Early Detection of Liver Cancer using Soft Computing –A Review

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Abstract— Liver is the important parts of the human beings as well as a sixth dangerous disease in the world is liver cancer tumors. There are two types of liver tumors such as malignant and benign. The benign type of tumors is the initial stage tumors and they cause no harm but there is other type called malignant which is the advanced stage. So the detection and diagnosing of malignant tumor is very important. The early detection of liver cancer tumor is very essential to provide the timely treatment so that the probability of curing the disease increases. The manual analysis of the tumor samples is time overwhelming, inaccurate and needs very efficiently trained persons to avoid diagnostic errors. So based on all these parameters into consideration, a soft computing based image mining approach of detecting these tumors in early stage were proposed. The image mining techniques such as classification and clustering are applied with Soft computing techniques such as fuzzy sets, neural networks, genetic algorithms, and rough sets. The objective of this study is to improve the liver cancer prediction with the application of soft-computing techniques.

Key words: Soft Computing, Liver Cancer, Classification, Clustering, Image Mining

I. INTRODUCTION

Liver cancer is a chronic cancer which originates in the liver. Basically cancer has 2 phases, benign which is earlier stage and malignant which is advanced stage. The benign type of tumors is the initial stage tumors and they cause no harm but there is other type called malignant which is the advanced stage. So the detection and diagnosing of malignant tumor is very important. Liver tumor is presently the most advancing and one of the most prevailing cancers in the world. Generally tumors will be developed inside the body tissues without any pre-intimation. Hepatocellular carcinoma is the most common type of liver cancer [22]. Detection of the liver tumor at the early stage can increase the chance of survival. Due to lack of obvious symptoms and the internal location inside the body, liver cancer is difficult to be diagnosed at an early stage. Thus, most of the researchers had proposed Artificial Intelligence (AI) classification techniques for cancer diagnosis. These techniques have been proven in assisting the experts to facilitate their decision making process [16]. An accurate medical diagnosis of liver cancer is an essential and the early detection and prediction of liver cancer is very essential to provide the timely treatment so that the probability of curing the disease will become high and survival rate of the patient will become more [1]. The pain and toxicity can be minimized if the disease is found in initial stages. Screening is the most popular method to detect the disease in the early stages before the symptoms are shown. Since the disease diagnoses is a very challenging and important task, medical research fraternity has received enormous interest globally in this area [6]. Liver cancer tumor can identify by different techniques such as Ultrasound, Magnetic Resonance Imaging (MRI), Computed Tomography (CT) and Positron Emission Tomography (PET). It is necessary to use an image mining technique which helps in efficient and accurate prediction and diagnosis of liver cancer [5]. Medical image mining refers to the application of mining techniques on medical images. The main goal of medical image mining is to extract clinically relevant information from the medical images to assist the physicians in accurate diagnosis and detection of diseases. The image mining techniques such as Classification and clustering are used for suitably analyzing the medical images for the prediction of liver cancer. The fundamental objective of carrying out image classification or clustering in medical image mining is to analyze the image contents and classify them into appropriate disease categories [10], [15], [19].

Different clinical values for attributes and biomarkers have been taken as an input and match these with the reference values to predict the diseases accurately. The outcome of this would help doctors, scientists, pharmacists in understanding the characteristic and association of attributes which is responsible for these diseases and provide proper diagnosis method and in discovering new drugs. The early detection of liver cancer can be helpful in curing the disease carefully [9], [24].

In the following sections, section II presents a review of various liver cancer based papers and in Table-1 comparison of soft computing methods along with performance. Next in section III, processes of liver cancer prediction along with the diagram were explained. In section IV & V, soft computing techniques and Image mining techniques were discussed and in section VI, final conclusions were made and discussed.

II. REVIEW ON LIVER CANCER

The reviews on various soft computing based liver cancer disease research papers are described briefly as follows.

Due to lack of obvious symptoms and the internal location inside the body, liver cancer is difficult to be diagnosed at an early stage. The early detection and prediction of liver cancer helps in curing the disease completely. So the requirement of techniques to detect the occurrence of liver cancer in early stage is very essential.

Ulagamuthalvi et al. [1] proposed a automatic identification of liver tumor using support vector machine approach which uses ultrasound liver tumor images. The paper proposes SVM classifier for the automatic identification from different textural features method used for segmentation and classification and achieved a overall classification accuracy of 96.72%.

Manuel Cruz et al. [2] proposed decision system in liver transplants using multi objective evolutionary algorithm that maximizes the probability of survival and minimizes the

probability of non-survival. This is done with the two models of neural networks.

Ulagamuthalvi et al [3] presents liver cancer tumor segmentation using ultrasound images. This paper proposes full automatic region growing algorithm with texture parameters. High pass filter, histogram equalization and spatial information of pixels are used for segmentation.

