Analysis of Liver Anomalies in CT Image Using Feature Extraction Method GLRLM and PHOG Algorithm

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***Abstract*— The liver is the largest organ of the body, located in the upper left of the abdomen and performs various important functions like clearing toxins from the blood, production of blood proteins and bile to help in digestion. However, liver diseases are one of the leading causes of deaths worldwide. In a CT scan, indications of cancer presence can be Identified by a difference in pixel intensity from that of the liver. Manual segmentation and classification of CT scans are laborious and time-consuming for a clinical setting. Automatic segmentation, on the other hand, is a very challenging task, due to various factors. Our proposed system is focused on detection of anomalies present in the liver. As a first step, Liver CT- scan image is acquired. Then the disease present in the liver is segmentation using binary tree quantization. By extracting features such as Pyramid Histogram of Oriented Gradients (PHOG) and Gray level Run Length Matrix (GLRLM) from the segmented region.**

Keywords—liver, segmentation,binary tree quantization, Pyramid Histogram of Oriented Gradients (PHOG), Gray level Run Length Matrix (GLRLM)

1. INTRODUCTION

Medical Imaging is playing very important role in most of the clinical procedures and in detecting and diagnosing different human diseases. The three dimensional view of the body can be viewed and imaged by different medical imaging technique such as Ultrasound, Computed Tomography(CT) Scanner and Magnetic Resonance Imaging which has taken across X-Ray imaging. By using the CT scanner, body's ailing region can be recognized with ease and this technique causes no pain to the patient [1]. The CT is the most commonly used cross sectional imaging technique for morphologic tumor detection [2]. The liver is one of the most efficient organs in human body. Without a healthy liver, we cannot survive because it affects nearly every organ in the human's body. The basic types of diseases that affect the liver are diffused liver diseases and focal liver diseases. The diffused liver diseases influence the whole liver surface, such as fatty and cirrhotic liver. If the diseases affect a small region of the liver surface, these diseases are called focal liver diseases. Disease are Cyst, Hemangioma (Hem), and Hepatocellular Carcinoma (HCC) [3].

The median filter is a simple nonlinear operator that replaces the middle pixel in the window with the median-value of its neighbors. The moving windows for the median filter were 7 × 7; it is a particularly effective to removes pulse or spike noises [4]. It is the best filtering technique in reducing salt and pepper noise while maintaining the sharp edges in an image, The minor disadvantage of this filter is it cannot differentiate between noisy and non-noisy details [5]. The 3 by 3 neighborhood value is used as default value which makes the fifth value from ninth pixel becomes the output value for the pixel under evaluation for median filtering [6].

Automatic segmentation of the liver based on a priori knowledge of the image, such as location and shape of the liver. They have tested on the prototype on a CT scan images, and conclude that even their software is not one hundred percent reliable, and able to perform better.[7]

The integration of different methods for liver segmentation and abnormality classification methods like Adaptive thresholding, Morphological operators, Connected component labeling (CCL), Watershed algorithm and Region growing algorithm which propose an attempt that combines different techniques in order to compensate their individual weaknesses and to exploit their strengths. Experimental results confirm that their approach is robust, fast and able to effectively detect the presence of abnormalities in the liver.[8]

The liver segmentation is done for CT images using adaptive threshold method and morphological processing. Extraction of the tumor is done by means of Fuzzy C-Means (FCM) clustering from the segmented liver region. tumor segmentation and classification algorithm proved as efficient which can make computation feasible and less time-consuming.[9]

Comparative study of different methods and how those algorithms are used to detect the liver is done. They have comparative Thresholding Method, Marker controlled watershed, Region growing method, Label connected component method, Clustering method and Neutrosophic Set. They say out that Neutrosophic Set has best results[10]

The CT/PET medical images are used for the segmentation of liver anomalies. The preprocessing was done by the median filter and the segmentation was performed by binary tree quantization algorithm. The binary tree quantization algorithm produces better results than conventional K-means segmentation algorithm.[11]After looking into many papers

which uses different algorithm for segmentation there are few disadvantages and advantages. So we have stuck to binary tree quantization algorithm in our work for getting the best result.

