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## IMAGE SEGMENTATION TECHNIQUES IN DIP

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**ABSTRACT:** *Segmentation simply means to subdivide or segment the whole thing into its parts, when this word “segmentation” is used in the field of imaging system it means to subdivide or segment the image into its constituent regions or objects. In this process, input is whole image and after applies the segmentation algorithm the output is abstract representation of the image that is of our interest. There is various segmentation techniques used to make image smooth and easy to evaluate. In this paper we present a review of basic image segmentation techniques from last few years and on the basis of some factors we provide comparison among them.*

**KEYWORDS:** *image processing, segmentation, thres holding, clustering, pixion.*

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### I. INTRODUCTION

Image Segmentation is the process of dividing an image into various parts in order to identify objects and certain other important information stored in the digital image. There are many ways to perform the segmentation. The criteria of segmenting the image depend upon the area of interest or we can say that level of segmentation depends upon the problem being solved [1]. The application area of image segmentation is very wide, it is used in almost every area of science i.e. removing noise from an image, medical images [2]-[6], satellite imaging, machine vision, computer vision, biometrics, military, Image Retrieval [7]-[8], extracting features and recognizing objects from the given image [9]- [11]. After segmentation the entire image is divided into the different regions and pixels in the each region have the same features. The pixels within the each region have certain common characteristics such as color, contours, intensity and texture. It is important to isolate the boundaries of any image in the form of its segments [17].

### II. IMAGE SEGMENTATION TECHNIQUES

In order to analyze the digital image we need highly corrected image to identify the image characteristics and suitable of various faster digital image processing algorithms. The outcome of any real time application depends on the type of image processing used. In this paper, we have studied, reviewed and analyzed important image segmentation techniques those are given below:

1. Threshold (Intensity) based methods
2. Discontinuity based methods
3. Similarity(Region) based methods
4. Clustering methods
5. Graph based methods
6. Pixion based methods
7. Hybrid methods

### 1. THRESHOLD BASED METHOD

Thresholding methods are based on the fact that the pixel within the certain range of intensity value exhibit one class and rest of the pixels in the image represent other class. Thresholding method can be implemented locally or globally. In case of global threshold method the brightness values has to be chosen as a threshold value to segment the image into object and the background. This method produces the binary image from the original image. In this method those pixel who satisfy the threshold value may be considered as an object pixel and has an intensity value is equal to '1' and rest of the pixel is to be considered as a background pixel and has an intensity value equal to '0'. The threshold based segmentation techniques are inexpensive, faster in calculation and it can be used in real time applications [13].

$$g(u, v) = \begin{cases} 1, & f(u, v) \geq T \\ 0, & \text{Otherwise} \end{cases}$$

Where  $g(u, v)$  is the output image of input image  $i(x, y)$  and  $T$  is predefined threshold value.

Local thresholding method is also known as adaptive thresholding method. In case of local thresholding threshold values ranges over the image local characteristics after subdividing the images into the regions.

Now let us consider an image having an intensity of point  $(u, v)$  represented by  $f(u, v)$  with two different objects and identify two different thresholds  $T_1$  and  $T_2$  such that

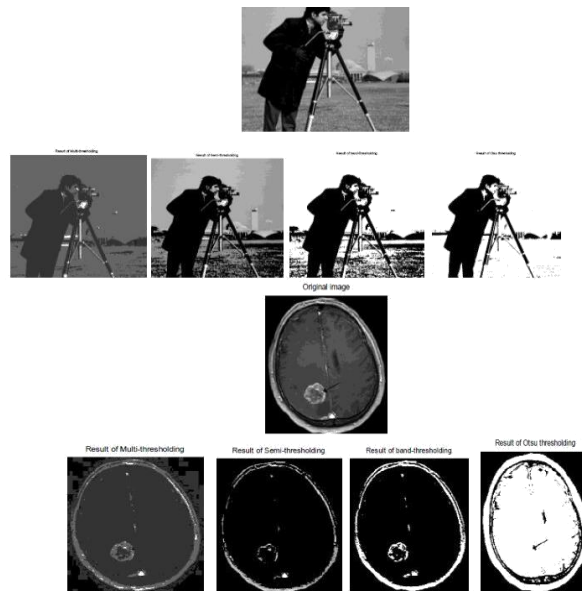


Figure 1

$$\left. \begin{aligned} T_1 \leq f(u, v) \leq T_2 & \text{ for one object} \\ f(u, v) \geq T_2 & \text{ for the other object} \\ f(u, v) \leq T_1 & \text{ for the background} \end{aligned} \right\}$$

## 2. DISCONTINUITY BASED SEGMENTATION

In discontinuity based method, there is an abrupt change in intensity, such as point, line, and edge. Spatial mask is used to detect these type of discontinuities, spatial domain techniques are those techniques, which directly work with the raw data of image i.e. pixel values, to get a new image.

