

A SURVEY ON DIFFERENT IMAGE SEGMENTATION TECHNIQUES AND K-MEANS ALGORITHM

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ABSTRACT

In image processing, segmentation refers to the process of partitioning a digital image into multiple segments. Image segmentation is used to locate objects and boundaries (lines, curves, etc.) in images. In image segmentation every pixel in an image is assigned with a label so that pixels with the similar label share certain characteristics. The end result of image segmentation is a set of segments that together cover the entire image, or a set of contours which are extracted from the image. Each of the pixels in a region is similar with respect to some property and characteristics, such as colour, intensity, or texture. A number of algorithms have been proposed due to the importance of image segmentation but based on the image that is inputted, the appropriate algorithm should be chosen to obtain the best results.

Keywords: Clustering, Threshold, Edge Detection, K - Means

1. INTRODUCTION

All image processing operations generally aim at a better identification of objects of interest, i.e., at finding appropriate local features that can be differentiated from other objects and also from the background. The next step is to check each individual pixel to identify whether it belongs to an object of interest or not. This operation is called *segmentation* and it produces a *binary image*. A pixel has the value one if it fits in to the object; otherwise it is zero. Segmentation is the operation at the threshold between *image analysis and low-level image processing*. After segmentation, it is known that which pixel belongs to which object. The image is partitioned into regions and we know the discontinuities as the boundaries between the regions. Various types of segmentation are portrayed in fig 1.

2. TYPES OF SEGMENTATION

The various types of segmentation includes

2.1 REGION BASED:

Region based methods are based on continuity. In this technique, the entire image is divided into sub regions depending on some rules like all the pixels

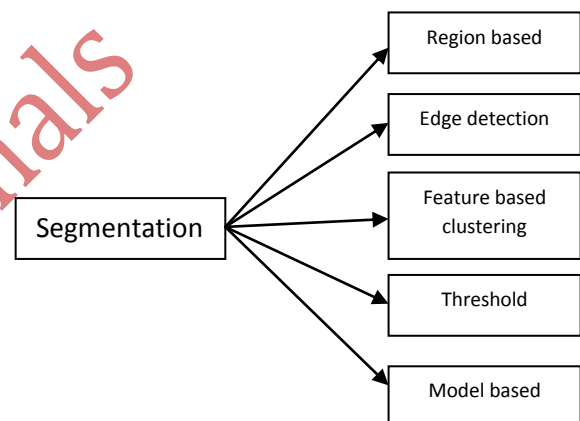


Fig 1: various types of segmentation

in one region must have the same gray level. The thresholding technique is bound with region based segmentation. The area that is discovered for segmentation should be closed. It is also known as “**Similarity Based Segmentation**”. There will not be any break due to missing edge pixels in this region based segmentation. In each step at least one pixel is related to the region and is taken into consideration. After identifying the change in the colour and texture, the edge flow is converted into a vector.

2.2 EDGE BASED

Segmentation can also be performed by using edge detection techniques. There are various edge based techniques and is described in Fig 2. Edges are detected to identify the discontinuities in the image. Edges on the region can be traced by identifying the pixel value and it is compared with the neighbouring pixel values. For this

classification they use fixed and adaptive feature of Support Vector Machine (SVM). In this edge based segmentation, the detected edges need not be closed. There are various edge detectors that are used to segment the image.

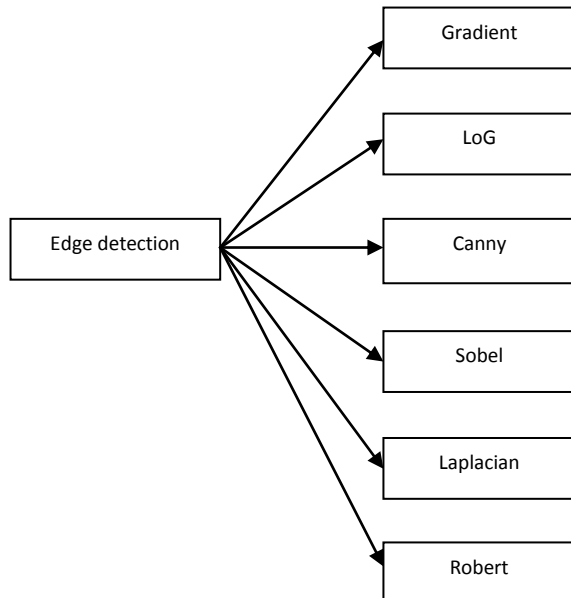


Fig 2: Types of Edge Detection

The steps followed during Canny edge detector are as follows:

1. The surface of the image is smoothened using Gaussian Convolution, in order to reduce the effect of noise.
2. To detect the edge strength and edge directions the Sobel operator is applied to the selected image.
3. The edge directions are also taken into considerations for non-maximal suppression i.e., the pixels that are not related to the edges are identified and then, they are reduced.
4. Final step is elimination of the broken edges i.e., the threshold value of an image is considered and then the pixel value is compared with the threshold obtained. If the pixel value is high than the threshold, then it is considered as an edge or else it is rejected.

The Canny Edge Detection procedure is portrayed in the fig 3. Various Edge Detectors are described.

- Gradient edge detector - The edges are detected by calculating the minimum and maximum of first derivative
- Laplacian edge detector - Zero Crossing is found in second derivative to identify the edges
- Sobel Edge Detector - uses Convolution Kernel to detect the edges.
- Robert's Edge Detector - Magnitude of the spatial gradient is calculated for edges

- Canny Edge Detector - uses high spatial gradient but it takes more computation than Sobel and Robert's Edge Detector.

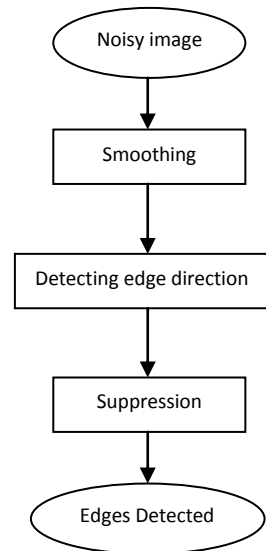


Fig 3: Canny Edge Detector procedure

The technique that is used for the remote sensing image segmentation has high spatial resolution. The two important activities for segmentation are extracting the edge information from the edge detector and pixels labelling. The benefit of this technique is information from the weak boundary can also be retrieved. Positional accuracy is improved by spatial resolution. Based on the edge flow, the image is segmented. It identifies the direction of the change in colour and texture of a pixel in an image to segment. Since the edges are not completely closed there will be some gap. Those gaps are filled by edge linking. The broken edges are extended in the direction of the slope for the link to get the connectivity for segmentation.

2.3 THRESHOLD:

Image segmentation by using threshold method is quite simple approach for segmenting images. This method can be applied for images having light object on darker background or vice versa. Thresholding algorithm will choose a proper threshold value T and this selected value is used to divide image pixels in to several classes and separate objects from the background. The pixel (x, y) for which $f(x, y) \geq T$ is considered to be foreground while any pixel (x, y) which has value $f(x, y) < T$ is background. Based on the selection of threshold value, there are two types of thresholding method.

2.3.1 Global Thresholding:

Global (single) thresholding method is used when the intensity distribution between the objects of foreground and background are very different. A single value of threshold can be used to differentiate objects apart when the differences between foreground and background objects are very distinct. Thus, in this type of thresholding, the value of threshold (T) depends completely on the grey level value of the image and the property of the pixel. Some most common used global thresholding methods are Otsu method, entropy based thresholding, etc.

2.3.2 Local thresholding

In local thresholding images is divided into several sub regions and then choose various thresholds (Ts) for each sub region respectively. Thus, threshold depends on both $p(x, y)$ and $f(x, y)$. Some of the local thresholding techniques are simple statistical thresholding, histogram transformation thresholding, 2-D entropy-based thresholding, etc.

2.4 FEATURE BASED CLUSTERING:

Segmentation is also done by Clustering. In this method the image is converted into histogram and then clustering is done. Pixels of the colour image are clustered for segmentation using an unsupervised technique called Fuzzy C. This is applied for ordinary images. If it is a noisy image, it leads to fragmentation. A clustering algorithm i.e., K-means is used for textured images segmentation. It groups the related pixels to sector the image. Segmentation is also entirely depending on the features of the image. Differences in the colour and intensity values are used for segmentation. For segmentation of colour image employ Fuzzy Clustering technique, and this iteratively creates colour clusters using Fuzzy membership function in colour space concerning to image space. The technique is doing well in recognizing the colour region.

