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# Analysis of various Image Segmentation Techniques

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***Abstract:*** **The recent development in image processing plays an important role in large number of applications. Image segmentation is one of the main focus areas in digital image processing. Image segmentation is the procedure of dividing an image into several segments. The main focus of image segmentation is to recognize object from digital images or any significant information. A large number of algorithms & techniques have been proposed to solve segmentation problem. This paper presents the study of different image segmentation techniques and made the comparative study of these techniques.**

***Keywords: Segmentation, Threshold, Region Based, ANN, Clustering***

## I. Introduction

Digital image processing is a field of computer science which deals with automated processing, manipulating images and interpreting the visual information. It plays a significant role in many applications such as television, photography, robotics, remote sensing, medical diagnosis and industrial inspection. It is a form of signal processing in which we take image as input and produce output as enhanced image or extract characteristics/features from the image. The process of Image Segmentation consists of three stages:

1. Image Processing-Noise & unwanted information is removed from the image.
2. Initial object discrimination- Images are segmented into groups with similar characteristics/ features.
3. Clean up of Image boundary- object boundaries are decreased to single pixel widths.

After an image has been pre-processed properly in order to eliminate noise then segmentation is carried for interpretation of image. Image segmentation is a procedure in which regions or features/characteristics based on some similarity are discovered and clubbed together. Image segmentation use different techniques such as thresholding, edge detection, region detection, or any combination of these techniques. The result of the segmentation step consists of classified elements.

The different image segmentation techniques are mainly divided into two categories:

Detecting Similarities: Here the image is divided into sub images based on similarity in intensity of grey levels of image. The image is divided into small cluster or regions based on predefined criteria.

Several segmentation algorithms based on detecting similarities are:

1. Threshold Based
2. Region Growing
3. Region Splitting
4. Region Merging
5. Clustering

Detecting Discontinuities: Images are subdivided on the basis of change in intensity, this involve algorithms like edge detection.

## II. Image Segmentation Techniques

### *A. Threshold Based Segmentation:*

It is easiest and the simplest method for segmentation. This approach is used to transform a grey-scale image to binary image. A threshold value is defined and the image is split into group of pixels having value less than or equal to the defined threshold value. Threshold technique[1] is suitable for images having light objects over darker background. There are two types of threshold algorithms: Global, local[2]

Global threshold: One threshold value is selected for image and on the basis of that threshold value image is divided into two regions. Some of the commonly used globalthresholding methods are Otsu method, entropy-based thresholding, etc.
Local thresholding: -Image is divided into various regions and different threshold value for different regions. Some common used local threshold techniques are entropy-based thresholding histogram transformation, simple statistical thresholding. [3]
Threshold method is simple and processing speed is fast. This algorithm will work well when object and background have high contrast. The drawback is it unable to give accurate result when image has no major grey scale difference or image with overlapping grey scale.

*B.* ***Edge Based Segmentation****:*

This technique is based on the detection of discontinuity. An edge is defined as a set of connected pixels which lies on the boundary between two regions having different grey value. These pixels on the edge are called edge points [4].An edge is extracted by estimating the derivative of the image function.
Edge based segmentation [5][12]operates with the pixel position of the image that are aligned parallel to the boundaries of the objects seen in the image. It implied that the edge of a region or an object then it is closed and that the number of objects of interest is equivalent to the number of boundaries in an image. For proper segmentation, the boundaries edge are identified must be roughly equal to that of the object in the input image. This method does not work well on Edge-less, very-noisy, edge that are very horizontal and Texture –margin. It works well for images having good contrast.
The organization of the edge detection algorithms based on the interactive study of edges.
Classical based edge detectors (first derivative)

- Prewitt operator
- Sobel operator
- Canny operator
- Test operator
- Zero crossing (second derivative)
- Laplacian of Gaussian (LOG)
- Gaussian edge detectors
- Colored edge detectors

*C.* ***Region Based Segmentation:***

Generally, in region based segmentation the image is segmented into different groups or regions based on similar characteristics. The properties like area, shape, statistical parameters and texture is used to form different regions. There are three basic techniques based on this method [11].

1. Region Growing Method: It is a method that club pixels or sub regions into larger regions. The easiest approach is pixel aggregation. Here we start with a set of "seed" points and from these grows regions by adding neighboring pixels to each seed points based on some common properties (such as gray level, texture, color, shape). This technique is better as compared to edge based segmentation for noisy images where edges are difficult to identify.
2. Region Splitting: The region starts growing from a group of seed points, The entire image is considered as a single region and start dividing this to subregion region which does not satisfy condition of homogeneity.
3. Region Merging Method: Region merging is completely different from region splitting. Here we start with smaller regions and combine them based on some common properties(such as gray level, variance).Mostly, splitting and merging approaches are carried out iteratively.

