM, and

then they extract statistical measures from this matrix. From every image acquired, region of interest is selected and GLCM parameters are found out using GLCM matrix. We have considered the following GLCM parameters:

Contrast=$\sum_{(i,j)} |i-j|^2 P(i,j)$ ——— (1)

Correlation = $\sum_{(i,j)} P(i,j) \left[\frac{(i-\mu)(i-\mu)}{\sqrt{\sigma 2 \sigma 2}}\right]$ ——— (2)

Energy = $\sum_{(i,j)} P(i,j)^2$ ——— (3)

Homogeneity = $\sum_{(i,j)} \frac{Pi,j2}{1+(i-j)}$ ——— (4)

Where P=image, i,j=coordinates , P(i.j)=Intensity value at i,j

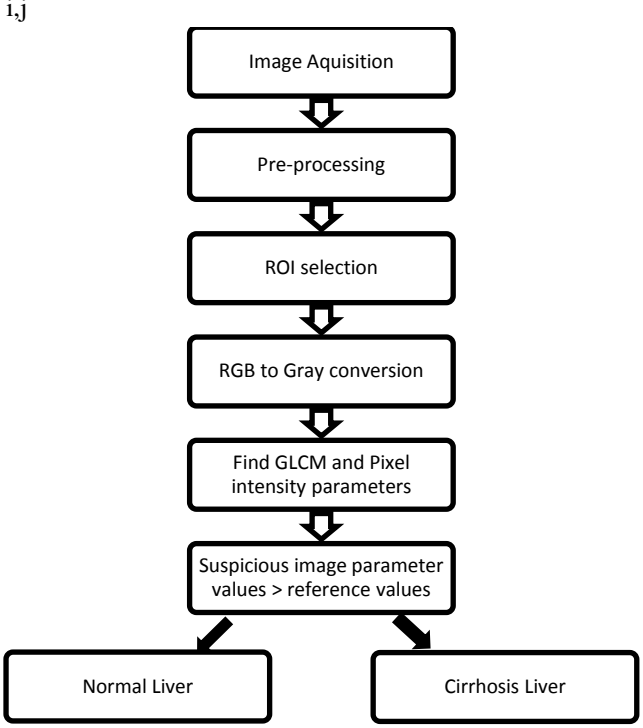

Figure 1: Block Diagram

Pixel intensity matrix Analysis:

The word pixel is based on a contraction of pix (from word "pictures", where it is shortened to "pics") and el (for "element"). The pixel intensity matrix of the gray image is then found for which the standard deviation, mean, entropy and variance are found.

Standard deviation:

$S=\left[\frac{1}{n-1}\sum_{i=1}^{n}(x_i - x)^2\right]^{1/2}$ ——— (5)

Where,

$x=\frac{1}{n}\sum_{i=1}^{n} x_i$

And n is the number of elements in the sample

Mean:

$X^{\wedge} = \frac{\sum_{i=1}^{n} x_i}{n}$ ——— (6)

Where,x_i= Intensity value

Entropy:

$H(X) = \sum_{i=1} p(x_i) \log p(x_i)$ ——— (7)

Where: $p(x_i)$ is probability of x_i

Variance:

$Var(X) = \sum p_i.(x_i-\mu)^2$ ——— (8)

Where μ is the expected value, i.e. $\mu=\sum p_i.x_i$

From the values obtained a decision rule is framed to test the abnormality of the image of interest. The average values of all the parameters are found; these average values are taken as reference values and a reference data set is created. The parameters of every suspicious image would be compared with the reference value and an abnormality can be suspected using these reference values.