2.5 MODEL BASED:

Markov Random Field (MRF) based segmentation is otherwise named as Model based segmentation. An inbuilt region smoothness constraint is available in MRF and it is used for colour segmentation. Components of the colour pixel tuples are considered as independent random variables and used for further processing. MRF is merged with edge detection for identifying the edges precisely. MRF has spatial region smoothness constraint and there are correlations among the colour components. 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.

3. K – MEANS ALGORITHM

It is an algorithm to group or to classify your objects based on features/attributes into K number of group. K is positive integer number. The classification is done by minimizing the sum of squares of distances between data and the corresponding cluster centroid. Thus, the idea of K-mean clustering is to classify the data. For example of data classification refer table 1.

Example: Suppose we have 4 objects as training data and each object have 2 attributes. Each attribute represents coordinate of the object.

Object Attribute	1 (X): weight index Attribute	2 (Y): quality
Product A	1	1
Product B	2	1
Product C	4	3
Product D	5	4

Table 1 : Classification of data

The difficulty is to determine which products belong to cluster 1 and which products belong to the other cluster. Each product represents one point with two components coordinate.

The K – Means algorithm needs three user-specified parameters: the number of clusters (k), cluster initialization, and the distance metric. This clustering procedure is used to allot every pixel to one of the clusters. Using the properties of the cluster centre each and every pixel is assigned to one of these classes. Each pixel of an object is classified into k clusters based on some constraint. Therefore each pixel is classified into any of the k clusters by calculating the Euclidean distance between the pixel and each colour indicator. The clusters correspond to nucleus (high saturation), background, and other cells.

Depending on the minimum distance from each indicator each pixel of the entire image will be labelled to a particular colour. Once these actions are performed we perform:

Edge enhancement (used by the sobel operator), to enhance the borders of the membranes and the cells

Canny edge detection, to obtain output with continuous edges

Dilation, to connect the separated points of the membrane

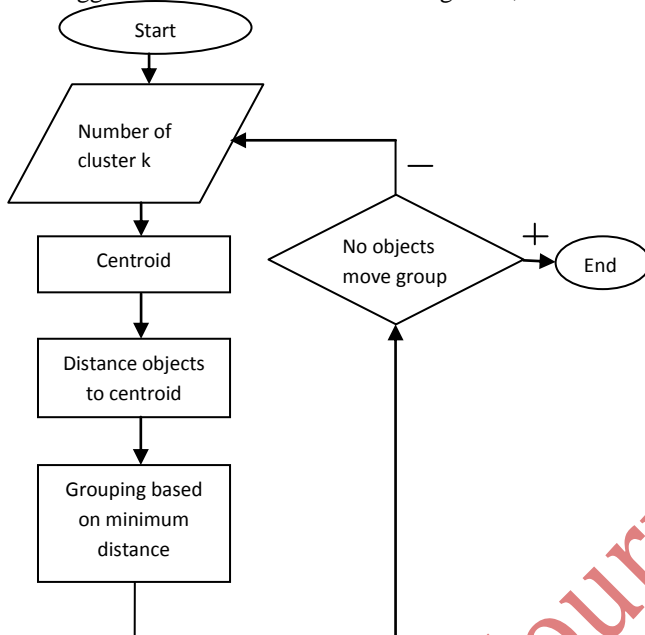
Hole filling, to fill the holes

Basic algorithm of K - Means

Algorithm 1 Basic K-means Algorithm.

- 1: Select K points as the initial centroids.
- 2: repeat
- 3: Form K clusters by assigning all points to the closest centroid.
- 4: Recompute the centroid of each cluster.
- 5: until The centroids don't change

The limitations of this algorithm include K-means struggles when clusters are of differing sizes,



densities, non-globular shapes. And K-means has problems when the data contains outliers.

4. CONCLUSION

Image segmentation has developed into a very important task in today's state of affairs. In the present day world computer vision has become an interdisciplinary field and its applications can be found in any area like medical, remote sensing, electronics and so on. Thus, to find an appropriate segmentation algorithm based on your application and the type of inputted image is very important. In this paper the author has explained and suggested a few application specific segmentation algorithms which also take into consideration the type of image inputted like colour, gray scale and text.

5. ACKNOWLEDGEMENTS

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