Review of Image Segmentation Technique

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Abstract: Due to the revolution of computer technology image-processing techniques has become very important in a wide variety of Applications. The Image segmentation is most important process of image processing. Image segmentation is the technique of dividing an image into small parts, that parts are called as segments. It is very useful for image compression or object recognition applications, because for these types of applications, it is inefficient to process the whole image. There arevarious image segmentation techniques thathelps in image segmentation based on certain image features like pixel intensity values, color, textures, etc. The various image segmentation techniques are reviewed anddiscussed in this paper.

Keywords: Image segmentation; similarity detection; edge fuzzy clustering; thresholding

I.INTRODUCTION

Digital image processing is the use of computer algorithms to perform image processing into digital images.Image segmentation is very important and challenging process of image processing. Image segmentation is the techniques are used to partition an image into meaningful parts have similar features and properties. The aim of segmentation is simplification i.e. representing an image into meaningful and easily analyzable way. Image segmentation is the first step in image analysis. The main goal of image segmentation is to divide an image into several parts/segments having similar features or attributes. The main applications of image segmentation are: Medical imaging, Content-based image retrieval, Automatic traffic control systems, Object detection and Recognition Tasks, etc. The image segmentation can be classified into two basic types: Local segmentation (concerned with specific part or region of image) and Global segmentation (concerned with segmenting in whole image, consisting of large number of pixels). The image segmentation approaches can be categorized into two types based on properties of image.

A. Discontinuity detection based approach:
Discontinuity detection is anapproach which is based on discontinuity region for segmentation of an image.In this technique, partition of an image is based on change in the intensity. [1],it includesan edge detection algorithm for image segmentation.

B.Similarity detection based approach:
Similarity detection is an approach which is based on finding the similar region of an image. The following are the techniques that come under this are: region growing, thresholding techniques and region merging and splitting. All these techniques divide an image with the help of similar pixels. This approach is also used for clustering the data. In this approach, clusters of pixels are formed that have similar features.

So image segmentation has mainly three perspective approaches. These are:

1. Region Approach: This falls under similarity detection approach.
2. Edge detection and Data Clustering Approach: Edge detection approach comes under discontinuity detection approach but data clustering comes similarity detection based approach.

II.CLASSIFICATION OF IMAGE SEGMENTATION TECHNIQUES:

Image Segmentation has several techniques for dividing the images into segments. Each technique has its own features. All these techniques follow mainly two basic approaches for image segmentation. The two approaches are:region based approach and edge based approach. All techniques of image segmentation is broadly divided into three parts. These are as follows: [2].
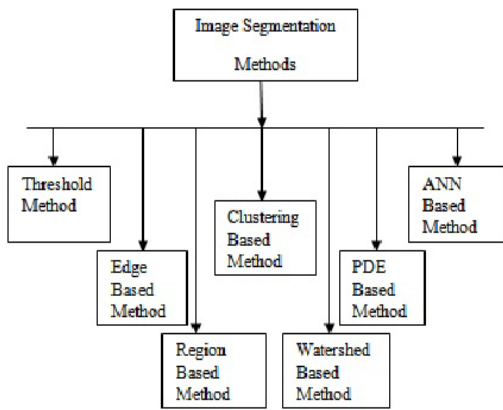
Fig.1Image Segmentation Technique

A.   Structural   Segmentation   Techniques: This technique is based upon having knowledge about the structure of the image which is going to be segmented. In other words, this technique works by having the information about the structure of an image.

B.   Stochastic   Segmentation   Techniques:This technique is based on pixel values of an image for segmentation of an image. In other words, it takes help of discrete pixels for segmenting an image.

C. *Hybrid Techniques*:The word hybrid means mixture of things. The hybrid techniqueis a techniquewhich uses the features of both structural segmentation technique and stochastic segmentation technique. Hence hybrid technique segmented an image with the help of structure of an image as well as with discretevalue of pixel.

