OPEN ACCESS INTERNATIONAL JOURNAL OF SCIENCE & ENGINEERING

CAD OF LIVER CIRRHOSIS BY EDGE PIXEL COUNT

Dr. Punal M Arabi[1], Mrs. Gayatri Joshi[2], Mrs. Surekha Nigudgi[3]

Department of Biomedical Engineering, ACS College of Engineering, Banglore, [1,2,3]
arabi.punal@gmail.com. gayatrijoshi@gmail.com. sursanju@gmail.com

---

Abstract: Liver disease is one of the major causes of death globally. Cirrhosis is a late stage complication caused by many forms of liver diseases and conditions which results in loss of liver cells and irreversible scarring of the liver. About 216,865 deaths are attributed annually to liver diseases. Symptoms of cirrhosis cannot be identified easily since they are non-specific in addition to the fact that often no signs and symptoms develop until liver damage is extensive. This paper proposes a computer aided diagnostic method to identify liver cirrhosis using MRI images by finding the number of pixels of edge detected binary image of healthy and cirrhotic liver. The results obtained show that there is a difference of about tens of thousands of pixels exists between healthy and cirrhotic liver. Hence there is a possibility of CAD of liver cirrhosis by the proposed method.

Keywords: *CAD, Cirrhosis, Edge Detection, Pixel Count, Matlab 2015a..*

----------∴∴∴----------

I INTRODUCTION

Liver is the biggest organ which weighs 1500gm approximately and is located in the upper right corner of abdomen in the human body. The liver carries out around 500 metabolic functions resulting in production of bio-chemicals and releasing it into blood stream or directly into the specific organ. It produces substances that help in fighting infections and in clotting of blood. It filters toxins and infectious agents out of the blood. Liver also helps in the digestion of certain nutrients from foods, and stores energy for later use. The liver suffers by many diseases like jaundice, acute liver failure, hepatitis, liver cancer, liver cirrhosis etc. Liver disease is one of the major causes of death globally. Cirrhosis is a last stage complication caused by many forms of liver diseases and a condition which results in loss of liver cells and irreversible scarring of the liver. The liver responds to damage of the cells by producing strands of scar tissue that surround islands (nodules) of healing cells, making the liver knobby. At first, the liver inflammation causes it to swell. As the disease progresses there are increase in amount of scar tissue in the liver, the liver will actually shrink. Many blood vessels are pressed by scar tissue in the liver. This interrupts the blood flowing to liver cells, which then die. Loss of liver cells hinders the liver's ability to perform its normal functions. Loss of the liver functioning affects the body in many ways. Cirrhosis, if severe enough, can cause many different complications such as Portal hypertension, Hepatic encephalopathy, gastrointestinal bleeding, Fluid retention (ascites), Hepatorenal syndrome and more. The symptoms of liver cirrhosis are Tiredness (fatigue) or even exhaustion, Weakness, nausea, Loss of appetite leading to weight loss and Loss of sex drive. Many people do not know they have cirrhosis until they have a complication like jaundice, fever, vomiting, diarrhea, itching, abdominal swelling or bloating, weight gain, swelling in ankles and legs, difficulty in breathing, extreme sleepiness, blood in vomiting and feces, easy bruising and also show mental abnormalities like confusion, delirium, personality changes and hallucinations. The common causes are chronic alcoholism and hepatitis. According to WHO, 46% of the world population suffer from liver cirrhosis during 2010, the mortality by liver cirrhosis was around a million. In 2016, according to age-standardized death rate of liver cirrhosis by world health organization of all alcohol-attributable deaths, alcohol consumption is estimated to cause 21.3% by digestive diseases, 20.9% by unintentional injuries and 19.0%, by cardiovascular diseases and diabetes respectively.

The diagnosis of liver cirrhosis can be suggested by history, physical examination, liver imaging, laparoscope and blood

tests of the patient and can be confirmed by liver biopsy. If the liver diseases are diagnosed at an early stage it can be treated and liver is one of the organs which revert back to its initial state when the liver diseases are detected in early stages. Treatment for cirrhosis cannot reverse liver damage in the late stages, but it can stop or slow progression of the disease causing it and reduces complications. Treatment depends on what is causing the cirrhosis. This paper aims at developing computer aided software for the easy diagnosis of early and late detection of liver cirrhosis. According to a survey in 2017 in India doctor-population ratio is 0.62:1000 which doesn't match the criteria laid by world health organization that is 1:1000. So, there is a need for easy diagnosis of the diseases; this work aims at developing a method that would ease the diagnosis of liver cirrhosis as mentioned above.

