LIVER IMAGE FEATURE EXTRACTION AND CLASSIFICATION TECHNIQUES FOR ANALYZING LIVER CIRRHOSIS

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Abstract: In this modern era, people suffering liver disease increases day by day. The liver affects different diseases like cirrhosis, hepatitis virus A, B, C, Cancer etc. Liver cirrhosis is the end stage of chronic liver disease. Steatosis or fatty liver is said to be the leading cause of cirrhosis. The greatest challenge lies in early detection of liver cirrhosis caused by Non Alcoholic Steatohepatitis (NASH) with higher classification accuracy. This paper reviews the current researches and development on different methods of liver feature extraction and classification techniques. The aim of this paper addresses the survey on various image processing techniques have been used on the advanced version of Adaptive Classifier to early detection of the liver cirrhosis caused by NASH.

***IndexTerms* - Steatosis; Feature Extraction; Texture Analysis; Classification.**

I. INTRODUCTION

In the human body, liver is a vital internal organ. It is a metabolic organ in the body and perform different functions that is produce a protein, cholesterol and bile acid. Liver's main job is to filter blood coming from the digestive tract, before passing it to the rest of the body. The liver affects different diseases like cirrhosis, hepatitis virus A,B,C, Cancer etc. Liver cirrhosis due to hepatic steatosis is a life threatening disease. Steatosis or fatty liver is said to be the leading cause of cirrhosis. The primary factor of liver diseases is excessive consumption of drugs, poison and drinking too much alcohol.

Liver cirrhosis due to hepatic steatosis is the end stage of chronic liver disease. Hepatic steatosis is the abnormal fat accumulation in the hepatic cells and the liver. Steatosis may be the result of a short-term or long-term condition, which by itself is not harmful, but may lead to different kinds of problems such as liver cirrhosis. Steatosis is a reversible condition that can be resolved with changed behaviours. The early detection of liver cirrhosis is important and there are chances of saving the liver from serious problems.

Medical imaging is an essential aspects of medical science for visualization of anatomical structures and functional or metabolic information of the human body. Liver cirrhosis is detected by various imaging techniques such as Computer Tomography, Ultrasound, and Magnetic Resonance Imaging. Among the several imaging modality, ultrasound is more accurately detected the cirrhosis. Image processing techniques are used to extract the features of hepatic steatosis and liver cirrhosis.

The gross morphologic appearance of a cirrhotic liver is categorized by the size of the parenchymal nodules such as micro nodular, macro nodular, or mixed. Micro nodular cirrhosis is characterized by regenerative nodules of relatively uniform and small size. In macro nodular cirrhosis, the parenchymal nodules are larger, and more variable in size. Image texture can be qualitatively defined in following categories of fineness, coarseness, smoothness, and surface granulation, randomness, irregular or hummocky. This irregular pattern is due to rough as well as scares on the surface of cirrhotic liver. The normal liver architecture is distorted by scar tissue which forms a band of connecting tissue joining the periportal and perivenous areas. It is often said that micro nodular cirrhosis may be converted into cirrhosis of macro nodular type.

Liver images have granular structures called texture. Normal liver usually differs with the diseased one in terms of intensity texture. Texture is a combination of repeated pattern with regular and irregular frequency. This variation helps in determining the corresponding disease. In the classification of liver cirrhosis, medical imaging techniques are plays an important role. Classifying a liver into normal liver and cirrhotic liver depends completely on the features of the liver.

Image processing technique has been used on the advanced version of adaptive classifier to early detect the liver cirrhosis caused by Non Alcoholic Steatohepatitis with high classification accuracy. Ensemble classification [17] refers to a collection of methods that learn a target function by training a number of individual learners and combining their predictions. An ensemble returns a class label prediction based on the collection of votes of its constituent classifiers. Hence, an ensemble is considered to be more accurate than its constituent classifiers. Generally, an ensemble has higher classification accuracy than its constituent classifiers. Hence, it is widely used for classification purposes. In this regard, a discussion is made to summarize different techniques used for extracting the features of hepatic steatosis and liver cirrhosis, and classifying liver diseases. This work has been proposed an idea to classify the liver images into normal liver and cirrhotic liver.

II. LITERATURE REVIEW

We briefly mention here some of the methods that have been used in the past for accurately predicting the liver cirrhosis caused by NASH (Non Alcoholic Steatohepatitis). In several liver imaging techniques, ultrasound is the least expensive but most precise tool for predicting liver abnormalities. Based on ultrasound images, a lot of liver texture analysis techniques have been proposed in the past. Several image feature analysis methods and different ensemble classification techniques are addressed in the literature survey.

A. Feature Extraction Methods

Feature extraction is a quantitative method that can be used to quantify and detect structural abnormalities in different tissues. In this section several fatty liver feature extraction methods and liver cirrhosis feature analysis techniques are mentioned.

1. Steatosis or Fatty liver Feature Extraction Methods:

Maria Tsiplakidou et al. [1] proposed an automated hepatic steatosis assessment through liver biopsy image processing. This methodology is developed in two stages. Initially, several image pre-processing steps are used to generate the image in which the fat detection and evaluation is made. In the second stage, some candidate image regions are tracked and then an initial check is carried out. Basically, the system involves the following steps such as i) Image acquisition ii) Image Pre-processing iii) Region of interest(ROI) selection v) Feature extraction vi) Finally, some initial check is carried out.