Mangesh et al [4] discussed about soft computing techniques on medical data set and its comparison. The classification techniques use the WEKA tool for decision making in medical diagnosis. It is noted that KNN is the effective classifier for the analysis and diagnosis.

Classification is a process of data analysis used for extracting a model for learning and making the classes of given data objects, based on that prediction will be made for objects whose class label is unknown [4].

Wenli Lee et al [5] proposed an ensemble creation algorithm that can form an ensemble with high generalization performance. It also presents the feasibility of ensemble classifiers in characterizing ultrasonic liver tissue.

Tanupriya et al [6] presents about the soft computing applied to cancer. Soft computing techniques detects patterns from large ,noisy and complex data sets which makes well suited for medical applications that depend on complex, proteomic and genomic measurements and hence it is frequently used in liver cancer diagnosis and prediction.

Crez et al [7] presents multi –objective evolutionary algorithm and various techniques to select individuals from the pareto front to obtain artificial neural network models to aid decision making. The probability of graft survival will assist medical experts to achieve the best possible decision with the principles of efficiency and equity.

Xuechen li et al [8] proposed an automatic segmentation method for the liver cancer using fuzzy C means clustering to extract liver region automatically. The method achieves an accuracy of 99.86% and hence the method is more effective in dealing with over segmentation problem.

Crez et al [9] proposed the rule based system for the liver based problem solving to address the problem of organ allocation, the memetic Pareto evolutionary nondominated sorting genetic algorithm 2, a multi-objective evolutionary algorithm, was used to train radial basis function neural networks, where accuracy was the measure used to evaluate model performance, along with the minimum sensitivity measurement. The neural network models obtained from the Pareto fronts were used to develop a rule-based system. This system will help medical experts allocate organs.

M.Rajeshwaran et al [11] proposed a segmentation method for the liver cancer using support vector machine classifier which is considered to be a best method for identification of ultra sound liver tumor image to detect normal and abnormal condition.

Sharifa et al.[16] proposed the performance comparison of support vector machine and artificial neural network for liver cancer classification. It is noted that performance of SVM classifier is better than ANN classifier in terms of accuracy. It is noted that different ANN transfer functions and different SVM kernel functions can be used to improve the classifier performance.

Divya.V et al.[22] presents the classification of liver images to detect the stages using unsupervised classifier and abnormal detection through spatial Fuzzy clustering algorithm. It uses a segmentation method of Spatial Fuzzy C-Mean clustering algorithm, for segmenting computed tomographic images to detect the liver tumor in its early stages. The neural network will be used to classify the stages of liver tumor into benign, malignant or normal.

Marwa et al. [23] describes the application of adaptive neuro-fuzzy inference system (ANFIS) model for classification of liver tumor as benign or malignant by analyzing CT liver images. Decision making was performed in four stages. the adaptive neuro-fuzzy inference system (ANFIS) classifier is trained by texture features and Discrete Wavelet Transformation features separately is proposed to classify CT tumor images into two classes that are malignant and benign. It is noted that the DWT is more effective than traditional texture features.

III. PREDICTION OF LIVER CANCER

Predicting liver cancer by analyzing the related medical images is the proposed concept as shown in the figure-1. The early detection of liver cancer is very essential to provide the timely treatment so that the probability of curing the disease will be high. The Soft Computing methods provide solutions to liver cancer. The cancer image patterns are designed and these patterns are compared with the sample image data to find out the affected cancer patterns by applying the Soft Computing Techniques [3], [4], [15], [19].

The Soft Computing Techniques applied to medical images are used to predict the lung cancer. Also their comparisons are listed in the Table-1. By applying Suitable Clustering and classification techniques and their analysis gives the prediction of liver cancer.

Soft computing Methods used	Accuracy	Sensitivity	Image	Citation	Year
Support Vector Machine (SVM)	96.72%	NA	ultrasound	[1]	2012
Rule based system	97.60%	47.2%	CT	[2]	2012
Segmentation, Region Growing Histogram Equalization	92.34%	NA	ultrasound	[3]	2012
KNN	67.53%	NA	CT	[4]	2012
Fuzzy C means clustering	99.86%	99.89%	CT	[8]	2013

Artificial neural network	66%	55.76%	CT	[9]	2013
SVM Classifier	98.76%	95.67%	ultrasound	[11]	2014
SVM Classifier	63.11%	36.67%	CT	[16]	2014
ANN Classifier	57.28%	75%	CT	[16]	2014
Fuzzy c means, NN	86.895	67.88%	CT	[22]	2016
Fuzzy c means, texture features	90%	91.6%	CT	[23]	2016
Fuzzy c means, DWT features	96%	96.1%	CT	[23]	2016

