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# A SURVEY OF VARIOUS IMAGE SEGMENTATION TECHNIQUES

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**Abstract**— In computer vision, image segmentation is the process of partitioning a digital image into multiple sections. The goal of segmentation is to optimize and/or change the representation of an image into something that is more important and easier to examine. Image segmentation is used to identify objects and background in images. 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 properties. Image segmentation is a signal processing tool that is widely employed in many applications including object based coding, object tracking, object detection, image retrieval, and clinical organ or tissue identification. This survey, critically analyzed various segmentation techniques such as thresholding, edge based segmentation, fuzzy and k-means clustering, region based segmentation and also covered image segmentation overview such that its types, classification.

**Key Words**— Image Segmentation, Clustering, Thresholding, Partitioning, classification.

## I. INTRODUCTION

Image segmentation is the process of identifying and separating relevant objects and structures in an image. This is a basic problem in image analysis–accurate segmentation of objects required further processing and analysis can be performed. In image segmentation image is separated in to some regions and in that region each pixel is similar with respect to some of the characteristic such as the color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic(s).

The main purpose of the segmentation process is to get more information in the region of interest in an image which helps in annotation of the object scene. Image segmentation aims at domain-independent partition of the image into a set of visually distinct and homogeneous regions with respect to certain properties. The main goal of segmentation is to clearly differentiate the object and the background in an image. The result of segmentation of image is considerably depends on the accuracy of feature computation. Image segmentation is the computer aided so that the computerization of medical image segmentation plays an important role in medical imaging applications. Image segmentation process that subdivides an image into its constituent parts and extracts those parts of interest or objects.

## II. SEGMENTATION TECHNIQUES

Image segmentation has emerged as an important phase in image based applications. Segmentation is the process of separating a digital image in to multiple regions and extracting a meaningful region known as the region of interest (ROI).Image segmentation algorithms are based on either discontinuity principle or similarity principle. The intention behind the discontinuity principle is to extract regions that differ in properties such as intensity, colour, texture, or any other image statistics. The objective behind the similarity principle is to group pixels based on common property.

 

### 2.1 Thresholding

Threshold is one of the widely methods used for image segmentation. It is helpful in discerning foreground from the background. By selecting a sufficient threshold value T, the grey level image can be change to binary image. The binary image contain all of the essential information about the position and shape of the objects of interest (foreground). The benefit of obtaining first a binary image is that it reduces the complexity of the data and simplifies the process of recognition and classification. The most usual way to transform a grey-level image to a binary image is to select a single threshold value (T). Then all the grey level values below this T will be classified as black (0), and those above T will be white (1). The segmentation problem becomes one of selecting the proper value for the threshold T. A frequent technique used to select T is by analysing the histograms of the type of images that want to be segmented.

### 2.2 Clustering

Clustering is defined as an unsupervised learning task, where one needs to locate a finite set of categories known as clusters to classify pixels. The grouping of pixels into clusters is based on the principle of the intra class similarity minimization and the inter class similarity maximization.

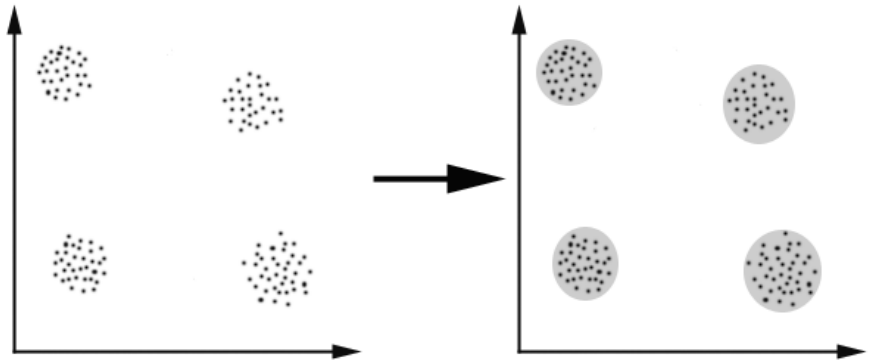

**Figure.1. Clustering**

According to characteristics of an algorithm, we may divide the clustering algorithms into broadly hard clustering and soft clustering.

#### 2.2.1 Hard Clustering

Hard clustering methods are applicable to data sets that have a large difference between groups i.e. it has sharp boundaries between clusters and a pixel belongs to one and only one cluster. The most popular algorithm of hard clustering algorithm is K-means clustering algorithm. It is simple to implement and computational cost is also low, which makes it the first preference with large data sets. But in this technique, "K" the number of clusters must be determined .It may lead to different results for each execution which depends on initial cluster centroids.

#### 2.2.2 Soft Clustering

Fuzzy clustering techniques are used when there are no crisp boundaries between objects in an image. These techniques classify pixel values with great extent of accuracy and are suitable for decision applications like tissue classification and tumour detection etc.