Discontinuity Based Methods are divided into the following categories:

1. Edge based Segmentation
2. Line based Segmentation
3. Point based Segmentation

There are four types of edges that may be in an image (i) step- edge (ii) ramp-edge (iii) ridge edge (iv) ramp edge.

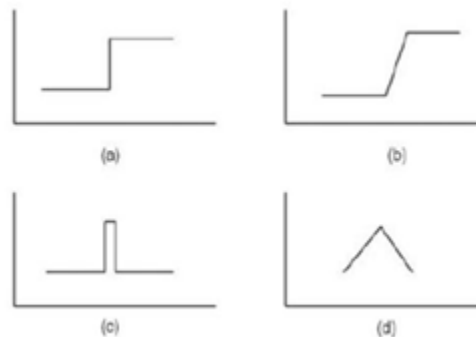


Figure 2

### A. First Order derivative operator

The detection of the presence of an edge at a point in an image can be calculated by the first derivative. The second derivative have certain properties the first proper is that it generate two derivatives for every edge in an image and the second property is that it its zero crossing is used for calculating the center of the thick edge.

There are the following operators are used in this section are

- a) Robert's cross gradient operator
- b) Prewitt's operator
- c) Sable's operator

#### a) Robert's Cross gradient operator

It is the first and simplest derivative operative which can be used to find the edge in the given images. It finds the image in rows and columns separately and then the resultant edge can be found. The masks used to solve in x and y direction.

-1	0
0	1

0	-1
1	0

#### b) Prewitt's operator

This operator uses 3x3 masks to find the edge. The masks used in x and y direction is given as:

-1	-1	-1
0	0	0
1	1	1

-1	0	1
-1	0	1
-1	0	1

**c) Sobel's operator**

This is one of another operator to find the edge in an image and its corresponding mask are given below:

-1	-2	-1	-1	0	1
0	0	0	-2	0	2
1	2	1	-1	0	1

**B. Second Order derivative operator**

These types of operators function as zero crossing detection of the second derivative of the gradient. These methods find the local maxima in the gradient value and consider it as an edge. The mostly used second derivative is Laplacian operator.

The most commonly used second order derivative operators for edge detection are the Laplacian of Gaussian (LoG) operator and canny edge operator.

**(a) Laplacian of Gaussian operator**

In the Laplacian of Gaussian operator the Laplacian of an image highlights the regions where there is a rapid intensity change. The operator usually takes a single one gray level image as an input and also generates one gray level image as an output.

1	1	1	-1	2	-1
1	-8	1	2	-4	2
1	1	1	-1	2	-1

0	1	0
1	-4	1
0	1	0

**(b) Canny Edge Operator**

Another Second order derivative operator is known as canny edge detection operator as compared to rest of the operators as far as these experimental results are considered. It determines the strong and weak edges in the image. Because image contain noise so firstly it should be smoothed and for this purpose we apply circular two-dimension Gaussian function and we compute the gradient of the result and finally by using the gradient magnitude and direction we find the approximation of strength of edge and direction at every point. After finding the array of gradient we see that it consists of unwanted ridges near the local maxima and this has to be removed by the process of non-maxima suppression to find the discrete orientations of the normal edge. After that the double thresholding is applied to remove false fragments. For this purpose we use two threshold T1 and T2 where T2 is approximately double of T1 i.e.  $T=2T1$ . This is to be explained through the below segmented image using edge operator.