This paper includes the various techniques of Image Segmentation with its advantages and disadvantages. It is difficult to include the mathematical terms. So this paper does not include mathematical description and includes only theory of them. The popular techniques used for image segmentation are: thresholding method, edge detection based techniques, region based techniques, clustering based techniques, watershed based techniques, partial differential equation based and artificial neural network based techniques etc. These all techniques are different from each other with respect to the method used by these for segmentation.

III. .IMAGE SEGMENTATION TECHNIQUES:

A.   Thresholding Method

The most popular and commonly used method for image segmentation is Thresholding methods. In this method, image pixels are divided with the help of intensity level of an image. This method is mainly used to distinguish the foreground objects from background images. In this objects are lighter than its background. Selection of this method depends upon our prior

knowledge. The thresholding method is broadly classified into three categories.

1)Global Thresholding: Global Thresholding is based on selecting an appropriate threshold value i. e. T. This T is a constant and output image depends upon this T value.

$$q(x,y) = \begin{cases} 1, & \text{if } p(x,y) > T \\ 0, & \text{if } p(x,y) <= T \end{cases} \qquad \ldots\ldots(1)$$

2) Variable Thresholding: Another type of thresholding method is Variable thresholding. In this method, the value of T varies over an image. It is further divided into two categories:

- Local Threshold: In this the value of T depends upon the neighborhood of x and y.
- Adaptive Threshold: The value of T is a function of x and y.

3). Multiple Thresholding: In this type of thresholding, there are multiple threshold values like T0 and T1. By using these output image can be computed as:

$$q(x,y) = \begin{cases} m, & \text{if } p(x,y) > T1 \\ n, & \text{if } p(x,y) <= T1 \\ o, & \text{if } p(x,y) <= T1 \end{cases} \qquad \ldots\ldots(2)$$

Threshold values can be calculated with the help of peaks of histogram.

The various advantages of thresholding method are as follows:
- Simple to implement
- Fast (especially if repeating on similarimages).
- Good for some kinds of images (e.g.,documents, controlled lighting)

Disadvantages:
- No guarantees of object coherency—may have holes, extraneous pixels, etc.

B.   Edge Based Segmentation method

A connected pixel that is found on the boundary of the region is called an edge. So these pixels on an edge are known as edge points[3]. Edge can be calculated by finding the derivative of an image function. Some edges are very easy to find. These are: Ramp edge, Step edge, Roof edge, Spike edge.Step edge is an abrupt change in intensity level. Ramp edgeis a gradual change in intensity. Spike edgeis a

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quick change in intensity and after that returns immediately toan original intensity. Roof edge is not instantaneousover a short distance. Edge based image segmentation method falls under structural techniques [4].

C. Region Based Segmentation Method:

This method is based on segmented an image on the basis of similar characteristics of the pixels.Region Based segmentation method is further divided into two categories:

1)Region growing methods: The region growing based segmentation methods are the methods that segments the image into various regions based on the growing of seeds (initial pixels). These seeds can be selected manually (based on prior knowledge) or automatically (based on particular application). Then the growing of seeds is controlled by connectivity between pixels and with the help of the prior knowledge of problem, this can be stopped. The basic $_{algorithm}$ (based on 8-connectivity) steps for region growing method are:

If (x,y) is the original image that is to be segmented and s(x,y) is the binary image where the seeds are located. Let 'T' be any predicate which is to be tested for each (x , y) location.

- First of all, all the connected components of
'S' are eroded.
  - Compute a binary image P_T. Where $P_T(x, y) = 1$, if $T(x, y)$ = True.
  - Compute a binary image 'q', where $q(x, y) = 1$, if $P_T(x, y) = 1$ and (x, y) is 8-connected to seed in 's'.

These connected components in 'q' are segmented regions.

Segmentation algorithms based on region mainly include following methods:

Region Growing:- Region growing is a procedure that group's pixels in whole image into sub regions orlarger regions based on predefined criterion [5]Region growing can be processed infour steps:-

(i). Select a group of seed pixels in original image [6].

(ii) Select a set of similarity criterion such as grey level intensity or color and set up astopping rule.

(iii)Grow regions by appending to each seed those neighboring pixels that havepredefined properties similar to seed pixels.

