Segmentation Techniques Comparison in Image Processing

R.Yogamangalam[#1], B.Karthikeyan[#2]
[#] School of Computing, SASTRA University,
Thanjavur, TamilNadu, India
[1] iswaryaramalingam3@gmail.com
[2] karthikeyan@it.sastra.edu

Abstract:

In day-to-day life, new technologies are emerging in the field of Image processing, especially in the domain of segmentation. This paper presents a brief outline on some of the most common segmentation techniques like thresholding, Model based, Edge detection, Clustering etc., mentioning its advantages as well as the drawbacks. Some of the techniques are suitable for noisy images. In that Markov Random Field (MRF) is the strongest method of noise cancellation in images whereas thresholding is the simplest technique for segmentation.

Keywords: Threshold, Clustering, MRF, Edge Detection

I. INTRODUCTION:

Segmentation is the most important part in image processing. Fence off an entire image into several parts which is something more meaningful and easier for further process. These several parts that are rejoined will cover the entire image.Segmentation may also depend on various features that are contained in the image. It may be either color or texture. Before denoising an image, it is segmented to recover the original image.The main motto of segmentation is to reduce the information for easy analysis. Segmentation is also useful in Image Analysis and Image Compression.

II. CLASSIFICATION:

Segmentation can be classified as follows:

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

The classification is specified in Fig 1

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]

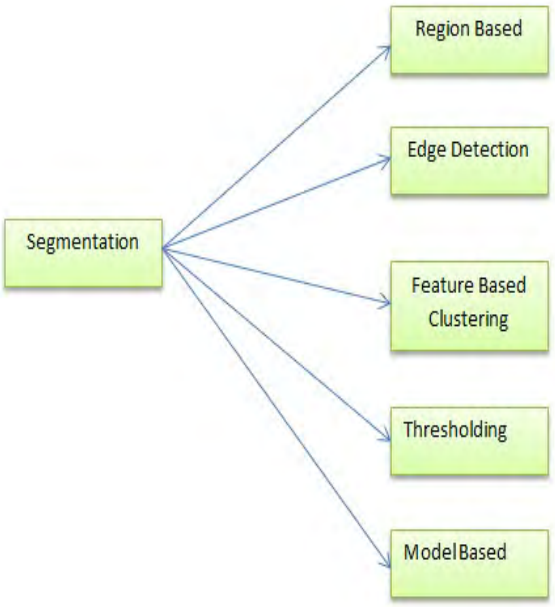

Fig 1.Various types of segmentation

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 3, which is as follows:

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]

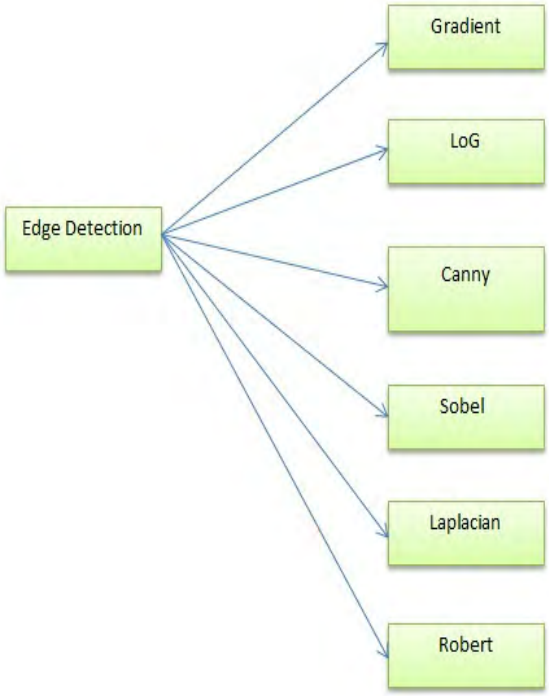

Fig 2: Types of Edge Detection

The Canny Edge Detection procedure is described in the flowchart.

Edges are the discontinuities in the sense of intensity, which gives us a layout of an object. All objects in the image are traced when the intensities are calculated accurately [30].

Fig 3: Canny Edge Detector procedure

Various Edge Detectors are described.

- The edges are detected by calculating the minimum and maximum of first derivative in gradient edge detector.
- Zero Crossing is found in second derivative to identify the edges in Laplacian edge detector.
- Sobel Edge Detector uses Convolution Kernel to detect the edges.
- Magnitude of the spatial gradient is calculated for edges in Robert's Edge Detector.
- Canny Edge Detector also uses high spatial gradient but it takes more computation than Sobel and Robert's Edge Detector. [32]

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 [9]. Spatial resolution for segmentation improves positional accuracy [29]. 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 [12].

Segmentation can also be done through edges. There will be some gap between the edges as it is not closed. So, the gap is filled by edge linking. The broken edges are extended in the direction of the slope for the link to get the connectivity for segmentation [14].

c. Threshold:

Thresholding 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 [35]. The threshold values are obtained from the edge detected image. So, if the edge detections are accurate then the threshold too. Segmentation through thresholding has fewer computations compared to other techniques. [23]Segmentation is based on "his ton". For a particular segment there may be set of pixels which is termed as "his ton". Roughness measure is followed by a thresholding method for image segmentation. [18]

Segmentation is done through adaptive thresholding. The gray level points where the gradient is high, is then added to thresholding surface for segmentation [10] 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 [26]. 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 [2].

A basic clustering algorithm i.e., K-means is used for segmentation in textured images. It clusters the related pixels to segment the image [8] Segmentation is done through feature clustering and there it will be changed according to the color components [15]. Segmentation is also purely depending on the characteristics of the image [31]. Features are taken into account for segmentation. Difference in the intensity and color values are used for segmentation [17].

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 [19]. Real time clustering based segmentation. A Virtual attention region is captured accurately for segmentation. [20] Image is segmented coarsely by multithresholding .It is then refined by Fuzzy C-Means Clustering. The advantage is applied to any multispectral images [22]

Segmentation approach for region growing is K-Means Clustering. [1] 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 thresholding [11].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 SRG [24].

e. *Model Based:*

Markov Random Field (MRF) based segmentation is known as Model based segmentation [6]. An inbuilt region smoothness constraint is presented in MRF which is used for color segmentation [3]. 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 [34].

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. Multiresolution 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. [25]

The segmentation may also be done by using Gaussian Markov Random Field **(**GMRF**)** where the spatial dependencies between pixels are considered for the process [7] Gaussian Markov Model (GMM) based segmentation is used for region growing.[1] 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. [33]

III. EXPERIMENTAL RESULTS:

The various segmentation techniques are performed in this section. A simulation study is done to compare the various methods for segmentation and to detect the edges accurately.

Fig 4: Shows the result of Canny edge detection, where the image is detected in the Sobel and then processed in the canny edge detector.

Fig 4: Canny Edge Detection

Fig 5: Represents the result of Gradient Edge detector or LoG.

Fig 5: LoG

Fig 6: Shows the result of thresholding which gives us the accurate result.

Fig 6: Thresholding

Fig 7: Shows the result of Laplacian edge detector

Fig 7: Laplacian

IV. CONCLUSION:

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

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