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Image Segmentation Based Survey on the Lung Cancer MRI Images

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Abstract: Differentiating cancer affected part in lungs and giving proper solution to the problem are toughest job in medical field. Doctors face many problems in correctly spotting up of cancer affected area in lungs. Image processing can be a solvent for this type of issues, especially to identify the cancer affected areas in lungs. Historical data of different types of lung cancer images are collected and image processing methods are carried out for the identification of cancer affected regions in the lungs by the physicians and experts. This research work carried out a survey on the lung cancer data analysis done by various researchers. Also, it suggests the best method and technique applied for the prediction of cancer in the affected parts of lungs.

Keywords: Image Segmentation, Lung Cancer Data, Image Clustering, k-Means Clustering, Fuzzy C-Means Clustering

I. INTRODUCTION

Image processing is one of the core area used for various domains to identify cancer affected regions in lungs of MRI images. Identification of cancer affected parts in lung is mainly initiated with image processing techniques such as noise removal, feature extraction, identification of affected regions and possible comparison with historical data of lung cancer. Usually, digital image processing follows many techniques to unite different shapes in image into single unit. In this article, it is followed with clever bit technique for identifying particular region in the lung image. The region identified through the segmentation technique can be viewed from different angles and with different lighting. The basic advantages in choosing the technique is to identify, color difference between cancers affected region and those not affected parts by finding the intensity of images.

The human visual system performs special tasks for identifying color difference between cancer affected area and not affected area in the lung image. Very skilful programming and lots of processing power are necessary in identification of color difference. Manipulations of data in the form of an image through several possible techniques are very essential for identification of color through image segmentation techniques. An image is usually interpreted as a two-dimensional array of brightness values, and is most familiarly represented by such patterns as those of a photographic print, slide, television screen, or movie screen. An image can be processed optically or digitally with a computer. Image processing has the combination of various artificial intelligence areas like fuzzy logic, pattern recognition and machine learning. The essential technique, (Image processing) is carried out for segmenting the images and used for further process. The image segmentation layers can be differentiated as understanding image, analysis image and processing of image. Various methodologies are carried out to extract the cancer affected part in the lung. This research work discusses about the different research articles that are carried out by various researchers in the literature.
The organization of the paper is structured as follows. Session 2 discusses about introduction and some of the related papers of image segmentation. Session 3 explores the lung cancer image segmentation in detail. Finally, section 4 concludes the research work based on the results of related works of the previous papers.

II. IMAGE SEGMENTATION TECHNIQUES

Image processing follows various steps in processing cancer affected parts of lungs. Image segmentation plays a major role for every image processing process. In image segmentation process, the digitally converted lung image has to be divided into various regions. Usually an image segmentation technique identifies objects, sets boundary and identifies other relevant regions in the image. This survey focuses on various steps involved in images segmentation and researchers work on lung cancer images. The image segmentation can be categorized into six major types, which is very clearly shown below.

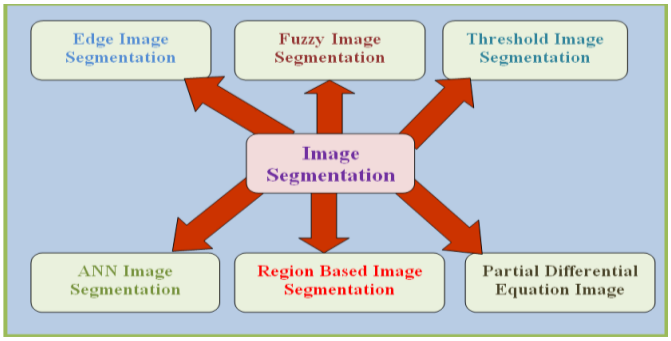

Figure 1: Image Segmentation types

2.1. Edge Image Segmentation

Edge or Corner boundary is a part or region between two different regions, mostly defined with gray scale level. Detection or identification of corners is carried out with identified object borders which are surrounded, which also helps in detecting intensity value of an image. Corner identification technique is the most essential part for analyzing an image and recognition of patterns. Corner identification provides a physical extent to the object and follows different detection methodologies as follows:

Roberts Edge Detection: Roberts's Edge detection is one of the oldest image processing edge detection technique stated by Lawerence Roberts in the year 1963. The edge detection

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operator used by Roberts is very simple, quick to execute and very easy to measure 2-D spatial gradient of an image. The operator also gives highlighted regions for high spatial gradient regions which often correspond to edges. The Roberts operator uses grayscale image for processing and provides the resultant images in grayscale. Absolute magnitude spatial gradient points are calculated from the output image pixel [1].