A paperback approach based on the part PHOG features with curve weighted is proposed to detect caldera. The course-to refine detection method is used for caldera detection which accounts for changes in illumination, appearance and scale. The algorithm was using images from Mars. The results demonstrated the efficiency and high accuracy of the proposed algorithm. As the algorithm is well known for the curve shaped detection, we would like to pick the PHOG in our work [12].

The proposed method combines the texture features of several orientations of the GLRLM along with LBP texture operator resulting in better classification rate. This can be attributed to the generation of improved feature vectors. An excellent application of such texture classification techniques lies in the field of medical imaging, remote sensing as well as pattern and face recognition [13].The GLRLM best algorithm for the texture classification techniques especially in the medical imaging, hence we have used this for our work.

II.METHODOLOGY

A. *The proposed system block diagram*

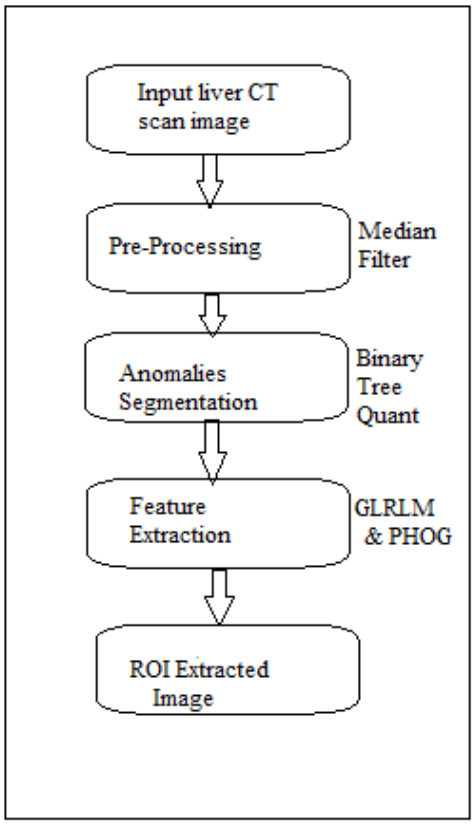

Fig-1 Block diagram of proposed system

B. *Data set collection*:

CT image sequences is been obtained from Department of Radiology, JSS Hospital, Mysuru and Apollo BGS, Mysuru.

C. *Preprocessing*

In signal processing it is often desirable to be able to perform some kind of noise reduction on an image or signal. Pre processing of the input image is done using median filter, it is best known method used to remove salt and pepper noise. The median filter is a nonlinear digital filtering technique, often used to remove noise. Such noise reduction is a typical pre-processing step to improve the results of later processing .Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise.

Consider a color image I in the RGB color space then

$$I(X,Y) = \begin{bmatrix} I_{R,}(X,Y) \\ I_{G,}(X,Y) \\ I_{B,}(X,Y) \end{bmatrix} \qquad \text{.....(1)}$$

Where I(x, y), is the pixel vector at location (x, y) in the color image I.

The median filter is applied to each component of color image as follows

$I(X_R,Y_R) = \text{med}_R \{I(X, Y) / X,Y\varepsilon W\}$
$I(X_G,Y_G) = \text{med}_G \{I(X, Y) / X,Y\varepsilon W\}$ .....(2)
$I(X_B,Y_B) = \text{med}_B \{I(X, Y) / X,Y\varepsilon W\}$

Where w is a window of odd size I(xb,yB) represents the coordinates of the median values for each color component.

$$\widetilde{\mathbf{R}}_n = \mathbf{R}_n - \frac{1}{N_n}\mathbf{m}_n\mathbf{m}_n^t$$

The three vectors can be combined to a median matrix m such that, M= $I(X_R,Y_R), I(X_G,Y_G), I(X_B,Y_B)$

.....(3)

D. *Segmentation*

The binary tree quantization algorithm is based on orchard and Bauman approach. The clustering concept is applied in the construction of binary tree and it follows divide and conquer approach. The principal component analysis (PCA) is utilized in the splitting of a node into sub nodes which is based on largest Eigen value. The splitting of a node into two nodes was found by principal component analysis (PCA). The principal Eigen vector is determined which has largest eigen value. The transformation by PCA is based on the second order statistics (covariance) of the original data. The binary tree quantization algorithm steps can be summarized as follows:

