Volume 3, Issue 10, October 2013 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Review of CAD Techniques for Liver Tumor Detection

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Abstract -The incidence of liver tumor has increased many folds. Estimated liver cancer death per 1000 in men is 14.0 in 2010 and in women is 11.5. Detection of tumor based on analysis by a radiologist has its own disadvantages of human error creeping as the liver tumor grows from stage one to stage four. The chances of survival highly depends on early detection tumor and than classification as Malignant (cancerous) and Benign (non cancerous) tumors. In this paper an effort has been made to review the existing CAD techniques to find out technique giving best result in term of computational time, sensitivity, specificity and accuracy so that is required some changes can be made or suggested to further impose the result.

Key words – Benign (hemangioma), hepatocellular carcinoma (HCC), Metastasized, Particle Swarm Optimization (PSO), Seeker Optimization algorithm (SOA),

I. INTRODUCTION

The body is made up of trillions of living cells. Normal body cells grow, divide into new cells, and die in an orderly fashion. Cancer begins when cells in a part of the body start to grow out of control. There are many kinds of cancer, but they all start because of out-of-control growth of abnormal cells. Cancer is one of the leading causes of adult deaths .In India, the international agency for research on cancer estimated indirectly that about 6,35,000 people died from cancer in 2008, representing about 8% of all estimated global cancer deaths and about 6% of all deaths in India. In 2010, more than 5,56,000 cancer deaths were estimated in India for people of all ages, and 71·1% occurred in people aged 30–69 years [1]. Accurate detection of liver cancer is more important than treatment planning. In an attempt to achieve accuracy, computational time must also not be compromised. To fulfill these requirements computer assisted analysis is required.

Medical image processing has become an essential component in many field biomedical applications such as tumor detection, automatically determining the volume of a heart chamber, screening lung scans for possible disease. S.Priyadarsini and Dr.D.Selvathi present a paper "Survey on Segmentation of Liver from CT Image"in IEEE international conference on Advance communication control and computing technologies, 2012. They illustrate that Segmentation of liver from images of the abdominal area is critical for diagnosis of tumor and for surgical procedures. The various approaches used for liver segmentation are Threshold based, Model based, Level Set based, Region based, Active contour, and clustering based. The manual segmentation of the liver is very time consuming, and hence concentrate on automatic segmentation. The merits and demerits of various automated techniques for Liver segmentation are analyzed in detail. They concluded that several novel hybrid approaches may be developed [2].

Pavlidis in 1988, Haralick and Shapiro in 1985, Pal and Pal in 1993, concluded in their papers that Efficient image segmentation is one of the most critical tasks in automatic image processing[3][4].

Marius George Linguraru presents a paper "Tumor burden analysis on computed tomography by Automated Liver and Tumor Segmentation" at IEEE transactions on medical imaging. In this paper they had concluded that Computed tomography is commonly adopted for imaging abdominal organs for diagnosis and preoperative planning. The automated computer-aided diagnosis (CAD) of livers from medical scans can provide quantitative data. The automated segmentation of livers is addressed first. From an initial segmentation of the livers, the areas of atypical local shape are determined using training sets. Liver segmentation errors are reduced significantly and all tumors are detected [5].

There are many Neural-network-based image segmentation techniques such as Hopfield neural networks model. Traditional fuzzy Hopfield neural network (FHNN) is one of the excellent segmentation methods for CT image. Although FHNN has the capacity of searching values with high precision, it has obvious disadvantages, such as local minimum and slow convergence. In order to make up these shortcomings and find the right global minimum, a FHNN Algorithm based on genetic approach is proposed in the paper "CT Image Segmentation by using a FHNN Algorithm Based on Genetic Approach" published by Jia Xin-Wang, Ting Ting-Zhang, at 3rd Bioinformatics and Biomedical Engineering, June 2009. Genetic Algorithms (GAs) can successfully search values in complicated, enormous and multimodal space. At the same time, it is able to provide robust, fast and close approximate solution to fitness function of an optimization problem [6].

