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# Image segmentation by using K-Means Clustering

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***Abstract:*** *Image segmentation plays a significant role in computer vision. It aims at extracting meaningful objects lying in the image. Generally there is no unique method or approach for image segmentation. The goal of image segmentation is to cluster pixels into salient image regions i.e. regions corresponding to individual surfaces, objects, or natural parts of objects. The idea is to change the representation of an image into something that is more meaningful and easier to analyse. Clustering is a powerful technique that has been used in image segmentation. The cluster analysis partitions an image data set into a number of disjoint groups or clusters. The clustering methods such as K-means, Adaptive K-means, K-medoids and Modified k-means has been discussed in this work. K-means clustering is one of the popular methods because of its simplicity and computational efficiency. However, K-means clustering is dependent on the choice of the initial centroids and has the problem of giving different results on every run of the algorithm. In this work, we propose two center initialization methods for the use in K-means.*

***Keywords:*** *Means clustering, Image Segmentation*

## 1. INTRODUCTION

1.1. Image segmentation can be defined as the classification of all the picture elements or pixels in an image into different clusters that exhibit similar features. It is the process of partitioning a digital image into multiple segments based on pixels. The goal of image segmentation is to cluster pixels into salient image regions i.e. regions corresponding to individual surfaces, objects, or natural parts of objects. The idea is to change the representation of an image into something that is more meaningful and easier to analyze

1.2. Image segmentation is an important part of image processing and it also has various applications in engineering, bio-medicine and other areas. So far, a number of methods has been developed with the aim to identify the distinct region of objects in the image. This paper is devoted to application of three different methods of segmentation which are the watershed distance transform, gradient watershed transform and region growing method on microscopic crystal image. Before segmentation, the image was enhanced by pre-processing methods, such as denosing and adjusting of intensity. Segmentation is considered for both overlapping and no overlapping objects by all methods. Segmentation of the overlapping objects by the region growing method has been improved by certain mathematical processes that are described in this paper. Segmentation involves partitioning an image into groups of pixels which are homogeneous with respect to some criterion. Different groups must not intersect each other and adjacent groups must be heterogeneous.

“Image segmentation is the division of an image into a set of no overlapping regions whose union is the entire image. The purpose of segmentation is to break down the image into parts that are useful with respect to a particular application.”

## 2. IMAGE SEGMENTATION

1.1. Segmentation partitions an image into distinct regions containing each pixels with similar attributes. To be meaningful and useful for image analysis and interpretation, the regions should strongly relate to depicted objects or features of interest. Meaningful segmentation is the first step from low-level image processing.

1.2. Image segmentation is the process of separating a clone image into multiple parts (sets of elements, also known as super elements). The goal of segmentation is to simplify and/or change the delegation of an image into something that is more meaningful and easier to identify.

1.3. “Image segmentation is the division of an image into a set of no overlapping regions whose union is the entire image. The purpose of segmentation is to break down the image into parts that are useful with respect to a particular application.” There is no universally accepted method for image segmentation and therefore it remains a challenging problem in image processing and computer vision. Based on different technologies, image segmentation approaches are currently divided into following categories, based on two properties of image.

## 3. THRESHOLDING

3.1 The simplest method of image segmentation is called the thresholding method. During the thresholding process, individual pixels in an image are marked as "object" pixels if their value is greater than some threshold value (Assuming an object to be brighter than the background) and as "background" pixels otherwise. This convention is known as threshold above. Variants include threshold below, which is opposite of threshold above; threshold inside, where a pixel is labeled "object" if its value is between two thresholds; and threshold outside, which is the opposite of threshold inside. Typically, an object pixel is given a value of “1” while a background pixel is given

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a value of "0." Finally, a binary image is created by coloring each pixel white or black, depending on a pixel's labels. The key parameter in the thresholding process is the choice of the threshold value (or values). Several different methods for choosing a threshold exist.

## 4. REGION GROWING

Region growing is a simple region-based image segmentation method. It is also classified as a pixel-based image segmentation method since it involves the selection of initial seed points. The first region growing method was the seeded region growing method. This method takes a set of seeds as input along with the image.

The seeds mark each of the objects to be segmented. The regions are iteratively grown by comparing all unallocated neighboring pixels to the regions. The difference between a pixel's intensity value and the region's mean δ is used as a measure of similarity. The pixel with the smallest difference measured this way is allocated to the respective region. This process continues until all pixels are allocated to a region.Seeded region growing requires seeds as additional input. The segmentation results are dependent on the choice of seeds. Noise in the image can cause the seeds to be poorly placed.