Table 1: Soft-Computing Techniques & Performance

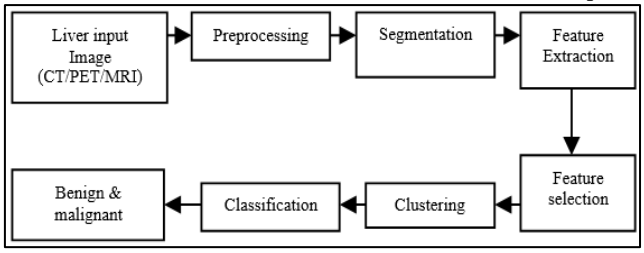

Fig. 1: Processes of Liver Cancer Prediction

IV. SOFT -COMPUTING TECHNIQUES

Soft computing is a combination of methodologies which works synergistically and provides flexible information processing potential for handling uncertain situations. Its aim is to exploit the tolerance for imprecision, uncertainty, approximate reasoning, and partial truth in order to achieve tractability, robustness, and low-cost solutions Principal Soft computing techniques includes fuzzy sets, neural networks, genetic algorithms, and rough sets are most widely applied in the medical image mining. Soft computing is a consortium of methodologies that provides flexible information processing capability. Soft Computing played an important role in early detection and diagnosis of liver cancer diseases analytically with improved effectiveness and suitable accuracy with the help of methods and proper attributes reference value [4],[12],[25].

V. IMAGE MINING TECHNIQUES

The image mining techniques such as Classification and clustering are used for suitably analyzing the medical images for the prediction of liver cancer. The fundamental objective of carrying out image classification and clustering in medical image mining is to analyze the image contents and classify them into appropriate disease categories [24, [25].

VI. CLASSIFICATION

Classification is a process of data analysis used for extracting a model for learning and making the classes of given data objects, based on that prediction will be made for objects whose class label is unknown. The classification is done in main two steps: training data and testing data [4].

Thus, most of the researchers had proposed Artificial Intelligence (AI) classification techniques for liver cancer diagnosis. These techniques have been proven in assisting the experts to facilitate their decision making process. There are many types of AI classification techniques have been used for liver cancer diagnosis such as Genetic Algorithm (GA), Fuzzy Set (FS), Artificial Neural Network (ANN), Support Vector Machine (SVM) and Rough Set (RS). Classifiers are used to classify the cancer data as benign tumors (non-cancerous) or malignant tumors (cancerous). Recently, ANN and SVM are the classifiers that have been widely used by the researchers for liver cancer classification due to their good classification accuracy performance [7], [13], [16], [18]

A. Clustering

Clustering is a common technique for statistical data analysis, which is used in many fields, including machine learning, data mining, pattern recognition, image analysis and bioinformatics. Clustering is an unsupervised classification technique used for grouping the images into various decease classes. The selection of appropriate method for clustering is an important task in medical diagnosis and the choice of efficient clustering method should be done carefully to suits the desired task. Among the fuzzy clustering methods, fuzzy c-means (FCM) algorithm is the method used in image segmentation because it has robust characteristics for ambiguity and it has a good performance in a large class of images. The k-Means clustering algorithm is one of the most commonly used methods for partitioning the data. A fuzzy clustering method assigns degrees of membership in several clusters to each input pattern. A fuzzy clustering can be converted to a hard clustering by assigning each pattern to the cluster with the largest measure of membership [12], [13], [22].

– Accuracy

Accuracy of a classification algorithm is nothing but the number of correctly classified instances. Accuracy of classifier is given by Higher the accuracy, that classifier is more effective

– Sensitivity

In medical research, sensitivity is used to measure the percentage of correctly classified benign tumors. It estimates the classifier's performance on different classes.

– Segmentation

Segmentation is played an important role in image processing. Image segmentation refers to the process of partitioning an image into groups of pixels which are homogeneous with respect to some criterion. The result of segmentation is the splitting up of the image into connected areas. Thus segment is concerned with dividing an image into meaningful regions. The image segmentation techniques such as thresholding , region growing, statistics models, active control modes and clustering have been used for image segmentation because of the complex intensity distribution in medical images, thresholding becomes a difficult task and often fails. Fuzzy c means algorithm is used for the segmentation of ultrasound images to increase detection rate.

Ultrasound image Segmentation is very difficult because of poor quality [8], [9], [11].

VII. CONCLUSION

Early detection and prediction of liver cancer can be helpful in curing the disease. So the requirement of techniques to detect the occurrence of liver cancer tumor in early stage is increasing. Soft computing methods based on image mining can help to make the prediction of liver cancer diseases more reliable, more effective and efficient. The methods such as support vector machine and artificial neural network classifiers gives the better performance in diagnosis and prediction of liver cancer. It is noted from the performance table that better accuracy can be achieved by using the methods such as support vector machine, Fuzzy c means and rule based system. Different ANN transfer functions and different SVM kernel functions can be used to improve the classifier performance. Hence it helps doctors in making diagnosis, prediction and decision making most accurate and efficient.

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