Liu Jian-hua in the paper "Contour correction liver cancer CT image segmentation method based on Snake model" discuss about to segment CT (computed tomography) images of liver cancer effectively. A new method based on Snake model was proposed. Image segmentation based on threshold was combined with image segmentation based on Snake model, and a contour correction process was added. It has been used to overcome optimization problems [7]. With the numerous recent developments of new segmentation methodologies, the requirement of their categorizations based on successful applications have become essential. Therefore, the first objective of this paper is to categorize the technologies of image segmentation by conceptualizing the implementation details. After that use optimization algorithm to provide high robust, fast and close approximation solution .Neural network is used to classify the tumor. Rest of the review paper is organized as follows. Section 2 as per the existing review papers discuss about segmentation approaches. Section 3 describes the optimization techniques for medical images. Section 4 states the review papers on neural network over medical images.

II. SEGMENTATION APPROACHES

In the medical sector, segmenting the liver is difficult since the image includes intensity homogeneities of other organs like kidney, spleen and pancreas. In MRI and CT images regions that appear homogeneous have similar anatomical information, while other imaging techniques such as dynamic positron emission tomography (dPET) or dynamic single photon emission computed tomography (dSPECT) give homogeneous regions with similar functional behavior. To manually segment an image is usually time-demanding and it also suffers from both inter and intrapersonal variations.

Image segmentation is the division of an image into regions or categories, which correspond to different objects or parts of objects. Every pixel in an image is allocated to one of a number of these categories. A good segmentation is typically one in which: Detecting Discontinuities, Detecting Similarities. Different approaches of segmentation are:

A. Region Based Segmentation Methods
B. Thresholding Method
C. Level set approach
D. Model Based approach
E. Graph cut

Segmenting images with level set methods was introduced at the end of the 1980’s and was based on previous work on moving curvatures. Since then several variants and improvements have come up. Some of the improvements are aimed at speeding up the processing. Other methods have strength related to specific challenges like noise and broken edges. Edge detection method attempts to resolve image segmentation by detecting the edges or pixels between different regions that have rapid transition in intensity are extracted and linked to form closed object boundaries. The result is a binary image. Histogram based approaches is one example of segmentation based on edge detection**.** Fully automatic liver segmentation using histogram tail threshold algorithm to segment the liver region by eliminating neighboring abdominal organs of the liver, such as the pancreas, spleen and kidneys [8]. Image segmentation by thresholding is a simple but powerful approach for segmenting images having light objects on dark background. The liver is segmented using global thresholding [9]. Later, some morphological operations are applied on the image to obtain the final segmented liver region. To select a global threshold value for the whole CT image is a drawback of this approach. A fixed threshold cannot be used for liver segmentation because the liver intensity differs according to the patient slice and the CT machine. The liver segmentation is also done with adaptive threshold techniques. The advantage of approach is that different threshold is used for different regions in the image [10].

Enhanced k-means clustering algorithm is implemented for liver segmentation. The system combines K-means is one of the simplest unsupervised learning algorithms that classify a given dataset into certain number of clusters. The main idea is to define K -centroids one for each cluster. The drawback of this K-means clustering, cyst region was not extracted properly. To improve its performance morphological opening by reconstruction operation is applied on the output of K-mean clustering algorithm. The main advantage of this approach is enhanced k-means clustering method better performance than region growing for cyst area segmentation in liver images. Fuzzy C means FCM clustering method for liver tumor segmentation is not very effective with noisy or outlying points and with clusters of different volume and unequal sample sizes [11]. To overcome these problems, an alternative FCM clustering algorithm is used. Alternative Fuzzy C Means (AFCM) is a segmentation algorithm that is based on clustering similar pixels in an iterative way, where the cluster centers are adjusted for all iterations. Region-based segmentation schemes attempt to group pixels with similar characteristics into regions. Conventionally, these are global hypothesis testing techniques. The process can start at the pixel level or at an intermediate level. Generation and filtering of good seed regions of high confidence is essential. The region-growing based approaches can provide good results on contrast enhanced images. These methods generally starts with the provision of a small region as seed point and proceeds with the addition of the neighboring voxels, which are of homogeneous intensities, iteratively to the grown region. This continues until the segmented region is accurately obtained. Given initially poor or incorrect seed regions, these techniques usually do not provide any mechanism for detecting and rejecting local gross errors in situations such as when an initial seed region spans two separate surfaces. There are two approaches in region-based methods: region growing and region splitting. In the region growing methods, the evaluated sets are very small at the start of the segmentation process. The iterative process of region growing must then be applied in order to recover The surfaces of interest in the region growing process, the seed region are expanded to include all homogeneous neighbors and the process is repeated. The process ends when there are no more pixels to be classified. Because initial seeds are very small, the processing time can be minimized by minimizing the number of times an image element is used to determine the homogeneity of a region. In region splitting methods, on the other hand, the evaluation of homogeneity is made on the basis of large sets of image elements. The process starts with the entire image as the seed. If the seed is in homogeneous, it is split in to a predetermined number of sub regions, typically four. The region splitting process is then repeated using each sub region as a seed. The process ends when all sub regions are homogeneous. Because the seeds being processed at each step contain many pixels, region splitting methods are less sensitive to noise than the region growing methods [12].