Hendrik Marsman et al. [2] came up with a strong association exists between steatosis in a donor liver and graft dysfunction after liver transplantation. Due to the growing shortage of donors, livers with increased fat content are being used more frequently for transplantation and carefully evaluating each donor liver before starting the transplantation procedure is crucial. In this paper, they compare the traditional visual estimation of liver steatosis by a pathologist with a measurement made by an automated image analysis system. They designed a 2-step study comprising (1) a prospective pilot study using a rat model of hepatic steatosis and (2) a retrospective clinical study using biopsy specimens obtained from cadaveric donor livers.

In the rat model of hepatic steatosis, they use an automated software to calculate the percentages of micro vesicular, macro vesicular, and total fat content of the digital pictures in each group were then determined. In the clinical study, obtained the percentages of micro vesicular, macro vesicular and total fat content from the pathologist's reports appearing in the hospital medical record. To identify a correlation between the determination of steatosis with the automated software and by the pathologist, data were analysed using the Pearson and rank correlation tests. A regression analysis was done to detect any association between the 2 determinations of steatosis. The result cannot differentiate the definitions of mild, moderate, and severe steatosis and also a very few moderately or severely steatotic livers were accepted for this study.

Giuseppa Esterina Liquori et al. [3] proposed an automated computerized methodology to assess the morphological and quantitative profile of fat liver accumulation, and provide novel insights into the clinico-pathological estimation of human liver steatosis. In the image analysis, lipid droplets are characterised by chromatic uniformity and circular shape. These features were used as discrimination criteria in developing algorithms for the automated image-processing software. The software operates the following three algorithms such as image conditioning, chromatic and morphologic analysis, classification and output generation. The results of image analysis are highly dependent on the quality of the histological specimens. They aimed to improve the currently available automated computerized methods by using semi-thin histological sections obtained from epoxy resin embedded samples, staining the sections with PAS-TB to label all cytoplasm areas not occupied by lipid droplets and using a specific software supplied with a morphological operator in addition to a chromatic one to select lipid droplets.

J. Kong et al. [4] develop a new computerized method for quantifying liver steatosis and to compare this method with other steatosis quantification methods, such as human scoring and radiology measurement. The degree of macro and micro vesicular steatosis is first estimated by visual inspection. Computer image analysis programs, referred to as algorithms, are then used to quantify the degree of steatosis in images of histology slides. In this study, white space has the usual appearance of what is typically considered steatosis, regarded by pathologists. They established an analysis pipeline consisting of four modules including whole slide image annotation, initial image region identification, tissue region transformation, and steatosis detection.

Scott Vander beck et al. [5] proposed method to test the hypothesis that decision support systems for pathologists, which include computational methods for quantification of the key histological features of NAFLD, more accurate and less variable scores and ultimately better phenotyping and improved patient outcome. Key liver biopsy features including macrosteatosis, central veins (CV), portal veins (PV), portal arteries (PA), sinusoids (SN) and bile ducts (BD). They compare the use of morphological features with the use of additional region properties. For that reason, feature vectors are created using only the morphological properties of the white region itself for comparison with other feature vectors that contain additional information about the texture and statistical properties of the white region and surrounding pixels. All supervised machine learning tasks are carried out with support vector machine.

Neogi N et al. [6] presented a method for classification of ultrasonography images of human fatty liver and normal livers using GLCM textural features. Further the classification is done with the help of Artificial Neural Network. For this purpose both unsupervised (using SOM) and supervised (using MLP) neural network used as classifiers simultaneously. SOM did not give better classification. MLP learning algorithm is the better classifier than the SOM. For classification, training and test data set were built with original features values and as well as pre-processed feature values.

Minhas Fu et al. [7] present a novel approach for detection fatty liver disease and heterogeneous liver using textural analysis of liver ultrasound images. In this paper, features are analysed using Wavelet Packet Transform. Here the obtained statistical features are classified using a multi - class linear support vector machine. The proposed system gives an overall accuracy of 95 percentages.

Andrade A et.al [8] came up with a novel approach for liver steatosis using ultrasound images. This paper presents a semi-automatic classification approach to identify fatty and normal liver. Several textural features have been extracted using First Order Statistics, Gray Level Run Length Matrix, Gray Level Co-occurrence Matrix, Laws texture energy and fractal dimension. Here a step wise regression has been used for the optimal feature selection. From the obtained features, three different classifiers such as Artificial Neural Networks (ANN), Support Vector Machines (SVM) and k-Nearest Neighbors (kNN) have been used to provide a binary representation of the classes in terms of normal and steatosis. The accuracy obtained in the three classifiers is 76.92 percentage for ANN, 79.77 pecentage for SVM and 74.05 percentage for k-NN.