*D.* ***Clustering Based Segmentation:***

Clustering is based on the idea of unsupervised learning. Clustering is a grouping method in which pixel on the basis of some similar characteristics or feature are combine together to form cluster. For that reason, we can say that a cluster is a set of pixels which has similarity between them but are dissimilar to the pixels associated with the different clusters. The characteristics such as color, texture, size etc. are considered in the formation of clusters. The performance of clustering method depends on similarity measure and its implementation. There are different kinds of clustering techniques: k-means clustering, fuzzy clustering, etc [6][7].

1. **K-Mean clustering**: This clustering technique is known as hard clustering because each pixel belong to one & only one cluster. As we know that image is a collection of pixel and each pixel must be associated with one cluster and there will be well defined boundaries between different cluster. K-means algorithm [12][15] is most common and simplest approach for clustering. In this technique 'n' number of pixels are grouped into k

clusters, where k < n. The several pixels of an image are classified into k number of clusters on the basis of some image attributes such as grey level intensity of pixels and distance of pixel intensities. Initially a centroid is chosen randomly from the set of pixels. While applying the K-Mean clustering on image for segmentation following steps are carried out:

**i.** The numbers of clusters are choosing randomly.
**ii.** Among the 'k' number of pixels are choose randomly are known as centroids.
**iii.** A centroid is identified by calculating a mean of certain region. All the centroids are kept far from each other.
**iv.** Every close by pixel is compared to every centroid & then assigned to the closest centroid. This pixel assignment done at beginning is the initial state.
**v.** In next state we recalculate the mean of each cluster & recomputed the location of centroid.
**vi.** Repeat the above two steps till there is no change in centroid position.

2. **Fuzzy Clustering:** Fuzzy clustering is also known a soft clustering because here each pixel belong to one or more clusters. In this technique we split the input pixels into different clusters/groups based on some similarity criteria such as intensity, distance, connectivity etc. Fuzzy clustering is applied on those images where there is no crisp boundary between objects. It is the algorithm which protects the maximum information and suitable for decision oriented applications like tumor diagnosis & tissue classification. The numerous algorithms proposed on fuzzy clustering are: Possibilistic C-means (PCM) and Fuzzy c means (FCM), etc [8].

*E. **ANN Based Segmentation:***

The structure & operation of neural network is very similar to the human brain. Over the last few years, artificial neural network is used for image segmentation problem. Here each pixel of an image represents a neuron. It comprises of a training network that determine the connection & weights between distinct nodes. On the basis of trained neural network set segmentation process is carried out [9],[10].In ANN based segmentation, firstly extract the feature from the images that acts as an input to the neural network. Based on the extracted feature the images are segmented. The advantage of this technique is fast computation, parallel processing, less prone to noise, independent of probability density distribution function. It is suitable for real time application.

Some of the most commonly used neural networks for image segmentation are Hopfield, BPNN, FFNN, MLFF, MLP, SOM, and PCNN. Segmentation of an image using neural network is performed in two steps, i.e., pixel classification and edge detection.

| Sno. | Segmentation Techniques | Advantages | Disadvantages |
|---|---|---|---|
| 1 | Threshold | • Do not require any prior information of the image.<br>• Low cost computation<br>• Fast and easy to implementation<br>• Used in real time applications. | • Doesn't work well for Images with broad and flat valleys or without any peak.<br>• Doesn't assure contiguous segmented regions because it neglects the spatial information of an image.<br>• Sensitive to noise.<br>• Selection of threshold value is difficult. |
| 2 | Region Based | • Give better result as compared to other segmentation techniques.<br>• Proper selection of seed gives accurate result than any other method.<br>• Provides flexibility to choose between interactive and automatic technique for image segmentation.<br>• Flow from inner point to outer region generates clear object boundaries.<br>• More immune to noise. | • Computationally expensive.<br>• Selection of noisy seed by user leads to flawed segmentation.<br>• Sequential by nature and quite expensive in both computation time and memory.<br>• To decide stopping criteria for segmentation is difficult task.<br>• Scan order dependencies may be yielded in SRG and can have considerable impact on minute regions. |
| 3 | Edge Based | • Easy to understand & implement.<br>• Suitable for images having better contrast between objects | • Not suitable for images with noise, edgeless & not having smooth boundaries. |
| 4 | Clustering | • Eliminates noisy spots.<br>• For small values of k, k- means is computationally faster.<br>• Reduces false blobs<br>• More homogeneous regions are obtained. | • Difficult to predict k with fixed number of clusters.<br>• Sensitive to initialization condition of cluster number and centre.<br>• Computationally expensive.<br>• Doesn't works well with non globular clusters. |
| 5 | ANN | • Suitable for real time applications.<br>• Insensitive to noise.<br>• highly parallel and fast computing capability<br>• No need to write complicated programs.<br>• Independent of the probability density distribution function | • Some kind of segmentation information should be known beforehand.<br>• Training time of neural system is long.<br>• Over training should be avoided. |

**III. Conclusion**

Through this review paper on image segmentation we discussed & compared different image segmentation techniques. These methods are used for object identification and recognition. We study the advantage & disadvantages of the above mentioned techniques. These techniques are not suitable on all images but for a specific type of images. Therefore, we can conclude that none of the segmentation techniques work effectively so image segmentation is still a challenge.

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