Some of the fuzzy clustering algorithms are Fuzzy C means, Gustafson-Kessel, Gaussian mixture decomposition, Fuzzy C varieties etc. Fuzzy C means is the most popular method as preserves more information than other approaches but in case of noisy images does not consider spatial information which has led to the development of several other algorithms as improved FCM, GSFCM, and Mean shift based FCM, etc.

 

### 2.3 Histogram Based Segmentation

Histogram-based image segmentation is one of the simplest and most often used segmentation methods. It uses the histogram to choose the grey levels for grouping pixels into regions. In an image there are two entities: the background and the object. The background is generally one grey level and occupies most of the image. Therefore, its grey level is a large peak in the histogram. The object or subject of the image is another grey level, and its grey level is another, little peak in the histogram.

### 2.4 Region Based Segmentation

Accurate and automated segmentation plays an important role in the image processing systems, as error in this process will be propagated further. The general purpose of the color image segmentation is to arrive at results insensitive to shadows, changes in lighting intensity and surface reflection properties (e.g. highlights). The region-based image segmentation creates regions by grouping together similar pixels with higher accuracy than pixel-based segmentation algorithms.

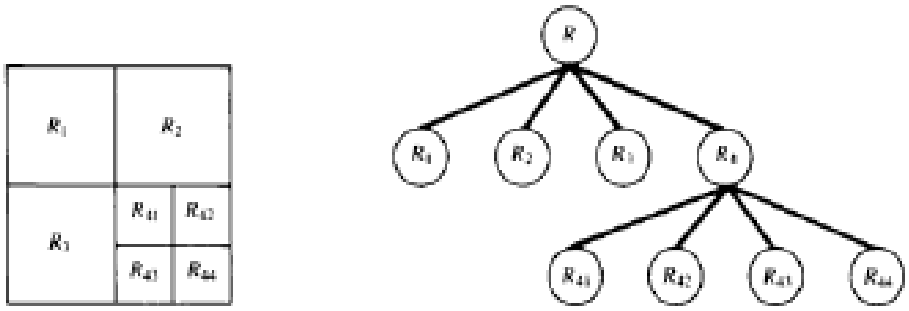

**Figure.2. Region Based Segmentation**

The region growing method, proposed just thirty years ago for grey level images, is present-days used efficiently for color image segmentation. Region growing is one of the most basic concepts used in image segmentation methods. Every single pixels (sometimes called seeds) are merged if their features (grey level, color or texture) are close enough. Color similarity can be established by calculating the value of a homogeneity criterion. Each tested pixel is compared to its immediate neighboring regions. If a homogeneity criterion is satisfied then the tested pixel belongs to region and all attributes of region are updated. If a uniformity criterion is not satisfied then the tested pixel with a new label starts as a new region. The method of growing is continued until all pixels in image merge in regions as equivalent as possible. Region growing is a bottom-up segmentation technique that can use different criteria for measurement of region homogeneity. These criteria are crucial in determining the segmentation results.

### 2.5 Graph Based Segmentation

Let G = (V,E) be an undirected graph with vertices vi ∈ V , the set of components to be segmented, and edges (vi; vj) ∈ E related to pairs of neighboring vertices. Each edge (vi; vj ∈ E has a related weight w((vi; vj)), which is a non-negative estimation of the dissimilarity between neighboring elements vi and vj . In the case of image segmentation, the elements in "V" are pixels and the weight of an edge is some measure of the dissimilarity between the two pixels connected by that edge (e.g., the difference in intensity, color, motion, location and some other local attribute).

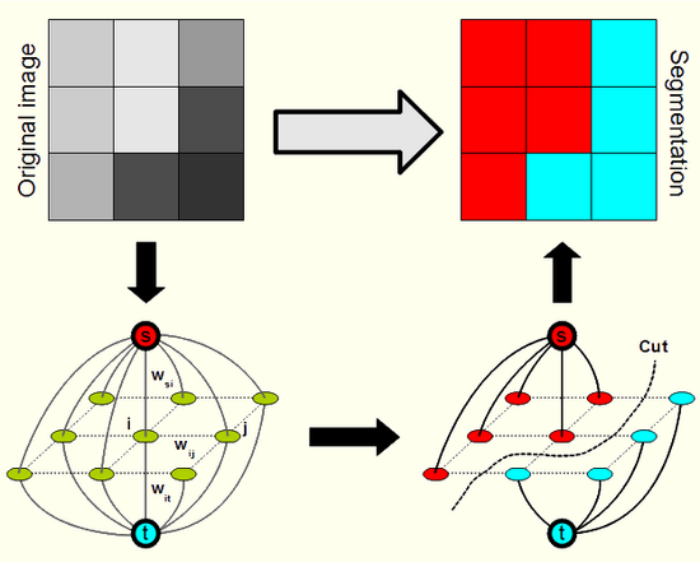


**Figure.3. Graph Based Segmentation**

In the graph-based approach, a segmentation S is a partition of V into components such that each component (or region) C 2 S corresponds to a connected component in a graph Go = (V;Eo). In other words, any segmentation is induced by a subset of the edges in E. There are several ways to measure the quality of segmentation but in general we want the elements in a component to be similar, and elements in divergent components to be unrelated. This means that edges between two vertices in the same component should have relatively low weights, and edges between vertices in dissimilar components should have higher weights.

