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 scarring 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:

\[
\text{Contrast} = \sum (i,j) (i-j)^2 P(i,j) \quad (1)
\]

\[
\text{Correlation} = \sum (i,j) P(i,j) \left( \frac{(i-\mu)(j-\mu)}{\sigma_i \sigma_j} \right) \quad (2)
\]

\[
\text{Energy} = \sum (i,j) P(i,j)^2 \quad (3)
\]

\[
\text{Homogeneity} = \sum_{(i,j)} \frac{P_{ij}}{1+(i-j)} \quad (4)
\]

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

Where \( \mu \) 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](image1)

![Figure 3: Set of Cirrhosis Liver images](image2)

#### Table 1: GLCM parameters for normal liver images

<table>
<thead>
<tr>
<th>Image</th>
<th>Contrast</th>
<th>Correlation</th>
<th>Energy</th>
<th>Homogeneity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.1202e+04</td>
<td>3.3992e-04</td>
<td>1.5392e-05</td>
<td>0.0362</td>
</tr>
<tr>
<td>2</td>
<td>4.0955e+04</td>
<td>-0.0064</td>
<td>1.5282e-05</td>
<td>0.0363</td>
</tr>
<tr>
<td>3</td>
<td>4.0908e+04</td>
<td>5.0334e-04</td>
<td>1.5280e-05</td>
<td>0.0364</td>
</tr>
<tr>
<td>Average</td>
<td>4.1022e+04</td>
<td>18.5224e-04</td>
<td>1.5318e-05</td>
<td>0.0363</td>
</tr>
</tbody>
</table>

#### Table 2: GLCM parameters liver cirrhosis images

<table>
<thead>
<tr>
<th>Image</th>
<th>Contrast</th>
<th>Correlation</th>
<th>Energy</th>
<th>Homogeneity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.0840e+04</td>
<td>-0.0029</td>
<td>1.5303e-05</td>
<td>0.7367</td>
</tr>
<tr>
<td>2</td>
<td>1.0910e+04</td>
<td>-0.0014</td>
<td>1.5306e-05</td>
<td>0.7362</td>
</tr>
<tr>
<td>3</td>
<td>1.0980e+04</td>
<td>-0.0029</td>
<td>1.5289e-05</td>
<td>0.7365</td>
</tr>
<tr>
<td>Average</td>
<td>1.0910e+04</td>
<td>-0.0024</td>
<td>1.5299e-05</td>
<td>0.7365</td>
</tr>
</tbody>
</table>

#### Table 3: Pixel intensity parameters for normal liver images

<table>
<thead>
<tr>
<th>Image</th>
<th>Standard Deviation</th>
<th>Mean</th>
<th>Entropy</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.7120</td>
<td>142.8990</td>
<td>6.6858</td>
<td>38.8953</td>
</tr>
<tr>
<td>2</td>
<td>8.5107</td>
<td>153.5749</td>
<td>7.1000</td>
<td>68.3029</td>
</tr>
<tr>
<td>3</td>
<td>8.7738</td>
<td>196.9776</td>
<td>5.1597</td>
<td>73.2975</td>
</tr>
<tr>
<td>Average</td>
<td>8.3321</td>
<td>164.4838</td>
<td>6.3152</td>
<td>60.1652</td>
</tr>
</tbody>
</table>

**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:

\[
S = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (x_i - \bar{x})^2} \quad (5)
\]

Where,

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

And n is the number of elements in the sample

Mean:

\[
\bar{x} = \frac{1}{n} \sum_{i=1}^{n} x_i \quad (6)
\]

Entropy:

\[
H(X) = -\sum_{i=1}^{n} p(x_i) \log p(x_i) \quad (7)
\]

Where: p(x_i) is probability of x_i

Variance:

\[
\text{Var}(X) = \sum p_i (x_i - \mu)^2 \quad (8)
\]

**Image Acquisition**

1. Pre-processing
2. ROI selection
3. RGB to Gray conversion
4. Find GLCM and Pixel intensity parameters
5. Suspicious image parameter values > reference values

**Figure 2:** Set of Normal Liver images

**Figure 3:** Set of Cirrhosis Liver images
Table 4: Pixel intensity parameters for Cirrhosis liver images

<table>
<thead>
<tr>
<th>Image</th>
<th>Standard Deviation</th>
<th>Mean</th>
<th>Entropy</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9.0236</td>
<td>96.6134</td>
<td>6.7387</td>
<td>20.6214</td>
</tr>
<tr>
<td>2</td>
<td>4.8787</td>
<td>124.6398</td>
<td>5.7690</td>
<td>19.3574</td>
</tr>
<tr>
<td>3</td>
<td>5.3987</td>
<td>120.2072</td>
<td>5.4994</td>
<td>26.9754</td>
</tr>
<tr>
<td>average</td>
<td>6.4337</td>
<td>113.8201</td>
<td>6.0023</td>
<td>22.3181</td>
</tr>
</tbody>
</table>

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.

ACKNOWLEDGEMENTS
The authors thank the Management and Principal of ACS College of Engineering, Mysore road, Bangalore for permitting and supporting to carry out the research work.

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