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A Survey Paper on Fuzzy Image Segmentation Techniques

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Abstract
The image segmentation plays an important role in the day-to-day life. The new technologies are emerging in the field of Image processing, especially in the domain of segmentation.Segmentation is considered as one of the main steps in image processing. It divides a digital image into multiple regions in order to analyze them. It is also used to distinguish different objects in the image. Several image segmentation techniques have been developed by the researchers in order to make images smooth and easy to evaluate. This paper presents a brief outline on some of the most commonly used segmentation techniques like thresholding, Region based, Model based, Edge detection..etc. mentioning its advantages as well as the drawbacks. Some of the techniques are suitable for noisy images.

***Index Terms*---** Segmentation, Edge Detection, Model Based, Region Based, threshold.

I. INTRODUCTION

Image segmentation is the process of partitioning of a digital image into multiple segments known as super pixels. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze.[1] [2] Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics.Image segmentation is commonly used key techniques in image representation of the digital images.

The task of image segmentation is to divide an image into a number of non-overlapping regions, which have same characteristics such as gray level, color, tone, texture, etc. Famous techniques of image segmentation which are still being used by the researchers are Edge Detection, Threshold, Histogram, Region based methods, and Watershed Transformation. Since images are divided into two types on the basis of their color, i.e. gray scale and color images. Therefore image segmentation for color images is totally different from gray scale images, e.g., content based image retrieval[1], [2]. Also which algorithm is robust and works well is depends on the type of image [3].

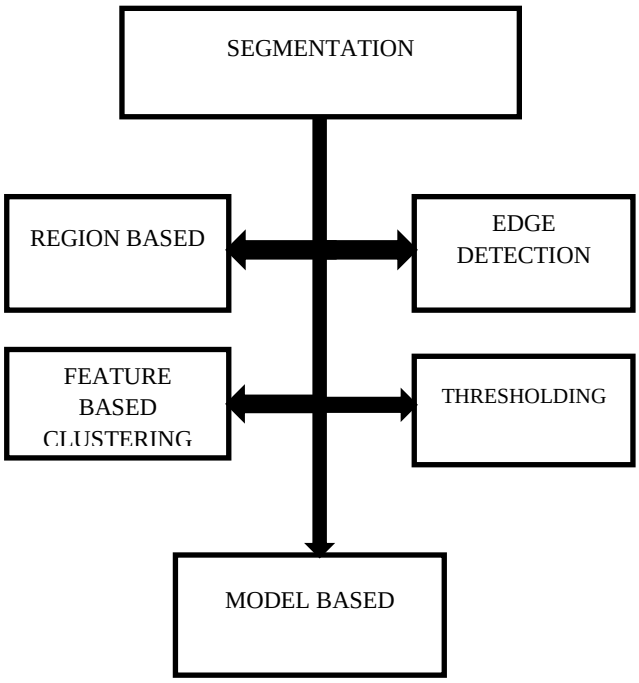

Fig 1.1 Various Types of Segmentation

The property of a pixel in an image and information of pixels near to that pixel are two basic parameters for any image segmentation algorithm. It can also be representing as similarity of pixels in any region and discontinuity of edges in image. Edge based segmentation is used to divide image on the basis of their edges.

Region based methods used the threshold in order to separate the background from an image, whereas neuralnetwork based techniques used the learning algorithm to train the image segmentation process [4].

The result taken from image segmentation process is the main parameter for further image processing research; this result will also determine the quality of further image processing process. Image segmentation algorithms play an important role in medical applications, i.e., diagnosis of diseases related to brain [5]-[8] heart, knee, spine, pelvis, prostate and blood vessel, and pathology localization. Therefore, Image segmentation is still a very hot area of research for image processing field. It is still a challenging task for researchers and developers to develop a universal technique for image segmentation [9].

Image segmentation is also used to differentiate different objects in the image, since our image is divided into foreground and background, whereas foreground of image is related to the region of interest, and background is the rest of the image. Hence, image segmentation will separate these two parts from one another.

II. CLASSIFICATION:

Segmentation can be classified as follows:

- Region Based
- Edge Based
- Threshold
- Feature Based Clustering
- Model Based.