Step 1: Image are taken as K-clusters.
Step 2: The color components are to be computed, following to that compute different fields of clusters.
Step 3: The first cluster is initialized as 'C1'
Step 4: The mean (µ1) and covariance matrix (CM1) of the cluster 'C1' is calculated.

$$\mathbf{R}_n = \sum_{s\in C_n} \mathbf{x}_s\mathbf{x}_s^t \qquad \text{.....(4)}$$

$$\mathbf{m}_n = \sum_{s\in C_n} \mathbf{x}_s \qquad \text{.....(5)}$$

$$N_n = |C_n| \qquad \text{.....(6)}$$

The steps in binary tree quantization algorithm can be summarized as follows using 2nd & 3rd calculate mean qn

$$q_n = \frac{m_n}{N_n} \qquad \text{.....(7)}$$

Using mean &the first equation we can calculate the co variance of class x

$$\tilde{R}_{n'} \qquad \text{.....(8)}$$

Step 5: Find the cluster, Cn with largest eigen value and its associated eigen vector.
Step 6: Form the initial cluster, and then display the newly formed cluster.

E. Feature Extraction

Feature extraction is applied to extract features using GLRLM algorithm and PHOG algorithm. In our work we are using two feature extraction methods, where GLRLM is used to compute seven texture parameters where as PHOG is used Orientation and angle extraction.

1-GLRLM (Gray Level Run Length Matrix)

The Gray Level Run Length Matrix (GLRLM) method is a best technique of extracting higher order statistical texture features. Let be the number of gray levels, be the longest run, and be the number or pixels in the image. The gray Level Run Length Matrix (GLRLM) is a two dimensional matrix of (G*R) elements in which each element gives the total number of occurrences of runs having length j of gray level i, in a given direction. GLRLM helps to crop a region of interest manually from an image and it computes seven texture parameters viz., short run emphasis (SRE) ,long run emphasis(LRE) ,gray level non-uniformity (GLN) ,run percentage (RP) ,run length non-uniformity (RLN) ,low gray level run emphasis (LGRE) and high gray level run emphasis (HGRE).

Table 1: GLRLM features

S. No	Features	Formulae
1	Short Run Emphasis (SRE)	$\frac{1}{n}\sum_{i,j}\frac{p(i,j)}{j^2}$
2	Long Run Emphasis (LRE)	$\frac{1}{n}\sum_{i,j} j^2 p(i,j)$
3	Gray level non-uniformity (GLN)	$\frac{1}{n}\sum_{i}\left(\sum_{j} p(i,j)\right)^2$
4	Run length non-uniformity (RLN)	$\frac{1}{n}\sum_{i}\left(\sum_{j} p(i,j)\right)^2$
5	Run percentage (RP)	$\sum_{i,j}\frac{n}{p(i,j)j}$
6	Low gray level run emphasis (LGRE)	$\frac{1}{n}\sum_{ij}\frac{p(i,j)}{i^2}$
7	High gray level run emphasis (HGRE).	$\frac{1}{n}\sum_{i,j} i^2 p(i,j)$

2-PHOG (Pyramid histogram of oriented gradients)

To get the PHOG features, first extract the edges from images. Here Canny edge detection tool is used to achieve this goal. Spatial layout information is the most important part in this section. Each image is divided into a sequence of increasingly finer spatial grids by repeatedly doubling the number of divisions in each axis direction, so along each dimension we have cells at level l. Before PHOG feature is formed, there is another parameter need to be settled. For counting histogram of edge orientations, the number of orientations is quantized into K-bins. Each bin in the histogram represents the number of edges that have orientations within a certain angular range. Consequently, local shape can be represented by a K-vector corresponding to the K bins of the histogram. That means level 0 is represented by a K-vector and level 1 by a 4K-vector, also level l by a K vector. In each cell, we calculate HOG, and then concatenation of all these HOG features to form a long vector as the representation of an image.

$$|G| = \sqrt{Ix^2 + Iy^2} \quad \text{..... (9)}$$

$$\theta = \arctan\frac{Iy}{Ix} \quad \text{.....(10)}$$

After the image is divided into the spatial grids at all the pyramid levels . The Gradient function is used for calculating orientation gradients. After calculating x, y derivatives (Ix and Iy), The magnitude and orientation of the gradient is also compute.