II LITERATURE SURVEY

G. IgnishaRajathi.et.al.[1] proposes a methodology for developing the image-based classification model of liver disease classification in segmented CT liver images. This methodology includes acquisition of image, preprocessing, extracting the liver region, mapping, 3D texture features were extracted from the intensity and the higher-order features after the VOI selected using segmentation of the liver image and validation. D Santhosh Reddyet.al.[2] proposed a CAD method using convolution neural networks and transfer learning for the classification of fatty liver diseases. M. Mirah Kasturi et.al.[3] proposes a method to detect and locate the cancerous cells using CT images of liver and lung using image enhancement and sobel detection technique. GehadismailSayedet.al.[4] proposed a computer aided diagnosis method for diagnosing liver diseases using CT liver images. this approach is based on fuzzy clustering and wolf optimization for automatic liver segmentation. Tarek M. Hassan et.al.[5] introduced methods of segmentation based on acquired medical images and also speaks on the work of different segmentation and classification techniques that have been proposed to diagnosis various liver diseases. SumedhSontakke et.al.[6] discuss about the method to diagnose live diseases using two algorithms i.e. back propagation and Support Vector Machine Algorithm. Sa'diyah Noor Novita Alfisahrin et.al.[7] presents technique to identify the patients with liver diseases based on 10 important attributes of liver disease using a Decision Tree, Naive Bayes, and NB Tree algorithms. Manuel Grana et.al.[8] present the applications of the Multivariate Mathematical Morphology (MMM) built on reduced supervised orderings based on the lattice auto-associative memories (LAAMs)which is employed in fMRI data classification. I-Ming Lei et.al.[9] presents a Computer Aided Diagnosis(CAD) system for the liver cirrhosis recognition in ultrasound liver images using the uniform LBP(u-LBP) features. K. Fujino et.al.[10] propose to use image processing techniques of the thresholding and shading which effectively extracts the HLAC features. Viviana Mihaela Bostan et.al.[11] design a noninvasive method based on an artificial neural network model that will serve to diagnose liver cirrhosis by using only the laboratory data.Temitopemapayi et.al.[12] present a study that combines difference image (di) with fuzzy c-means (fcm) for the detection of the vessels in retinal images; a post processing phase combining different morphological operations is applied, for the removal of noisy pixels.

Sen Qian et.al.[13] developed an approach for the medical image segmentation based on fuzzy c-means (fcm) and level set algorithm which had proved to be feasible. Maria Tsiplakidou et.al.[14] developed a methodology for automated detection and quantification of hepatic steatosis; the methodology is based on liver biopsy image analysis and can accurately assess liver steatosis. Shuzo Kanasaki.etal[15], presented a morphological diagnosis of the chronic liver disease using the ct and a quantitative assessment method is described. Yu-Hsiang Wu et.al.[16] propose a method in which the self-organization properties of the genetic algorithms are employed to tackle the problem of feature selection and extraction in ultrasound images, which can facilitate early disease detection of liver disease. Omer Kayaalti et.al.[17] carried the study that is aimed at producing some objective measures using image analysis, which will be of assistance in the diagnosis of cirrhosis.

III METHODOLOGY

A set of 20 MRI liver Images are taken for experimentation.

The acquired RGB images are converted into gray. RGB images are three-channel color images which takes three times as long as processing a grayscale image. Hence RGB to gray conversion is done to speed up the process. The grey image is then segmented using region growing technique followed by image resizing. The segmentation technique based on the similarity of adjacent pixels. A region is started with a single pixel (seed pixel) and the adjacent pixels are added to the current region if they are similar to the region. Image resizing is necessary when you need to increase or decrease the total number of pixels, whereas remapping can occur when you are correcting for lens distortion or rotating an image. For the resized images pre-processing is done for noise removal using median filtering. Eq. 1 shows the operation of the median filter:

$$y(n)=med[x(n-k),x(n-k+1),\ldots,x(n),\ldots,x(n+k-1),x(n+k)] \quad \text{[Eq. 1]}$$

where y(n) is the output, x(n) is the input and the filter collect the windows of N=2k+1 samples of input and performs median operation on it.