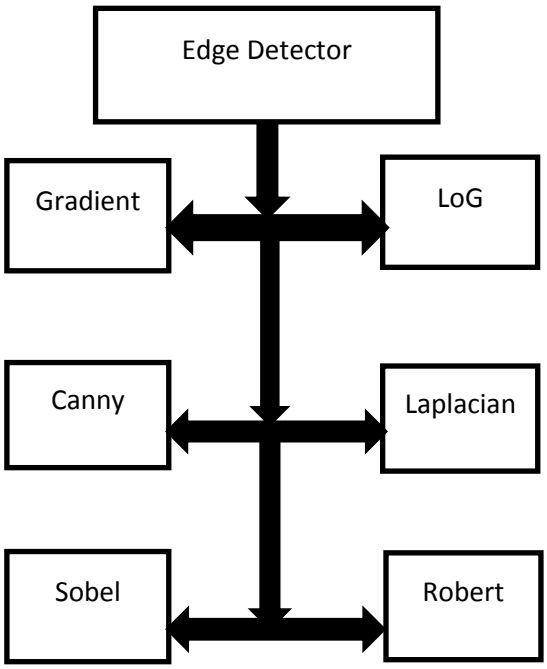

Fig 1.2 Types of Edge Detection

a. *Region Based*

In this technique pixels that are related to an object are grouped for segmentation [27].The thresholding technique is bound with region based segmentation. The area that is detected for segmentation should be closed. Region based segmentation is also termed as "Similarity Based Segmentation" [4]. There won't be any gap due to missing edge pixels in this region based segmentation [21]

The boundaries are identified for segmentation. In each and every step at least one pixel is related to the region and is taken into consideration [13]. After identifying the change in the color and texture, the edge flow is converted into a vector.From this the edges are detected for further segmentation [28]

b. Edge Based

Segmentation can also be done by using edge detection techniques. There are various techniques and is described in Fig 2. In this technique the boundary is identified to segment. Edges are detected to identify the discontinuities in the image. Edges on the region are traced by identifying the pixel value and it is compared with the neighboring pixels. For this classification they use both fixed and adaptive feature of Support Vector Machine **(**SVM**)** [5] In this edge based segmentation, there is no need for the detected edges to be closed.

There are various edge detectors that are used to segment the image. In that Canny edge detector has some step by step procedure for segmentation is mentioned in Fig 1.3, which is as follows:

Fig 1.2 Input Image

1. To reduce the effect of noise, the surface of the image is smoothened by using Gaussian Convolution.
2. Sobel operator is applied to the image to detect the edge strength and edge directions.

3. The edge directions are taken into considerations for non-maximal suppression i.e., the pixels that are not related to the edges are detected and then, they are minimized.
4. Final step is removing the broken edges i.e., the threshold value of an image is calculated and then the pixel value is compared with the threshold that is obtained. If the pixel value is high than the threshold then, it is considered as an edge or else it is rejected.[4]

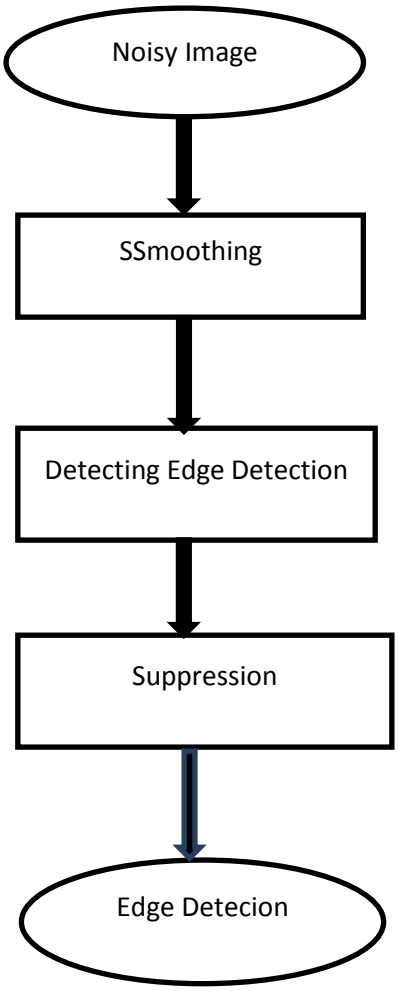

Fig 1.3 Canny Edge Detector

The technique that is used for segmenting the remote sensing image has high spatial resolution. The two step procedures for segmentation are extracting the edge information from the edge detector and then the pixels are labeled.

The advantage of this technique is retrieving information from the weak boundary too. Spatial resolution for segmentation improves positional accuracy .Based on the edge flow, the image is segmented. It identifies the direction of the change in color and texture of a pixel in an image to segment. Segmentation can also be done through edges.

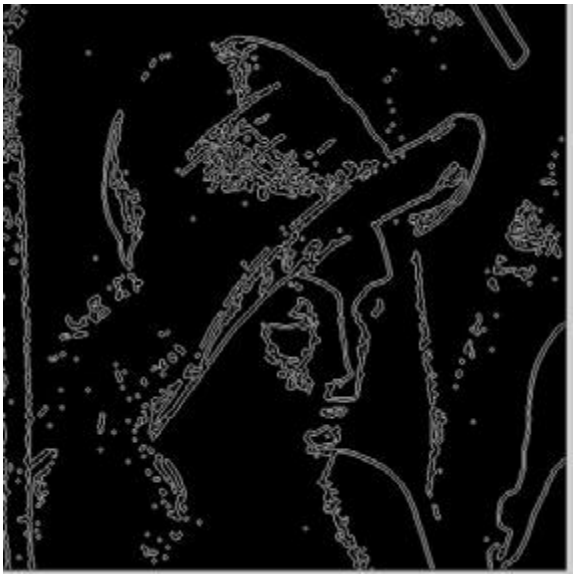

Fig Canny Edge Detection

Fig LoG

Advantages
1. An approach similar to how humans segment images.
2. Works well in images with good contrast between object and background.