II. RESULTS AND DISCUSSION

There are nearly 18 image set being collected for the HCC (Hepato cellular carcinoma) patients, and also collected data of the different diseased patient. The Hepato cellular carcinoma is one of the malignant liver tumors. The fig 2 is the original image.

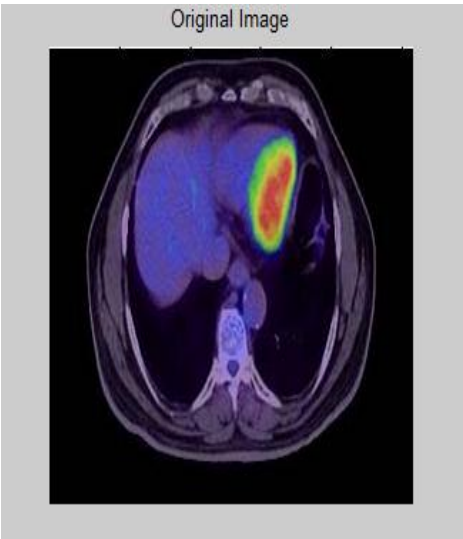

Fig 2:Original image

- Separating the color components and apply median filter to each color component.

Here for applying the median filter first we are separating the each color component RGB. After the separation the median filter is applied for each color components. The median filter removes the noise from the image individually as shown is the fig 3.

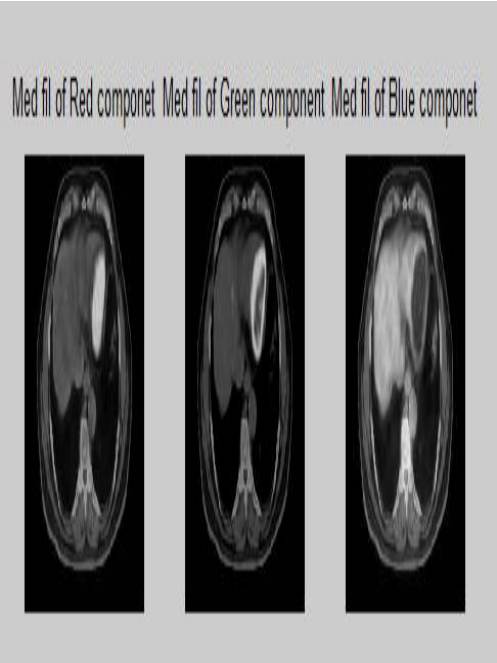

Fig 3: Median filter to each component

- Combine three median matrix

Ones the noise is removed from the image after the separation of the RGB components. We need to combine the gray scale images.

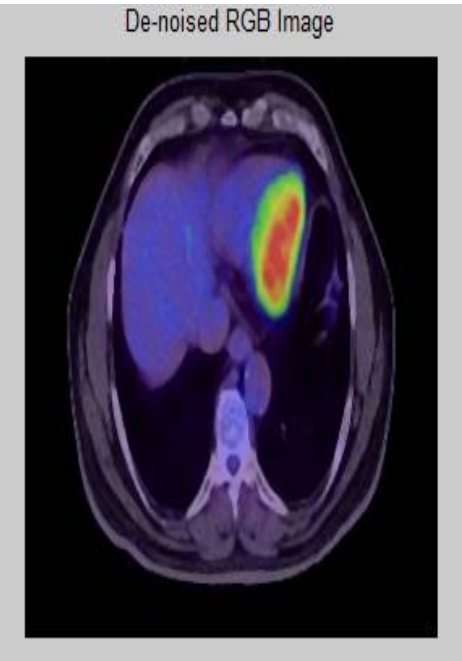

Fig 4: De-noised image

- Binary tree quantization cluster output

The Binary tree quantization is used for the segmentation of the anomalies from the images. Binary tree quantization cluster output with C=4 is shown in the below fig 4 image shows all the possibilities of the gray scale extraction. From those 4 images that is shown below it will select the nearest image for the feature extraction.