Sobel Edge Detection: Sobel edge detection is referred with the author Irwin Sobel and it is also called as Sobel filter. It has two masks, in which one is horizontal and other one is vertical. Generally 3*3 metric masks are used. Standard Sobel operators, for a 3×3 neighborhood, each simple central gradient estimate is vector sum of a pair of orthogonal vectors. Each orthogonal vector is a directional derivative estimate multiplied by a unit vector specifying the derivative's direction. The vector sum of these simple gradient estimates amounts to a vector sum of the 8 directional derivative vectors. Thus for a point on Cartesian grid and its eight neighbors having density values as shown: [2]

Prewitt Edge Detection: Corner detection or Edge detection algorithm is most popular Prewitt Detector technique used in image processing. It is also known as Discrete Differentiation operator. Gradient of the image intensity function is calculated by using it. Applying a horizontal and vertical filter in sequence Prewitt Edge filter detects edges. These two basic convolution filters are applied to the image and summed to form the final result [3].

Fuzzy Image Segmentation : Liu Yucheng [4] introduced fuzzy image segmentation algorithm which uses morphological opening and closing operations to enhance the image and perform the gradient operations on the resultant image [5]. Then compare the fusion algorithm with Watershed algorithm [6] and Prewitt methods, which found that fusion approach gives solution to the problem of over-segmentation of Watershed algorithm. It also saves the information about image and also improves the speed.

Syoji Kobashi [7] used fuzzy image segmentation (scale based) and fuzzy object model to segment the cerebral parenchyma region of new born brain MRI image. In first step Foreground region is separated, next correction of MRI intensity in-homogeneity is performed and then scale-base Fuzzy Object Model (FOM) is applied on resultant image. Results of proposed method are evaluated on the basis of Fast Positive Volume Fraction (FPVF) and Fast Negative Volume Fraction (FVNF). Results from experiment have shown that FOM (Fuzzy object model) has attained minimum FPVF and FVNF values. RefikSamet [8] proposed a new Fuzzy Rule based image segmentation technique to segment the rock thin segment images. RGB image of rock thin segment is taken as input and segmented mineral image is given as output. Fuzzy C Means is also applied on rock thin images and results are compared with both techniques. The researchers take sample image from minerals and features are distinguished on the basis of red, green and blue components of image.

2.2. Threshold Image Segmentation

In image segmentation, Threshold method technique is widely used. It is mainly used to discriminate foreground from background. In this method, a grey scale image is converted into binary image. The binary image contains all the necessary data regarding location and shape of the objects. Conversion to binary image is useful because it reduces the complexity of data. Threshold methods are as follows:

Global Thresholding: In the global thresholding, the intensity value of the input image should have two peak values which correspond to the signals from background and objects. It shows the degree of intensity separation between two peaks in an image.

Variable Thresholding: In variable thresholding, we separate the foreground image objects from the background, based on the intensities of each region.

- Local or regional thresholding.
- Adaptive thresholding.

Multiple Thresholding: Multiple thresholding can be defined as that segments a grey level image into several distinct regions [9]. . It defines more than one threshold for the given image and divides the image into certain brightness regions and it corresponds to the background and several objects.