The filtered image is enhanced using the contrast stretching to increase the dynamic range of the grayscale in the image.

The canny edge detection is applied to the resultant images. This technique as the following steps,

Smoothening the image using Gaussian filter given by the equation,

$$(x, y) = e^{-\frac{(x^2+y^2)}{2\sigma}} \quad \text{[Eq. 2]}$$

where x and y denote spatial coordinates of the image,σdenotes the standard deviation of coordinates and G(x,y) denotes Gaussian filter operation. The equation for smoothed image is given by,

$$f(x, y) = G(x, y) * f(x, y) \text{[Eq. 3]}$$

here$f(x,\ y)$ denotes smoothened image,$f(x,\ y)$ denotes processing image and $G(x,\ y)$ denotes gaussian filter operation.

here$f(x,\ y)$ denotes smoothened image,$f(x,\ y)$ denotes processing image and $G(x,\ y)$ denotes gaussian filter operation.

The gradient magnitude (M) and angle of the image (α) is calculated by:

$(x, y) = \sqrt{g}x2 + gy2$ [Eq. 4]

and

$\alpha(x.\ y) = \tan{-1}[gx/\ gy]$ [Eq. 5]

respectively. Here $gx = \delta fs/\delta x$ and $gy = \delta fy/\ \delta y$.

Applying non-maxima suppression to gradient magnitude image.

Using double thresholding and connectivity analysis to detect and link edges.

Following these procedures produces edge detected image which is then converted to binary. The number of pixels present in the binary images is counted to classify the normal and cirrhotic liver. Figure-1 and figure-2 shows the image of healthy and cirrhotic liver images respectively. Figure-3 shows the steps involved in the proposed method. Figure-4 shows the resultant image at the each step of proposed method.

