SURVEY ON SEGMENTATION TECHNIQUES FROM ULTRASOUND IMAGES

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Abstract: There are many segmentation techniques in the field of image processing,especially in domain of segmentation.The purpose of image processing is to segment the image into regions.This paper outlines on number of segmentation techniques like region based,threshold based,contour based and machine learning techniques.

Index Terms - Convolutional Neural Networks (CNNs),Fully Convolutional Network(FCN).

I. INTRODUCTION

Segmentation is most important part of image segmentation.The objective of image processing is to extract useful information from the images.The segmentation divides the images into objects or regions.Segmentaion is unsupervised learning in machine learning.

II. CLASSIFICATION OF TECHNIQUES:

1. REGION BASED SEGMENTATION TECHNIQUES

1.1. Region Growing:

In region-based image segmentation, region growing is one of the simple method.Pixel- based image segmentation method is the other name for this technique since it involves the selection of initial seed points. Region growing image segmentation technique inspects neighboring(adjoining) pixels of initial seed points and decides whether the adjoining pixels (the neighbors) should be added to the region. The process is iterative and is similar to general data clustering algorithms.

Issues faced in region growing image segmentation technique

1.The appropriate seed points selection is important:

The seed points are to be selected by the user.

2.Ample amount of image information is necessary:

The connectivity information or pixel adjacent information is helpful for us to decide upon the threshold and seed points.

3. minimum area threshold value:

None of the region in region growing method result will be smaller than this threshold value in the segmentedimage.

4. Similarity threshold value:

The regions will be considered as a same region if the difference of pixel-value or the difference value of average grayscale of a set of pixels less than "Similarity threshold value.

The criteria of similarities we choose is also very important. It usually depends on the original image and the segmentation result we want.

Some of the criteria which are often used are grayscale (average intensity or variance), color, and texture or shape.

Advantages :

1. Region growing methods can correctly segregate the regions that have the identical properties we define.

2. Region growing methods provides the original images which have clear edges with good segmentation results.

3. We only need a very small number of seed points to represent the property we want, then grow the region.

4. We ,the user can decide upon the seed points and the criteria we want to make.

5. We ,the user can choose the multiple criteria at the same time.

Disadvantages :

1. Region growing method is computationally expensive

2. Region growing method is a local method with no global view of the problem.

3. Region growing method is sensitive to noise.

4. A continuous path of points related to colour may exist which connects any two points in the image,unless the image has had a threshold function applied to it.

1.2.SPLIT AND MERGE SEGMENTATION:

Split and merge segmentation is an image processing technique that is used to segment an image. The image that has to be segmented is successively split into quadrants based on a homogeneity criterion and similar regions are merged to create the segmented result. This split and merge technique incorporates a quadtree data structure.There is a parent-child node relationship. The total region is considered as parent, and each of the four splits is considered a child.As suggested in the paper [1],this technique has these following advantages and disadvantages and needs some improvement.

Advantages

1. Split and Merge is Simple.

2. Split and Merge is computationally efficient.

Disadvantages

1. Split and merge segmentation is a sequential segmentation. The Split and Merge method based on different homogeneity criterion results in different results. Hence, the best homogeneous criterion for merging and splitting is difficult to find.

2. Split and Merge is an iterative algorithm which consumes more time and space and depends on the local properties and there is no simple way to add global properties of image.

So, from these disadvantages, it is clear that the Split and Merge method requires much more improvements.

2. CONTOUR BASED IMAGE SEGMENTATION:

Active contours are considered to be the most widely used and attractive image segmentation technique because they readily produce the continuous boundary with many sub regions, while compared to the kernel based edge detection technology which produces the discontinuous boundary of the image. Active contours are considered to be the most widely used and attractive image segmentation technique because they readily produce the continuous boundary with many sub regions, while compared to the kernel based edge detection technology which produces the discontinuous boundary of the image.