### 2.5.1 Markov Random Fields

Markov random field (MRF) model is not so old in remote sensing applications as compared to histogram thresholding. MRF model was conceptualised from Ising model. MRF model takes into account the neighbourhood relationship which makes it attractive for modelling texture and contexture of images. The detailed mathematics of types of MRF models and their estimations can be found in the book by Li. However, a short summary of applications on remote sensing image segmentation is presented here.

### 2.6 Edge Based Segmentation

Edge-based segmentation determines a large group of methods based on information about edges in the image. Edge-based segmentations rely on edges found in an image by edge detecting operators these edges mark image locations of discontinuities in grey level, colour, texture, etc. Segmentation Methods based on Discontinuity find for abrupt changes in the intensity value. These methods are known as Edge or Boundary based methods .Edge detection techniques are generally used for finding discontinuities in grey level images.

There are several methods for edge detection, but most of them can be grouped into two categories, search based and zero-crossing based. The search-based methods find edges by first computing a measure of edge strength, usually a first-order derivative expression. The zero-crossing based methods search for zero crossings in a second-order derivative expression calculated from the image in order to find edges.

### *2*.6.1. 1st order Derivative

**1) Prewitt operator**- it is a discrete differentiation operator, determining an approximation of the gradient of the image intensity function. At individual point in the image, the outcome of the Prewitt operator is either the corresponding gradient vector or the norm of this vector. The Prewitt operator is

based on requiring the image with a little, dividable, and integer valued filter in horizontal and vertical directions and is therefore relatively inexpensive in terms of computations.

**2) Sobel operator-** It is a discrete differentiation operator, finding an approximation of the gradient of the image intensity function. At every point in the image, the result of the Sobel operator is either the corresponding gradient vector or the norm of this vector. The Sobel operator is based on requiring the image with a small, dividable, and integer valued filter in horizontal and vertical direction and is therefore relatively inexpensive in terms of computations.

**3) Canny operator-** The Canny edge detector is an edge detection operator that uses a multi-stage algorithm to detect a wide range of edges in images. It was evolved by John F. Canny in 1986. Canny also invented a computational theory of edge detection explaining why the technique works.

### 2.6.2. 2nd Order Derivative

**1) Laplacian operator-** There must exist a point where there is a zero crossing. That point is the location of edge. Edge detectors that are depending on this idea are called Laplacian edge detectors.

**2) Zero-crossings-** In the field of Digital Image Processing, great significance is placed on operators which seek out edges within an image. They are called 'Edge Detection' or 'Gradient filters'. A gradient filter is a filter which pursue out areas of rapid change in pixel value. These points are normally mark an edge or a boundary. A Laplace filter is a filter suitable for this family, though it sets about the task in a different way. It pursue out points in the signal stream where the digital signal of an image passes through a pre-set '0' value, and indicates this out as a potential edge point. Because the signal has passed through the point of zero, it is known as zero-crossing.

### 2.7 Watershed Transform

The watershed transform can be classified as a region-based segmentation technique. The innovative idea underlying this method comes from geography: it is that of a landscape or topographic relief which is flooded by water, watersheds being the disparate lines of the domains of attraction of rain falling over the region. An approach is to imagine the landscape being dipped in a lake, with holes punched in local minima. When water arriving from different basins would meet, dams are built at points. When the water level has reached the highest peak in the landscape, the process is stopped. As a result, the landscape is partitioned in to regions or basins separated by dams known as watersheds.

When simulating this process for image segmentation, two approaches are used, either One finds basins, then watersheds by taking a set complement or one computes a complete partition of the image into basins, and subsequently finds the watersheds by boundary detection. To be more explicit use the expression `watershed transform' to denote a labelling of the image, such that all points of a given catchment basin have the same unique label, and a special label, distinct from all the labels of the catchment basins, is assigned to all points of the watersheds.

### 2.8 Model Based Segmentation

The human eye has the ability to recognize objects even if they are not completely visible. All the techniques mentioned above utilize only local information. In this case, specific knowledge is required about the geometrical shape of the object, which can then be compared with the local information to recreate the object. This segmentation technique is applicable only if we know the exact shape of the objects contained in the image.

## III. CONCLUSION

In this review of image segmentation study, the overview of several segmentation methodologies applied for digital image processing is described briefly. Even though many techniques are developed, not all types are useful for all types of images. It is establish that there is no perfect

 

method for image segmentation because the result of image segmentation is depends on several criteria; there are pixel, texture, intensity, similarity of images, image content. Consequently, it is not possible to consider a single method for all type of images nor all methods can perform well for a particular type of image.

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