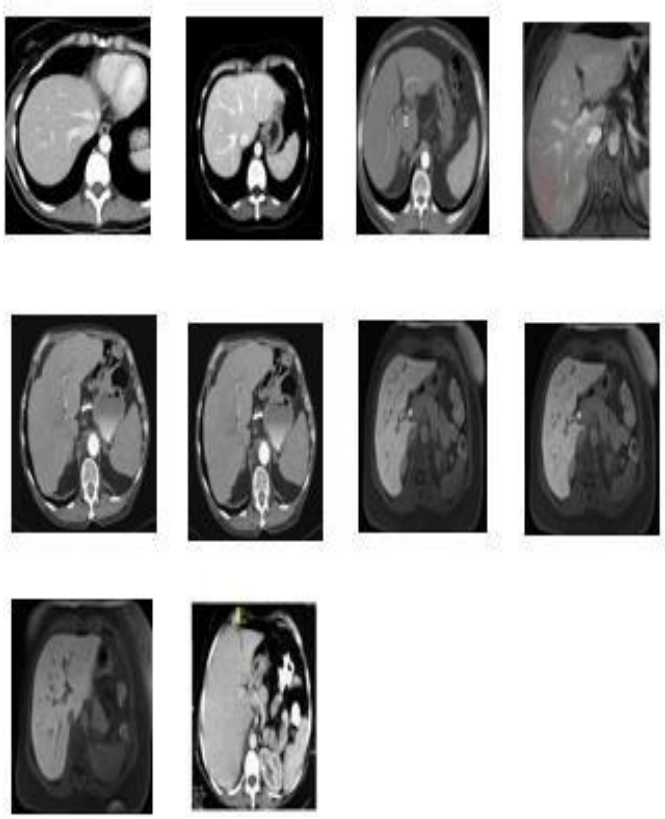

Figure-1: Healthy liver images

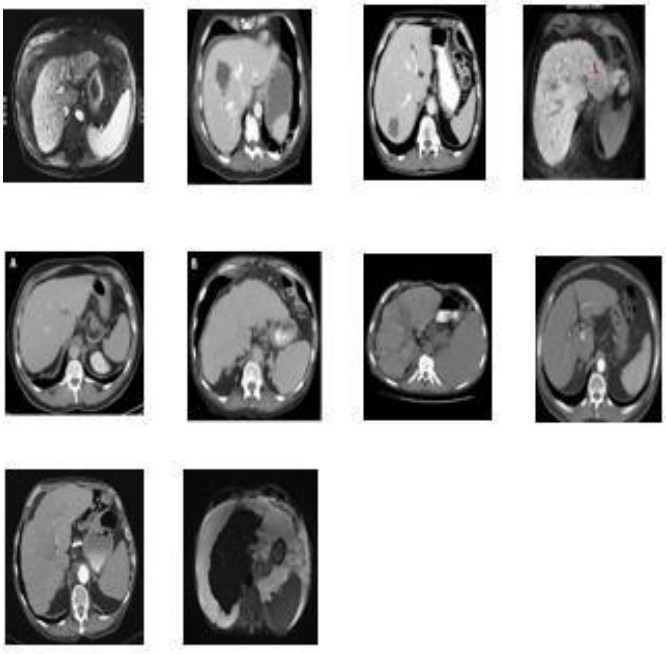

Figure-2: Cirrhotic liver images.

Figure -3 Methodology

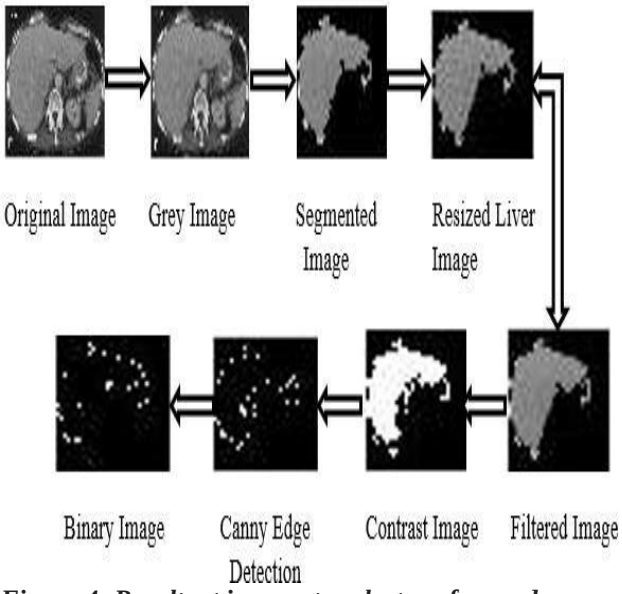

Figure-4: Resultant image at each step of procedure

IV DISCUSSION

A set of twenty MRI images of abdominal region containing normal or cirrhotic liver is taken for experimentation. Fig. 1 and Fig. 2 show the images of healthy and cirrhotic liver respectively.

The images are converted to gray. Liver portion in the gray image is segmented by region growing technique and preprocessed. In the pre-processing stage, the liver image is filtered using median filter to remove noise and the image is then enhanced by contrast stretching technique. The pre-processed image is subjected to edge detection, through Canny edge detection is, which is then converted to binary. The number of white pixels present in the binary image is counted and tabulated (Table-1).

Table 1 summarizes the calculations for counting the number of white pixels.

The average value of the number of white pixels present in the binary images under experimentation is found separately for healthy and cirrhotic liver images. From the Table 1 and Eq. 6, we can calculate the threshold value and through which we formulate the decision value.

$$T = \frac{(PC_{AV(HL)}) + (PC_{AV(CL)})}{2} \qquad \text{[Eq. 6]}$$

Here:

T: Threshold

$\boldsymbol{PCA(HL)}$: Average pixel count of a healthy liver

$\boldsymbol{PCA(CL)}$: Average pixel count of a cirrhotic live

The threshold value (T) was found to be T=35559pixels. Hence, we can say that if pixel count (PC) exceeds a value of 35559, the liver image is identified as healthy image

If PC <35559, the liver image is identified as a cirrhotic one

Out of the twenty images taken for experimentation, every image is identified correctly as a healthy or affected one. This leads to 100% accuracy of the proposed method.

V CONCLUSION

A method is proposed for the identification cirrhotic liver using white pixel count in the binary image. The results obtained show the feasibility of the proposed method. Since healthy liver has the smooth structure which is highly affected with nodule formations in the cirrhotic liver, there is a wide variation in pixel counts between both the cases. Though the experimentation done on a set of twenty images shows that the proposed method is 100% accurate, the accuracy can be confirmed only by experimenting the proposed method on

more number of liver images and also on liver images affected by other kinds of liver diseases.