IMAGE SEGMENTING USING CONTOUR BASED METHOD:
Their exist two types of Active Contours based on contour evolution: [2]
                1] Edge Based Contour Method
                2] Region Based Contour Method

2.1.Edge Based Contour Method:
Edge based contour method is purely based on Edge based segmentation. It consists of 2 parts:
- Regularity part, that detects the contours form
- Edge recognition part that attracts the image sub region boundary towards the boundaries of other.

Paper [3] presents a new method for detecting the edge of intravascular ultrasound images, based on geometric active contours. It uses level set method combined with B-spline to fit a smooth boundary to a vessel region.
Edge based has many disadvantages like active contours will omit the boundaries if it is blurry, and are sensitive to local minima.

2.2. Region-based Active Contours:
Region-based active contour models have two parts:
- Regularity part, that detects the contours smooth form.
- Energy minimization part, that searches for equality within a subset of a preferred feature.

Region based active contour is used to divide the image into several sub region ,those which belongs to 2 subsets that is either inside or outside the contours.
Active contours is integrated with the edge and region based in order to improve the performance of segmentation.

DISADVANTAGES:
- It is comparatively slow when compared to other techniques.
- It is very sensitive to noisy images.
- Doesn't suit for images which do not have well defined boundaries.

3.THRESHOLD BASED SEGMENTATION:

Segementation is usually divided into 2 types they are contextual and non-contextual.Threshold based segmentation is a non-contextual approach[4].It is one of the simplest segmentation techniques.The technique converts gray scale images to binary images.In thresholding technique,the image is split into several segments or junks using gray scale value or atleast one color to define the boundary.The advantage of converting to a binary image is it reduces the complexity of the data and it also simplifies the process of image recognition and classification.

By selecting a single threshold value the gray scale image is converted to binary image.
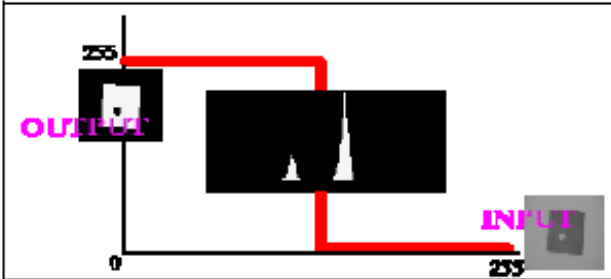
figure,1Thresholding non-contextual approach

The input to a thresholding operation is a gray scale image or a color image which outputs a binary image.Here we consider black pixels as background and white as foreground.This method of segmentation applies a fixed criteria to all pixels in image simultaneously.

There are three types of thresholding algorithms,they are :
1. Global Thresholding.
2. Local Thresholding.
3. Adaptive Thresholding.

3.1.GLOBAL THRESHOLDING:

When the intensity distribution of objects and background pixels are distinct the global thresholding technique is applicable.The single threshold values is used for a whole image in this technique.In this technique we choose threshold T that separates objects from background.if g(x,y) is a threshold version of f(x,y) at some global threshold T.

$$g(x,y) = \begin{cases} = 1 & if \quad f(x,y) \geq T \\ = 0 & otherwise \end{cases}$$

(1.1)

Based on threshold selection criteria we can divide global thresholding technique into many types.

3.1.1.Threshold selection based on histogram:

Let p1 and p2 be the gray value of the peaks of the histogram,The threshold value T is given by
T=(p1+p2)/2.   (1.2)
Or T is the gray level at the minimum between the two peaks.
T=min H(u) u€[p1,p2]   (1.3)
 where H(u) is the histogram value at gray level u between p1 and p2.

3.1.2.Threshold selection based on osu's method:

It is aimed in finding an optimal value for global threshold.This technique assumes that the histogram is bimodal this is the drawback.This method fails if two classes have different sizes and variable illumination.

3.1.3.Multithresholding method:

In this technique,the gray scale image is segmented into many distinct regions.for the given image it determines more than one threshold value and segments the image into certain brightness regions,which correspond to background and several objects.
DISADVANTAGE:
- Whenever the background illumination is uneven then global thresholding technique is not suitable.
- This doesn't give good result for the images with lots of variation in the intensities of pixels.