## 5. SPLIT-AND-MERGE

Split-and-merge segmentation is based on a quadtree partition of an image. It is sometimes called quad tree segmentation. This method starts at the root of the tree that represents the whole image. If it is found non-uniform (not homogeneous), then it is split into four son-squares (the splitting process), and so on so forth. Conversely, if four son-squares are homogeneous, they can be merged as several connected components (the merging process). The node in the tree is a segmented node. This process continues recursively until no further splits or merges are possible. When a special data structure is involved in the implementation of the algorithm of the method, its time complexity can reach O(nlogn), an optimal algorithm of the method.

## 6. EDGE DETECTION

Edge detection refers to the process of identifying and locating sharp discontinuities in an image. The discontinuities are abrupt changes in pixel intensity which characterize boundaries of objects in a scene. Classical methods of edge detection involve convolving the image with an operator (a 2-D filter), which is constructed to be sensitive to large gradients in the image while returning values of zero in uniform regions. There are an extremely large number of edge detection operators available, each designed to be sensitive to certain types of edges.

Type of Edge Detection Techniques:

1. Roberts Edge Detection
2. Sobel Edge Detection
3. Prewitt Edge Detection
4. Kirsch Edge detection
5. Robinson Edge detection
6. Marr-Hildreth Edge Detection
7. LoG edge detection

## 7. CLUSTERING

Clustering is a classification technique. Given a vector of N measurements describing each pixel or group of pixels (i.e., region) in an image, a similarity of the measurement vectors and therefore their clustering in the N-dimensional measurement space implies similarity of the corresponding pixels or pixel groups. Therefore, clustering in measurement space may be an indicator of similarity of image regions, and may be used for segmentation purposes.

Simple clustering methods use greedy interactions with existing clusters to come up with a good overall representation. For example, in agglomerative clustering we repeatedly make the best available merge. However, the methods are not explicit about the objective function that the methods are attempting to optimize. An alternative approach is to write down an objective function that expresses how good a representation is, and then build an algorithm for obtaining the best representation. A natural objective function can be obtained by assuming that we know there are k clusters, where k is known.

## 8. FIGURES AND TABLES

**Figure 1:** Sample Image

**Image segmentation**

$$(a)\ \bigcup_{i=1}^{n} R_i = R.$$

$$(b)\ R_i \text{ is a connected region, } \mathrm{i} = 1,\ 2,\ \ldots, \mathrm{n}$$

$$(c)\ R_i \bigcap R_j = \varnothing \text{ for all } i = 1, 2, \ldots, n.$$

$$(d)\ P(R_i) = TRUE \text{ for } i = 1, 2, \ldots, n.$$

**Region Growing**

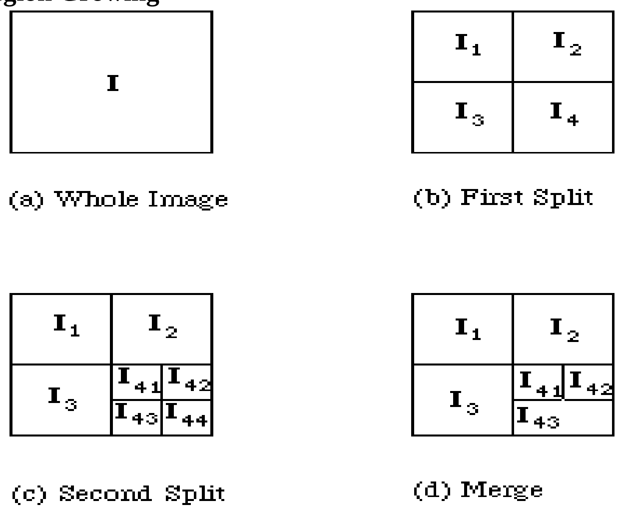


**Figure 2:** Split-and-merge. Example of region splitting and merging

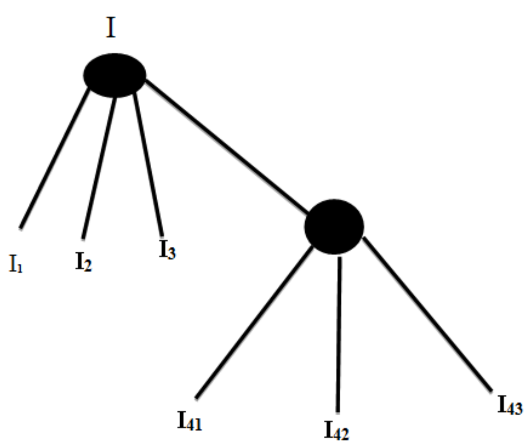


**Figure 3:** Diagram of region splitting and merging

| | | |
|---|---|---|
| -1 | 0 | +1 |
| -2 | 0 | +2 |
| -1 | 0 | +1 |

GX

| | | |
|---|---|---|
| +1 | +2 | +1 |
| 0 | 0 | 0 |
| -1 | -2 | -1 |

GY

**Figure 4:** Edge Detection

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