Huang Y et al. [9] introduces a texture analysis method for ultrasonic liver images based on spatial domain methods. In this paper different liver features are achieved by using GLCM, gray level histogram and GLDS. Images were subjected for denoising and extracting different statistical features. Here the obtained statistical feature parameters are classified by using Neural Network. The Probabilistic neural network (PNN) was applied to classify the normal and fatty liver with accuracy rate of 82.5 percentage and 87.5 percentage for normal and fatty classes, respectively.

2. Liver Cirrhosis Feature Extraction Methods:

Sneha Chandra et al. [10] presented an advanced technology to early diagnosis of diseases with high classification accuracy. In this paper, image processing techniques are used which work upon the features of the diseases, either observed directly or through supportive medical tests such as ultrasound, to generate categories for the attributes of the sample medical datasets. In this work, Nave Bayesian Classification or Simple Bayesian Classification which assumes that the effect of an attribute value on a given class is independent of the values of the other attributes. Adaptive Classifier has been generated by applying the Bagging technique on Rule-Based Classifier, K-means Classifier, and Nave Bayesian Classifier.

A. Ahmadian et al. [11] proposed a new texture analysis method for categorizing different liver diseases using Gabor wavelet texture feature extraction method and classified ultrasonic liver images into normal, cirrhosis and hepatitis groups. Features were extracted and images were classified into different categories using dyadic wavelet transform, Gabor wavelet transform and statistical moments. The results clearly show that the Gabor wavelet is more effective for texture classification than dyadic wavelet and statistical based methods. One main reason for this is because the dyadic wavelet loses some middle-band information, while the Gabor wavelet preserves them. Using Gabor wavelet transform, the spatial frequency plane can combine logarithmic and uniform spacing. Therefore, a more flexible decomposition of the entire frequency band can be achieved which has led to a superior discriminative of texture information.

D. Balasubramanian et al. [12] came up with an automatic classifying system which classified liver into benign, malignant, cyst and normal liver images using texture features extracted through SGLDM, RUNL, TEM and Gabor wavelets techniques.For each of the feature set, optimal feature selection is carried out using manual search and automated PCA technique. PCA based features and manually selected features were classified by K-means clustering algorithm and BPN respectively. Classification results of BPN were better than Kmeans.

Yoo Na Hwanga et al. [13] focused on improvement of the diagnostic accuracy of focal liver lesions by quantifying the key features of cysts, hemangiomas, and malignant lesions on ultrasound images. In this study, textural features are extracted by using first order statistics, gray level co-occurrence matrix, Laws and echogenicity. Optimal feature selection is carried out by principal component analysis were used as a set of inputs for a feed-forward neural network. Here the classification carried out by a two-layered feed forward neural network (FFNN) with a sigmoid function. FFNN is widely used as a classifier for lesions since it has a simple structure but is robust against noise.

For each lesion, the performance of the diagnosis was evaluated by using the positive predictive value, negative predictive value, sensitivity, specificity, and accuracy. The results of the experiment indicate that the proposed method exhibits great performance, a high diagnosis accuracy of over 96 percentage among all focal liver lesion groups (cyst vs. haemangioma, cyst vs. malignant, and haemangioma vs. malignant) on ultrasound images. The accuracy was slightly increased when echogenicity was included in the optimal feature set.

Virmani J et al. [14] proposed a SVM - based characterization of liver ultrasound images using Wavelet Packet Texture Descriptors. In this paper the new methods proposed for characterization of normal liver, cirrhotic liver and hepatocellular carcinoma. Here feature extraction is carried out by using two dimensional Wavelet Packet Transform. Genetic algorithm - support vector machine feature selection method was used to optimal feature selection. A multiclass SVM classifier is implemented for classification of normal, cirrhotic and HCC liver. 88.8 percentages was the accuracy achieved by their method.

Karan Aggarwal et al. [15] introduced a new method to identify the liver cirrhosis with modified LBP grayscaling and Otsu binarization. Otsus method is a high speed and effective thresholding approach is applied for image binarization. This paper presents a technique for detecting the cirrhosis of the liver through ultrasound images. Here the modified LBP with OTSU approach was applied on the selected features of both normal and cirrhotic liver. The present research work is an effort to detect and classify liver cirrhosis based on their structure and texture pattern retrieved from USI. OTSU is additionally added to LBP generated weighted gray scale image. OTSU is doing its normal job but it is applied not to the original image but to the modified LBP image.

Alaleh Alivar et al. [16] came up with a new method to classify the liver diseases using ultrasound images based on feature combination. Here feature extraction is achieved through feature combination of spatial-domain based and transform-domain based features. In this paper they extract three feature vectors using Wavelet Packet energy feature vector, Gabor filter energy feature vector and GLCM features. The obtained features are classified by KNN classifier to determine whether it belongs to normal or cirrhotic liver and some measures are used to quantify the performance of the proposed algorithm.

III. CONCLUSION

In recent years, many existing techniques have been utilized for early detection and prediction of liver cirrhosis. In this paper we proposed a framework which can be used to depict the different feature extraction methods and classification techniques for identifying the cirrhotic liver. Here a comparative study is carried out after analysing various types of digital images of cirrhotic liver and by suitably applying image processing techniques. This technique is very useful for early detection of liver cirrhosis.

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