3.2.LOCAL THRESHOLDING:

In this technique,the idea is to partition the image into m*n sub images and then choose a threshold.Tij(Threshold) for each sub image.
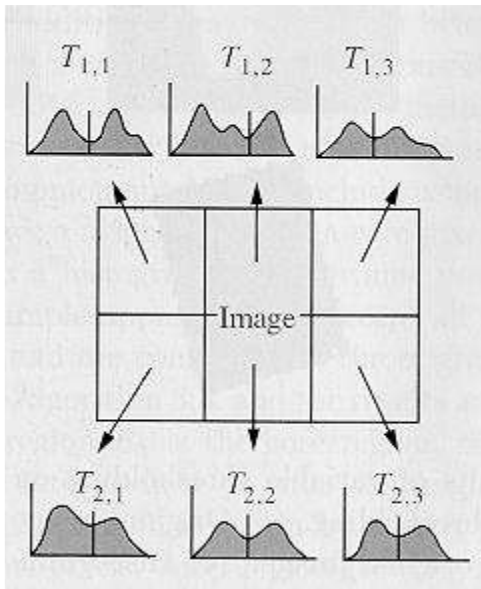
figure,2Sub images of an image

When the gradient effect is small with respect to the choosen sub image this technique I can be effectively used.The threshold value T depends on gray levels of f(x,y) and some local image properties of neighbourhood pixels such as mean or variance.Threshold function T(x,y) is given by,

$$g(x, y) = \begin{cases} 0 & if\ f(x, y) < T(x,y) \\ 1 & if\ f(x, y) \geq T(x, y) \end{cases} \quad (3)$$

Where T(x,y)=F(x,y)+T.

3.3.ADPATIVE THRESHOLDING:

This technique takes gray scale image as input and outputs binary image representing the segmentation.For each pixel threshold is calculated.If pixel value is below threshold it is set to background or foreground value.Different threshold values for different local areas used in this technique.

DISADVANTAGE:

It is expensive for computation and therefore not appropriate for real time applications.
The drawback of threshold based segementation is not suitable for complex images.

4. MACHINE LEARNING TECHNIQUES:

Machine learning-based image segmentation is by now firmly established as a robust tool in image segmentation. It has been used to separate homogeneous areas as the first and critical component of diagnosis and treatment pipeline. In Medical image segmentation it identifies the pixels of organs or lesions from background medical images such as CT or MRI images. In earlier, systems were built on traditional methods such as edge detection filters and mathematical methods. One of the machine learning approaches has become the popular dominant technique for a long period that is extracting hand-crafted.

APPROACHES:

4.1.Convolutional Neural Networks (CNNs):

A CNN is a branch of neural networks and consists of a stack of layers each performing a specific operation .Each intermediate layer receives the output of the previous layer as its input
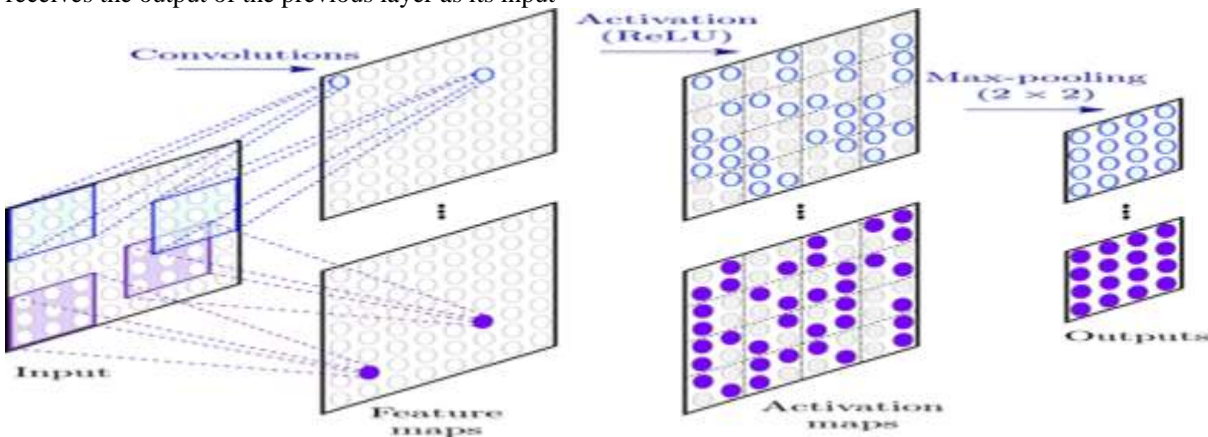
figure,3CNN