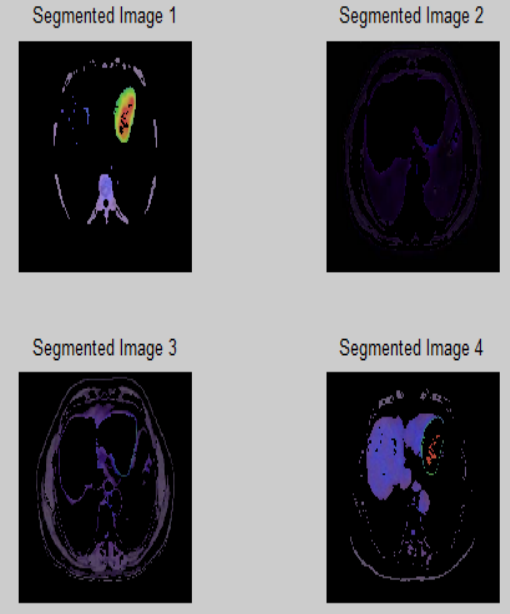

Fig 5: Binary tree quantization output

- The segmented image for feature extraction

Fig 6 is the image which is close to the tumor region as per the binary tree quantization; hence it is taken for the further feature extraction process. The binary tree quantization computes the cluster of pixels based upon their color. The input to this is the pre processed image, and the maximum possible clusters required.

The output will be segmented image, group of segmented images and noise free image.

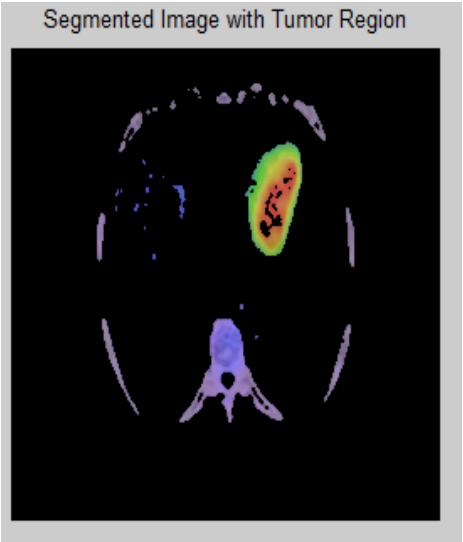

Fig 6: Segmented image with tumour region

- Extracted regions from the segmented image which is in fig 6

The feature extraction is done using 2 algorithms which is GLRLM and PHOG. Whereas mention earlier the GLRLM used for the texture extraction and as PHOG is used for Orientation and angle extraction from the image. We are using two algorithms for getting the best accuracy.

As shown in the fig 7 and fig 8 it extracts the region which is conjecture to the tumor. Further work can be done one this for the classification of the tumor region.

Fig 7: Cropped region 1

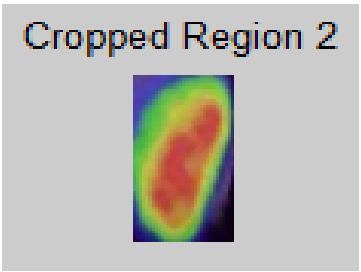

Fig 8: Cropped region 2

CONCLUSION

In this paper work segmentation and feature extraction of Tumor region is performed by binary tree quantization algorithm prior to segmentation the preprocessing was performed by median filter and the feature extraction is done by as Pyramid Histogram of Oriented Gradients (PHOG) and Gray level Run Length Matrix (GLRLM) from the segmented region. It is performed on HCC (Hepatic Cellular Carcinoma) patients .It can be further trained and classified using and SVM for both training and classification.

ACKNOWLEDGMENT

We whole heartedly thank JSS hospital and Apollo hospital Staff Mysuru for providing us the CT scan images required for work.

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