III. OPTIMIZATION ALGORITHMS ON MEDICAL IMAGES

In mathematics optimization is the selection of best element from some set of available alternative. Optimization problem consist of maximizing or minimizing a real function by systematically choosing input value from within an allowed set and computing the value of function. Sahar Yousefi, Reza Azmi in their paper "comparison and evaluation of three optimization algorithm in MRF model for brain tumor segmentation in MRI" discuss that MRF has been one of the most active research areas of MRI brain segmentation which seeks an optimal label field in a large space. The classical optimization algorithm is Simulated Annealing (SA) that could get the global optimal solution with heavy computation burden. This paper Results indicated that the MRF-SA-IGA approach outperforms two other methods in convergence speed and accuracy [14]. Liu Jian-hua et al in paper "Contour correction liver cancer CT image segmentation method based on Snake model" discussed on CT images of liver cancer effectively based on Snake model. Image segmentation based on threshold was combined with image segmentation based on Snake model, and a contour correction process was added. This method obtains a better result on liver cancer CT images segmentation [13].

N. Nandha Gopal, Dr.M.Karnan in paper "Diagnose Brain Tumor Through MRI Using Image Processing Clustering Algorithms Such As Fuzzy C Means Along With Intelligent Optimization Techniques" proposed a new CAD System for verification and comparison of brain tumor detection algorithm. PSO and GA automatically determine the optimal threshold value of given image. A novel approaches to segmentation using image processing clustering algorithm such as Fuzzy C Means and optimization tools such as GA and PSO were proposed [15].

IV. NEURAL NETWORK OVER MEDICAL IMAGES

An Artificial Neural Network (ANN) or commonly known as Neural Network (NN) is an interconnected group of artificial neurons that uses a mathematical or computational model for information processing based on a connectionist approach to computation. In most cases an artificial neural network is an adaptive system that changes its structure based on external or internal information that flows through the network. Neural network is used to classify the type of tumor.

The neural network was trained with training sample set in order to determine the connection and weights between nodes. Then the new images were segmented with trained neural network, for example, we can extract image edges by using dynamic equations which direct the state of every neuron towards minimum energy defined by neural network. Neural network segmentation includes two important steps feature extraction and image segmentation based on neural network. K.Mala et. al in paper "Neural Network based Texture Analysis of Liver Tumor from Computed Tomography Images", discussed the general CAD system for liver diseases can be divided into three parts. The first part is the extraction of the liver image from CT abdominal image. The second part is the suitable feature extraction from the liver image to characterize the different liver tissues. The third part is the classification of the liver diseases [16].

V. CONCLUSION

This paper concludes the reviews on medical image segmentation, optimization algorithms and neural network for classification process**.** Different segmentation approaches exists and each had their own merits and demerits. According the requirement of medical image segmentation method is selected. Different types of tumor exist and Neural network is used for training process for classification of tumors. Optimization refers to the art and science of allocating scarce resources to the best possible effect. Artificial neural networks, on the other hand process information the way biological nervous systems, such as the brain, for optimal decision making. Certain characteristics of their architecture and the way they process information makes them superior to conventional techniques on certain class of optimization problems.

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