(iv) Stop region growing when no more pixels met the criterion for inclusion in thatregion (i. e. Size, likeness between a candidate pixel & pixel grown so far, shapeof the region being grown).

2).Split and Merge: Two parts: Initially the whole image which is taken as a single region is repeatedly splituntil no more splits are possible, Quad tree is a splitting data structure, then two regions are merged if they areadjacent and similar, merging is repeated until no more merging is

possible. Three steps: usingImproved Quad Tree (IQM), 1st splitting the image, 2nd initializing neighbors list and the 3th step is mergingsplitted regions.

Advantages: connected regions are guaranteed and IQM reduces lengthyneighbor problemsduring merging.

Disadvantages: the position and orientation of the image lead to blocky final segmentationand regular division leads to over segmentation (more regions) by splitting. This drawback can beovercome by using Normalized cuts.

*D.*Clustering Based Segmentation Method

The clustering based techniques are the techniques, which segment the image into clusters having pixels with similar characteristics. Data clustering is the method that divides the data elements into clusters such that elements in same cluster are more similar to each other than others. There are two basic categories of clustering methods: Hierarchical method and Partition based method. The hierarchical methods are based on the concept of trees. In this the root of the tree represents the whole database and the internal nodes represent the clusters. On the other side the partition based methods use optimization methods iteratively to minimize an objective function. In between these two methods there are various algorithms to find clusters. There are basic two types of clustering .

1) Hard Clustering: Hard clustering is a simple clustering technique that divides the image into set of clusters such that one pixel can only belong to only one cluster. In other words it can be said that each pixel can belong to exactly one cluster. These methods use membership functions having values either 1 or 0 i.e. one either certain pixel can belong to particular cluster or not. An example of a hard clustering based technique is one k-means clustering based technique known as HCM. In this technique, first of all the centers are computed then each pixel is assigned to nearest center. It emphasizes on maximizing the intra cluster similarity and also minimizing the inter cluster equality.

2)Soft clustering: The soft clustering is more natural type of clustering because in real life exact division is not possible due to the presence of noise. Thus soft clustering techniques are most useful for image segmentation in which division is not strict. The example of such type of technique is fuzzy c-means clustering. In this technique pixels are partitioned into clusters based on partial membership i.e. one pixel can belong to more than one clusters and this degree of belonging is described by membership values. This technique is more flexible than other techniques.

E.Watershed Based Method

The watershed based method uses the concept of topological interpretation. In this the intensity represents the basins having hole in its minima from where the water spills. When water reaches the border of basin the adjacent basins are merged together. To maintain separation between basins dams are required and are the borders of region of segmentation. These dams are constructed using dilation. The watershed methods consider the gradient of image as topographic surface. The pixels having more gradient are represented as boundaries which are continuous[7].

F. Partial Differential Equation Based Segmentation Method

The partial differential equation based methods are the fast methods of segmentation. These are appropriate for time critical applications. There are basic two PDE methods: non-linear isotropic diffusion filter (used to enhance the edges) and sconvex non-quadratic variation restoration (used to remove noise). The results of the PDE method is blurred edges and boundaries that can be shifted by using close operators. The fourth order PDE method is used to reduce the noise from image and the second order PDE method is used to better detect the edges and boundaries[8]

G.Artificial Neural Network

Based Segmentation Method: A neural network is an artificial representation ofhuman brain that tries to simulate its learning process.An artificial neural network [9] [10] is often called aneural network or simply neural net.The artificial neural network based segmentation methods simulate the learning strategies of human brain for the purpose of decision making. Now days this method is mostly used for the segmentation of medical images. It is used to separate the required image from background. A neural network is made of large number of connected nodes and each connection has a particular weight. This method is independent of PDE. In this the problem is converted to

issues which are solved using neural network. This method has basic two steps: extracting features and segmentation by neural network.

IV. CONCLUSION

This paper includes a review on the current segmentation methods, and the main use of eachmethod with their principle ideas.Image segmentation is a big challenge in image processing and the researchers would evaluatetheir image segmentation techniques by using one or more of the techniques given above.

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39