Artificial Neural Network Image Segmentation

Wencang Zhao [10] proposed a new image segmentation algorithm based on textural features[11] and Neural Network[12] to separate the targeted images from background. Dataset of micro-CT images are used. De-noising filter is used to remove noise from image as a pre-processing step, Feature extraction is performed next, and then Back Propagation Neural Network is created, and finally, it modifies the weight number of network, and save the output. Proposed algorithm is compared with Thresholding method and Region Growing method. Based on speed and accuracy of segmentation, results shows proposed technique outperforms other methods .Lijun Zhang [13] proposed image segmentation based on neural network system with color images. They combined the Wavelet Decomposition and Self Organizing Map (SOM) to propose a new method, i.e., SOM-NN. Voting among child pixels selected the parent pixel. After initialization, ANN found the segmentation result which satisfies all levels. Wavelet decomposition is performed to remove noise. Hence wavelet decomposition and SOM-NN are combined to perform segmentation. Results have shown that the used methods has reduce noise and produce accurate segmentation. Shohel Ali Ahmed [14] proposed Image Texture Classification technique based on Artificial Neural Networks (ANN). Initially, image is captured and pre-processing is performed, then feature extraction process is carried out [15] is performed, whereas, ANN classifier [16] is used for texture classification, Clustering is performed to separates background from sub-images. Trained ANN combines the input pixels into two clusters which gives results with texture classification and segmentation of image as a ANN product.

2.3. Region Based Image Segmentation

Region Based segmentation is defined as a segment that produces similar image into various regions. It is used to determine the region directly by using grey values of the image pixels and portioning is done. Two basic techniques of region based segmentation are given below.

Region Growing Methods: Region growing is a technique that groups pixels or sub regions into larger regions based on predefined criteria. The pixels aggregation starts with a set of seed points in a way that the corresponding regions grow by appending to each seed points those neighboring pixels that have similar properties like grey scale, color, texture, shape etc. [17]

Region Splitting and Merging: In case of region splitting, the whole image is taken as a single region and then this region is being break into a set of disjoint regions which are coherent with themselves. Region merging opposes Region Splitting. A merging technique is used after each split and compares adjacent regions and merges them. It starts with small regions and merge the regions which have similar characteristics like grayscale, variance etc.

2.4. Partial Differential Equation (PDE) Image

Jinsheng Xiao [18] proposed a new non-linear discontinue partial differential equation (PDE) that models the level set method of gray images. A discrete method is also proposed to find numerical solution and to implement the filter.Non-Linear discontinue PDE formula is applied on image of cameramen using MATLAB. Results have shown that image edges and boundaries are remained blurred and can be shifted by using Close operator. More information can be saved by using the proposed scheme. Fengchun Zhang [19] presents a variation model using 4th order PDE with 2nd order PDE for finger vein image de-noising. Midpoint Threshold segmentation technique is used to extract the region of interest accurately. Fourth order PDE has reduced the noise very well, whereas 2nd order PDE has approximated the boundaries effectively. It can be observed from experiments that PSNR value of proposed method increases by 2 dB. This method is compared with threshold based segmentation algorithm and it is found that proposed method has segment the real finger vein image accurately. Chun Yuan[20] proposed a new segmentation model for color images. This model is based on Geodesic Active Contour (GAC) model. But GAC is only restricted to gray scale images. Therefore this model has an extension of GAC model, and known as color-GAC model. It uses the expression of the Gradient of color image.

2.5. Clustering Based Segmentation

Clustering based image segmentation segments images at grey level. It is easy to apply directly and can be extended to high dimension. Clustering is also applicable in multispectral and images in color.

III. IMAGE SEGMENTATION OF LUNG CANCER DATA

Nikhil R Pal [21], Edge Detection Method displays gray scale images depends on discontinuity detection, generally with less or more rapid gray level changes. This approach works with human predictive objects and aims to findthe excellent region disparity in image processing. V.K. Dehariya [22] uses the various peaks in images with corresponding regions. Computational time and image complexity for given image are reduced by applying this method. Rastgarpour M [23] assembles pixels in uniform regions and counts the region growth, split value, and merging their permutation. This method works well if homogeneity region norm in plain less image and removes irrelevance in image. Image noise removal technique followed in this paper is comparably stronger than Edge Detection method. Yang Yang [24] uses fuzzy operators, mathematics, properties and inference rules and give a mode to handle the uncertainty inheritance range in troubles, because of ambiguity instead of randomness. T.F. Wang [25] extends training period in working with image and finds that the initialization might affect the outcome problem as shown in Table 1.