Disadvantages
1. Does not work well on images with smooth transitions and low contrast
2. Sensitive to noise
3. Robust edge linking is not trivial

c. Threshold

Threshold is the easiest way of segmentation. It is done through that threshold values which are obtained from the histogram of those edges

of the original image. The threshold values are obtained from the edge detected image.

Fig Thresholding

c. Threshold

Threshold is the easiest way of segmentation. It is done through that threshold values which are obtained from the histogram of those edges of the original image. The threshold values are obtained from the edge detected image. So, if the edge detections are accurate then the threshold too. Segmentation through threshold has fewer computations compared to other techniques.

Roughness measure is followed by a threshold method for image segmentation. Segmentation is done through adaptive threshold. The gray level points where the gradient is high, is then added to threshold surface for segmentation. The drawback of this segmentation technique is that it is not suitable for complex images.

d. Feature Based Clustering

Segmentation is also done through Clustering. They followed a different procedure, where most of them apply the technique directly to the image but here the image is converted into histogram and then clustering is done on it. Pixels of the color image are clustered for segmentation using an unsupervised technique Fuzzy C. This is applied for ordinary images. If it is a noisy image, it results to fragmentation.

A basic clustering algorithm that is K-means is used for segmentation in textured images. It clusters the related pixels to segment the image Segmentation is done through feature clustering and there it will be changed according to the color components .Segmentation is also purely depending on the characteristics of the image. Features are taken into account for segmentation. Difference in the intensity and color values are used for segmentation.

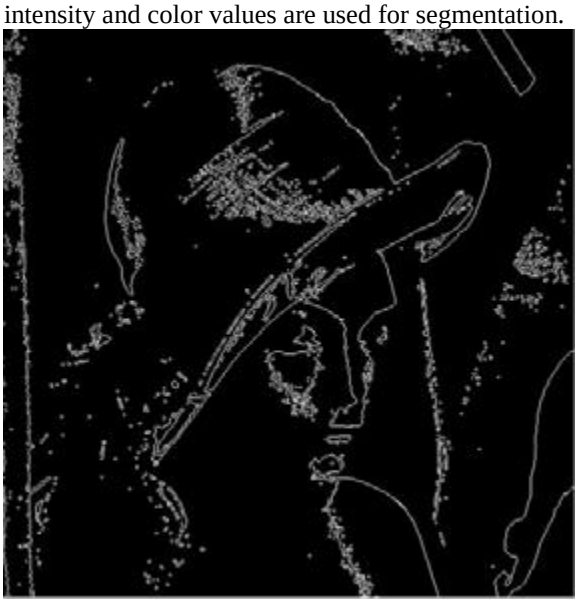

Fig Laplacian

For segmentation of color image they use Fuzzy Clustering technique, which iteratively generates color clusters using Fuzzy membership function in color space regarding to image space.

The technique is successful in identifying the color region. Real time clustering based segmentation. A Virtual attention region is captured accurately for segmentation. Image is segmented coarsely by Multi threshold. It is then refined by Fuzzy C-Means Clustering. The advantage is applied to any multispectral images.

Segmentation approach for region growing is K-Means Clustering. A Clustering technique for image segmentation is done with cylindrical decision elements of the color space. The surface is obtained through histogram and is detected as a cluster by threshold.

Seeded Growing Region (SRG) is used for segmentation. It has a drawback of pixel sorting for labeling. So, to overcome this boundary oriented parallel pixel labeling technique is obtained to do.

e. Model Based

Markov Random Field (MRF) based segmentation is known as Model based segmentation. An inbuilt region-smoothness constraint is presented in MRF which is used for color segmentation. Components of the color pixel tuples are considered as independent random variables for further processing. MRF is combined with edge detection for identifying the edges accurately.

MRF has spatial region smoothness constraint and there are correlations among the color components. Expectation-Maximization (EM) algorithm values the parameter is based on

unsupervised operation. Multi-resolution based segmented technique named as "Narrow Band". It is faster than the traditional approach.

The initial segmentation is performed at coarse resolution and then at finer resolution. The process moves on in an iterative fashion. The resolution based segmentation is done only to the part of the image. So, it is fast.

The segmentation may also be done by using Gaussian Markov Random Field (GMRF) where the spatial dependencies between pixels are considered for the process Gaussian Markov Model (GMM) based segmentation is used for region growing. The extension of Gaussian Markov Model (GMM) that detects the region as well as edge cues within the GMM framework. The feature space is also detected by using this technique.

III. CONCLUSION

This paper summarizes various segmentation techniques and the advantages and the disadvantages Thus segmentation is done to estimate the surfaces. Segmentation can be applied to any type of images. Comparing to other methods thresholding is the simplest and computationally fast. Depending on the application thetechnique varies.

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