This method is only performed on the MRI images and its application on other type of images like CT images is not done. The change in the pixel count of the image may also be due to other liver diseases too, so the same technique should be applied on other images with different liver diseases to determine its efficiency.

REFERENCES

1. G. IgnishaRajathi.etal "Chronic Liver Disease Classification Using Hybrid Whale Optimization with Simulated Annealing and Ensemble Classifier" Symmetry 2019 11, 33; doi:10.3390/sym11010033.

2. D Santhosh Reddy.etal "A Novel Computer-Aided Diagnosis Framework Using Deep Learning for Classification of Fatty Liver Disease in Ultrasound Imaging" 2018 IEEE 20th International Conference on e-Health Networking, Applications and Services 978-1-5386-4294-8/18 ©2018 IEEE.

3. M. mirahKasturi.etal"Efficient Edge Detection Method For Diagnosis Of 2D and 3D Liver and Lung images" International Conference On Inventive System And Control (ICISC) 2017 10.1109/ICISC.2017.8068661.

4. Gehadismailsayed.etal"An Automated Computer Aided Diagnosis System For Abdominal CT Liver Images" International Conference On Medical Imaging Understanding And Analysis 2016, MIUA 2016 volume 90, 2016, page 68-73.

5. Tarek M. Hassan.etal"Medical Image Segmentation for Liver Diseases" International Journal of Computer Applications (0975 – 8887) Volume 118 – No.19, May 2015.

6. SumedhSontakke. etal " Diagnosis of Liver Diseases using Machine Learning" 2017 International Conference on Emerging Trends & Innovation in ICT (ICEI) Pune Institute of Computer Technology, Pune, India, Feb 3-5, 2017, 978-1-5090-3404-8/17/$31.00 ©2017 IEEE.

7. Sa'diyah Noor Novita Alfisahrin. etal "Data Mining Techniques ForOptimatization of Liver Disease Clasification" 2013 International Conference on Advanced Computer Science Applications and Technologies 978-1-4799-2758-6/13 $31.00 © 2013 IEEE, DOI 10.1109/ACSAT.2013.81.

8. Manuel Grana. etal "Image Understanding Applications Of Lattice Autoassociative Memories" Ieee Transactions On Neural Networks And Learning Systems.

9. Yi-mingLei.etal"Cirrhosis Recognition of Liver Ultrasound Images Based on SVM and Uniform LBP Feature" 978-1-47--/1/ ©201 IEEE.

10. K. Fujino. etal "Liver Cirrhosis Classification on M-Mode Ultrasound Images by Higher-Order Local Auto-Correlation Features" Journal of Medical and Bioengineering Vol. 3, No. 1, March 2014.

11. Viviana Mihaela Bostan. etal "Creating a Model Based on Artificial Neural Network for Liver Cirrhosis Diagnose" The 9th International Symposium On Advanced Topics In Electrical Engineering May 7-9, 2015 Bucharest, Romania, 978-1-4799-7514-3/15/$31.00 ©2015 IEEE.

12. Temitopemapayi. Etal"Difference Image and Fuzzy C-Means For Detection Of Retinal Vessels" 2016 Ieee Southwest Symposium On Image Analysis And Interpretation (Ssiai). (2016).

13. Sen Qian. etal "Medical Image Segmentation Based OnFcm and Level Set Algorithm"2016 7th Ieee International Conference On Software Engineering And Service Science (Icsess).2016.

14. Maria Tsiplakidou.etal "Automated Hepatic Steatosis Assessment through Liver Biopsy Image Processing" 2016 Ieee 18th Conference On Business Informatics (Cbi). (2016).

15. Shuzo Kanasaki.etal "Diagnosis Of Liver Cirrhosis With The Use Of Multi-Detector Row Computed Tomography (Mdct): Morphological Approach And Quantitative Approach Using Statistical Geometric Hepatic Model" 2011 6th International Conference On Computer Sciences And Convergence Information Technology (Iccit). (2011).

16. Yu-Hsiang Wu.etal "Evolutionary Feature Construction For Ultrasound Image Processing And Its Application To Automatic Liver Disease Diagnosis" 2011 International Conference On Complex, Intelligent, And Software Intensive Systems (2011).

17. Omer Kayaalti. etal "Texture Analysis Of Liver Cirrhosis" 2010 15th National Biomedical Engineering Meeting (2010) .