III. RESULTS

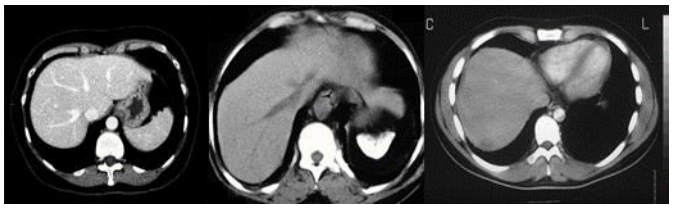

Figure 2: Set of Normal Liver images

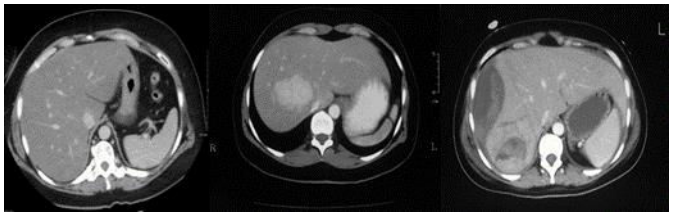

Figure 3: Set of Cirrhosis Liver images

Table 1: GLCM parameters for normal liver images

Image	Contrast	Correlation	Energy	Homogeneity
1	4.1202e+04	3.3992e-04	1.5392e-05	0.0362
2	4.0955e+04	-0.0064	1.5282e-05	0.0363
3	4.0908e+04	5.0334e-04	1.5280e-05	0.0364
Average	4.1022e+04	18.5224e-04	1.5318e-05	0.0363

Table 2: GLCM parameters liver cirrhosis images

Image	Contrast	Correlation	Energy	Homogeneity
1	1.0840e+04	-0.0029	1.5303e-05	0.7367
2	1.0910e+04	-0.0014	1.5306e-05	0.7362
3	1.0980e+04	-0.0029	1.5289e-05	0.7365
Average	1.0910e+04	-0.0024	1.5299e-05	0.7365

Table 3:Pixel intensity parameters for normal liver images

Image	Standard Deviation	Mean	Entropy	Variance
1	7.7120	142.8990	6.6858	38.8953
2	8.5107	153.5749	7.1000	68.3029
3	8.7738	196.9776	5.1597	73.2975
average	8.3321	164.4838	6.3152	60.1652

Table 4:Pixel intensity parameters for Cirrhosis liver images

Image	Standard Deviation	Mean	Entropy	Variance
1	9.0236	96.6134	6.7387	20.6214
2	4.8787	124.6398	5.7690	19.3574
3	5.3987	120.2072	5.4994	26.9754
average	6.4337	113.8201	6.0023	22.3181

Fig 2 Shows a set of Normal Liver images, Fig 3 Shows a set of Cirrhosis Liver images. Table 1 contains GLCM parameters for Normal Liver images, Table 2 contains GLCM parameters for Cirrhosis Liver images Table 3 contains Pixel intensity parameters for Normal Liver images, Table 4 contains Pixel intensity parameters for Cirrhosis Liver images.

IV. DISCUSSION

A set of three images of normal liver and cirrhosis liver CT images are taken for analysis for the proposed methods. These CT images are first pre-processed and the regions of interest are selected. This selected region of interest (ROI) is an RGB image which is converted to gray image. The average values of GLCM parameters: Contrast, Correlation, Energy, and Homogeneity and Pixel intensity parameters: Standard Deviation, Mean, Entropy and Variance are found and tabulated.

The tabulated results show that the GLCM parameters Contrast, Correlation and Homogeneity parameters of normal liver and Cirrhosis liver vary from each other whereas the energy values for both are nearly same. Contrast values of cirrhosis liver are higher than normal liver whereas Correlation and Homogeneity of normal liver holds a higher value than the cirrhosis affected liver.

Also, the pixel intensity matrices of these images are obtained. The parameters namely Standard Deviation, Mean, Entropy and Variance are found for every image taken for experimentation. The results show that the mean and variance of normal liver is more than that of Cirrhosis liver whereas standard deviation and Entropy of normal liver and Cirrhosis liver lies in same range.

V. CONCLUSION

The proposed methods are tested with a set of three normal and Cirrhosis liver images. The result obtained shows that the proposed methods works well to identify the Cirrhosis by using pixel intensity matrix and GLCM with clearly distinguished values in both cases at different ranges. The obtained parameters are to be tested on many more images to find out the accuracy of this method.

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