The output of each convolution layer is considered as an activation map, which highlights the effect of applying a specific filter on the input. Convolutional layers are usually followed by activation layers to apply non-linearity to the activation maps.
The multiple sources of information (T1, T2, and FA) in the form of 2D images are passed to the input layer of a CNN in various image channels.

2.5D approaches [5,6,7] are inspired by the fact that 2.5D has the richer spatial information of neighboring pixels with less computational costs than 3D.

The 2.5D architecture for multi-task segmentation is to evaluate the single network design .

The 2.5D approaches are benefiting from training the system with 2D labeled data, which is more accessible compared to 3D data and has a better match to the current hardware.

The 3D network is trained to predict the label of a central voxel according to the content of surrounding 3D patches.

The availability of 3D medical imaging and also the huge improvement in computer hardware has brought the idea of using 3D information for segmentation.

The 3D receptive field of Kleesiek's model is able to extract more discriminative information compared to 2D and 2.5 since the kernels have learned more precise and more organized oriented patterns as a volume

4.2.Fully Convolutional Network (FCN):

The FCN have to pixel-wise predictions from the full-sized image . The segmentation results are of each pixel .The fused with the results of other FCNs is to generate the final segmentation output. The technique was produced higher accuracy for big organs such as the liver , but it was yielded for lower accuracy while dealing with smaller organs.
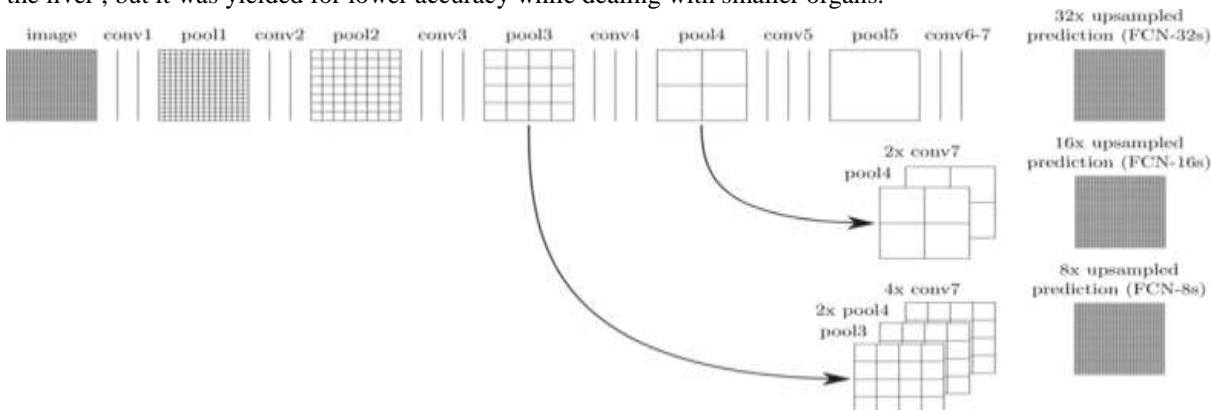
figure,4FCN

4.3.Recurrent Neural Networks (RNNs):

The RNN is empowered with recurrent connections which enables the network to memorize the patterns form last inputs.

CLSTM [8] was applied to the output layer of deep CNN. To achieve sharper segmentation by capturing the contextual information across the adjacent slices.

DISADVANTAGE:

- They need lot of training data.
- High computational cost.

III. CONCLUSION

In conclusion, the paper has surveyed various segmentation techniques, like active contours have been integrated.The paper has also explored various other techniques for segmentation of region, threshold and machine learning techniques, which can be used as the basis of our final year project for which we will be doing improvements using various approachs.

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