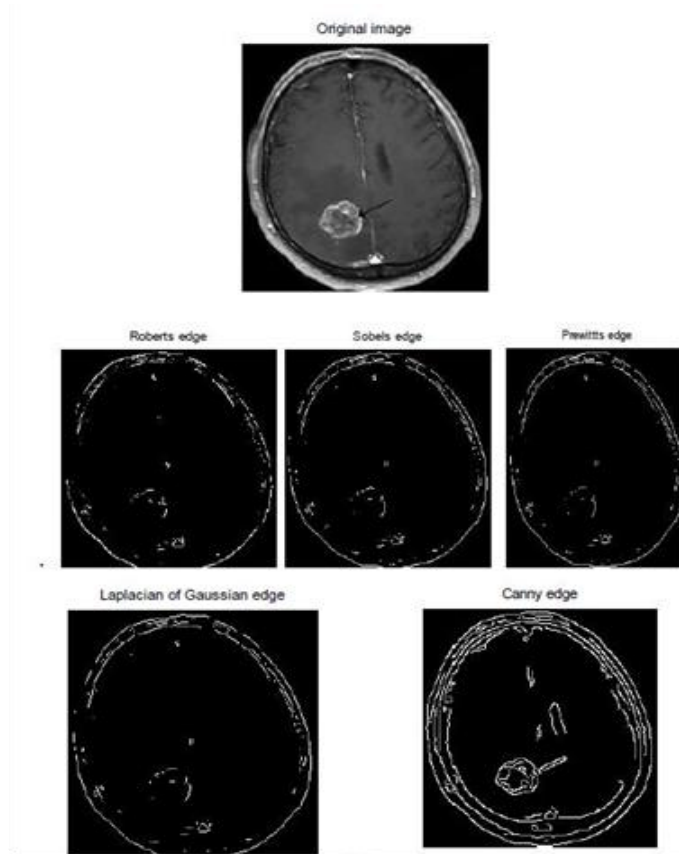


Figure 3

### 3. REGION (SIMILARITY) BASED SEGMENTATION

The main purpose of this region based segmentation is to generate a homogenous region which is combination of small regions and larger in size and have a very less number of regions in the resultant image. If the entire image is represented by the region R, then the process of segmentation divide it into the n distinct regions represented by S1, S2, S3, .....,Sn such that

$$\left. \begin{aligned} \cup S_i &= S, & S_i \cap S_j &= \emptyset, & \text{if } i \neq j \\ Prop(S_i) &= True, & \text{if } i &= 1, 2, 3, \dots, n \\ Prop(S_i \cup S_j) &= False, & \text{if } i &= 1, 2, 3, \dots, n \end{aligned} \right\}$$

*Region based segmentation is divided into the two categories*

1. Region Growing
2. Region split and merges

#### REGION GROWING METHOD

In this method the pixels are combined together to make a large region (which satisfy the predefined criteria [14]) to grow the region. At the first step we start with the seed point (a seed point is point from where we start our process) and then we perform the comparison to the neighboring pixel, once the neighboring pixel satisfy the given similarity property then only it can be added to that particular region.

### REGION SPLIT AND MERGE METHOD

This method consider the entire image as a one single region and then divides the entire image into the four quadrants based on the certain criteria. This method tests the quadrants against the same pre-defined criteria and breaks it into the four different quadrants. This process continues till no further sub division is possible or till the criteria is satisfied.



Figure 4

### 4. CLUSTERING BASED SEGMENTATION

In cluster based segmentation technique, data is consolidated into the groups based on the similar features and data having the similar feature must be grouped into one group and dissimilar to another group. Images may be grouped according to their contents. In the content based clustering the process of grouping is done based on the characteristics of the pixel like shape or texture etc. In this process there are number of techniques available but the most commonly used technique is K-mean clustering and fuzzy C-mean clustering algorithm. The clustering methods are usually divided into the two different categories:

1. Hierarchical Clustering
2. Partition Clustering

In **Hierarchical Clustering** we can change the number of clusters anytime during the clustering process if we want. There are two types of hierarchical clustering algorithm exist.

1. Agglomerative Clustering (builds)
2. Divisive Clustering (breakup)

The Agglomerative clustering starts with individual elements as a separate cluster and merge them successfully in order to make a large cluster. Agglomerate clustering starts with the top of the tree.

The Divisive algorithm starts with the complete set and divides it into the smaller number of clusters successively. The Divisive algorithm begins at the bottom.

In **Partition Clustering**, The most widely used algorithms are K-mean and Fuzzy C-mean clustering algorithms:

The main steps in **k-mean algorithm** are:

1. Choose the number of clusters randomly in the final set. Suppose we assume the number of cluster N.
2. After that randomly select N data points (in case of image, it is pixel) in the whole database (in case of image, it is complete image) as centroids of N clusters.
3. Now for every single data point (in case of image, it is pixel) find the nearest centroid and classify the data point into that cluster. After the step 3, we have all the data point (pixel) into the specified clusters and the total number of cluster is N which is specified at early stage.
4. So for every point in the cluster, we calculate the centroid of all the data points (pixels) contained in the cluster. Centroid may be considered as a median of the database within the cluster. Now again we get the N Centroid of N clusters.
5. Repeat the step 3 and step 4 until there no more change in the successive iteration.

The main Step in **FCM algorithm** is:

1. Assign the values to  $c$ ,  $q$ , and threshold  $\epsilon$ , partition matrix  $U = [u_{ij}]$ , cluster Centre and counter  $l$ .
2. Next save the membership values in the array
3. Now for each iteration, find the values of the parameter  $a_i^l, b_i^l$  for all pixels.

$$A_i^l = a_i^{l-1} + v_i p_k, b_i^l = b_i^{l-1} + v_i$$

4. After this update the cluster Centre after each and every iteration and compare the result with the previous value  $U^l - U^{l-1}$
5. Now we stop the iteration if the comparison difference is less than the defined threshold, else repeat the process.