Table 1: Image segmentation of lung cancer data

Authors	Segmentation Method	Description of Method	Benefits of Method	Findings/ Results
Nikhil R Pal et.al.[21]	Edge Detection Method	Displays gray scale image level changes	Human preferred objects can be implemented with fine region arrangements.	Edges are not clearly define Very difficult to form a boundary for images, but irrelevance in image can be removed.
Xu, Lei, et. al. [26]	Edge Detection Method	Initially a straight line is taken and Randomized Hough Transform (RHT) procedure is implemented on various curves.	Randomly pick two or n pixels and map them into one points in the parameter.	A curve expressed by a n parameter equation, instead of transforming one pixel into an n-1 dimensional hyper surface in the parameter space.
V. K. Dehariya et.al.[22]	Thresholding Method	Image peaks are corresponds to particular regions in image.	Image knowledge is not needed and computational time is reduced.	Doesn't work properly in nice image peak and plane images. No continues segmentation of regions is performed.
W. Jentzen., et al. [27]	Thresholding Method	Optimum threshold obtained from the adaptive thresholding method requires a priori estimation of the lesion volume from anatomic	These findings are associated with the limitation of the ITM. The ITM is especially useful for	Phantom data analysis showed that the *S/B*-threshold-volume curves of 18F-FDG and 124I were similar.

		images such as CT.	lesions that are only visible on PET.	
Rastgarpour M. et.al.[23]	Region Dependent Method	Separating, Counting, Merging and assembling pixel are performed.	More effective noise detection technique than Edge Detection method	Deals with computational time and segmentation based on splitting emerge pixel.
U. Nestle, et. al. [28]	Region Dependent Method	Data on the primary tumors of 25 patients with NSCLC were analyzed. They had F-FDG PET during initial tumor staging.	The different techniques of tumor contour definition by F-FDG PET in radiotherapy planning lead to substantially different volumes, especially in patients with inhomogeneous tumors	We found substantial differences between the 4 methods of up to 41% of the GTV vis. The differences correlated with SUV max, tumor homogeneity, and lesion size.
Yang Yanget.al.[24]	Fuzzy Method	Fuzzy operators, mathematics and implementation rules	Fuzzy membership function could be utilized to show the degree of few properties	Calculation occupied in fuzzy approaches could be intensive
Brown, M.S et. al. [29]	Fuzzy Method	Nodules are detected from among the opacities, modeled as inside the lung. Morphologic closing is applied to the lung so that nodules that contact the chest wall are enclosed.	An automated system was developed for detecting lung micro nodules on thin-section computed topographic images and was applied to data from 15 subjects with 77 lung nodules.	Images from 15 subjects that were not part of the development set were used to test the system. Among these images, the truth committee determined that there were collectively 57 micro nodules smaller than 3 mm and 22 nodules larger than 3 mm
Hill, D. L., et. al [30]	Fuzzy Method	The word registration is used with two slightly different meanings. The first meaning is determining a transformation that can relate the position of features in one image or coordinate space with the position of the corresponding feature in another image or coordinate space.	Many registration algorithms involve iteratively transforming image A with respect to image B while optimizing a similarity measure calculated from the voxel values.	The classical Procrustes problem, i.e. $T \in$ {rigid body transformations} has known solutions. A matrix representation of the rotational part can be computed using singular-value decomposition (SVD)
Kuhnigk, J. M., et. al [31]	Fuzzy Method	The exact localization of the lobe-separating fissures in CT images often represents a non-trivial task even for experts. Therefore, a lung lobe segmentation method suitable to work robustly under clinical conditions must take advantage of additional anatomic information.	Lung segmentation procedure is fully automated and therefore does not add to the user input necessary for the lobar segmentation. Since other methods exist to fulfill this task and we would rather focus on the lobe segmentation.	The preliminary intra- and inter-observer studies conducted already indicate a low variability (Similarity > 99.5%) of the generated results.
T.F. Wang et.al.[25]	Neural Network Method	Classification, Clustering and Neural Network are used.	Could entirely exploit the parallel nature of neural net.	Initialization might affect the outcome.

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IV. CONCLUSION

Image segmentation is the most important part of image processing techniques. This paper shows a clear cut idea for researchers to carry out research in image segmentation. This article also focuses on existing work carried out in this broad area of image segmentation. It also provides lot of ideas about measurements and methods used by the image segmentation researchers with description of each and every researchers

view. Hence, this work concludes that most of the researchers states fuzzy approaches give better results for any kind of image processing data.

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