## 5. GRAPH BASED SEGMENTATION METHODS

An image can be partitioned into mutually exclusive components, such that each component  $A$  is a connected graph  $G = (V, E)$ , where  $V' \subseteq V, E' \subseteq E$  and  $E'$  contains only edges built from the nodes of  $V'$ . In other words, nonempty sets  $A_1, A_k$  form a partition of the graph  $G$  if  $A_i \cap A_j = \emptyset$  ( $i, j \in \{1, 2, \dots, k\}, i \neq j$ ) and  $A_1 \cup \dots \cup A_k = G$ . The graph based methods are categorized into five classes: the minimal spanning tree based methods, graph cut based methods with cost functions, graph cut based methods on Markov random field models, and the shortest path based methods and the other methods that do not belong to any of these classes. Among the available techniques graph cut methods are widely used and was initially proposed by Yuri and Marie [14].

### 1. PIXON BASED SEGMENTATION

This method was proposed by pina & puetter in 1993. The pixon method is nonlinear method which is used to reconstruction of image in which the decision factor is pixons rather than pixel. To find the pixon representation we will use Fast Quad Tree combination method is used as a pre-processing step. After that the proper pixon can be represented by the suitable algorithm and at last segmented using the Fuzzy C-Mean algorithm are used.

Pixon Based method can be classified as follows:

1. Traditional Pixon Based Methods
2. Markov Random Fields model Pixon based methods
3. Wavelet threshold Pixon Based Methods

The Traditional Pixon Based method is simple to implement and has only two steps of generating the pixons and segmenting the image. Generating the pixon in this method has again steps:

- (i) Find a pseudo image with same resolution as the observed image
- (ii) To generate the pixon use the anisotropic diffusion
- (iii) Hierarchical clustering is used to extract the pixon

In the Markov Random field model the image is represented by the pixon-based model. In this model the pixons are clubbed with their attributes and adjacencies (edges and pixons.) To segment the image this MRF model is used with the help of pixon representation. Here Bayesian classification is used to segment the image. A Fast Quad tree Combination algorithm can also be used to extract the pixon representation.

### 2. HYBRID BASED SEGMENTATION

This method combines one or more other segmentation approaches, and gives better result comparatively or more stable segmentation results, it gives connected segmentation boundaries means boundaries are continuous between regions and there is no gap[15]. As for example when segmentation is carried out for medical imaging system then combination of threshold based method, clustering method is used along with region-edge based approaches [16]. The most widely used technique used in hybrid segmentation is **watershed method using morphological operations**. In the hybrid method, first find the

gradient of input image and then this gradient is represents “topographic surface”, where gray level values at each pixel considered as elevation of surface at that location. When a hole is punched in each regional minimum, then flooding is start by water flow through holes at uniform rate. When water is about to merge from different basins then there is a need to construct a dam to prevent merging. When above the water lines only top of dam is visible then these dam boundaries represent watershed lines of basins [12].

Main objective of this algorithm is to find the divided lines to prevent merging, these watershed lines shows the final dam which represents desired segmentation result. The process of spilling water is continued until the maximum level of flooding is reached (that is correspond to highest intensity value in given image).

### III. COMPARATIVE STUDY

Parameters	Threshold based method	Region based method	Discontinuity based method	Cluster based method	Fuzzy Mean method	C-
<b>Spatial Information</b>	Ignored	Considered	Ignored	Considered	Considered	
<b>Region Continuity</b>	Reasonable	Good	Reasonable	Reasonable	Good	
<b>Speed</b>	Fast	Slow	Moderate	Fast	Moderate	
<b>Computation Complexity</b>	Less	Rapid	Moderate	Rapid	Moderate	
<b>Automaticity</b>	Semi auto	Semi auto	Interactive	Automatic	Automatic	
<b>Noise Resistance</b>	Less	Less	Less	Moderate	Moderate	
<b>MultipeObject Detection</b>	Poor	Fair	Poor	Fair	Fair	
<b>Accuracy</b>	Moderate	Fine	Moderate	Moderate	Moderate	

Table 1



#### IV. CONCLUSION AND FUTURE SCOPE

Different techniques developed for image segmentation perform well and comparable to the methods used in practice. Result of image segmentation method is dependent on many factors such as intensity, texture, image content. Hence neither the single segmentation is applicable to all type of images nor do all the segmentation methods perform well for one particular image. So the process of segmentation depends on the various parameters.

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