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A Survey and Analysis of Image Segmentation using various Techniques

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ABSTRACT
Image segmentation is a key fundamental step in a modern computational system .It is a process to decompose an image into various parts, called regions & each is asset of pixels. So its goal is to produce an simple and meaningful image with better quality. To segment an image various image segmentation techniques are used like Region Based Technique, watershed, Discontinuity based techniques etc. In this paper we analyses the image by using all these methods and giving the results & comparison b/t all them.

Keywords
Image segmentation, watershed based segmentation, Cluster based segmentation, Edge detection based segmentation.

1. INTRODUCTION
Image Segmentation: Image segmentation is a process which is used to partitioning an image into various set of pixels called regions. In image segmentation the pixels having same characteristics like **Color, texture, Size, Intenties ets** are store in one region and other having different characteristics are stored in another region. The goal of segmentation is the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is also used to distinguish the **Object and Background in an image.** It can be used for various applications like medical images, character recognition, satellite images, industries automation, natural images etc and digital image processing. Many of the applications required high accuracy and faster image processing algorithms. In this chapter, we have studied, reviewed and analyzed important threshold, Watershed, Clustering, Discontinuity and region based image segmentation techniques and their variations.
In the process of image segmentation we assigning label to every pixel in an image such that pixels with the same label share certain visual characteristics. It is based on discontinuity and similarity of image intensity values [4-9]. The approach is to partition an image based on abrupt changes in intensity value such as edges. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image. After applying image segmentation to the image it can be used for 3D reconstruction in various fields. For intensity images many popular methods are there for image segmentation which includes threshold techniques, edge based methods, and region based techniques etc.

Image segmentation process having three stages.
First: Image pre-processing: in pre processing stage useless information is removed from the image.
Second: Initial object discrimination: In this stage objects are separated into groups with similar attributes.
Three: Object boundary clean up: In this object boundaries are reduced to single-pixel widths.

2. METHODS
There are various methods of image segmentation that are used to segment the image into various parts calls regions.

- WATERSHED IMAGE SEGMENTATION
- EDGE DETECTION SEGMENTATION
- CLUSTER BASED SEGMENTATION

2.1 WATERSHED SEGMENTA TION
Watershed algorithm, is first proposed by S. Beucher and L. Vincent and is developed rapidly in image segmentation field in recent years which is based on mathematical morphology. It is sensitive to weak edges, and is capable of acquiring one-pixel connected and closed contours with exact location. Watershed transform is the technique which is commonly used in image segmentation. It is now being recognized as a powerful method used in image segmentation due to its many advantages such as simplicity, speed and complete division of the image. Watershed transform or Watershed Algorithm is based on grey-scale morphology. It is classified as a region-based segmentation approach. Even when the target regions having low contrast and week boundaries, watershed transformation can provide closed contours. When a landscape or topographic relief is flooded with water, the divide lines of the domains of rain falling over the regions forms the watersheds. Intuitively, a drop of water falling on a topographic relief flows towards the "nearest" minimum. The "nearest" minimum is that minimum which lies at the end of the path of steepest descent. In terms of topography, this occurs if the point lies in the catchment basin of that minimum. An alternative approach is to imagine the landscape being immersed in a lake in which holes are pierced in the local minima is called the catchment basin. Water will be filled up at these starting local minima and at points where water coming from different basins would meet and dams will be built. When the water level reaches the highest peak in the landscape the process is stopped. As a result, the landscape is partitioned into regions or basins separated by dams, called watershed lines or simply watersheds. Figure: Watershed segmentation-local minima yield catchment basins; local maxima define the watershed lines.

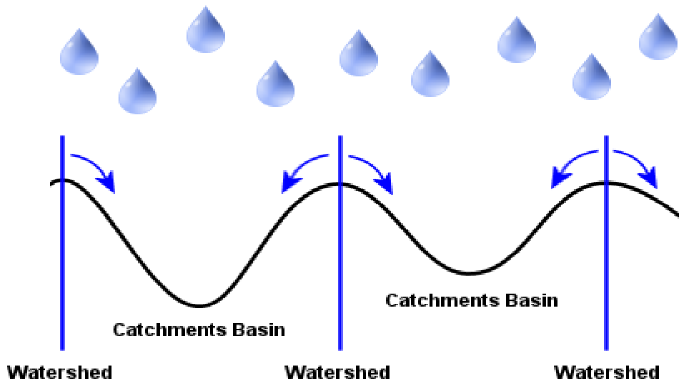

Fig - 1

The watershed transform is a broadly used technique for image segmentation. The watershed transform can be classified as a region-based segmentation approach.

Watershed algorithm which is a mathematics morphological method for image segmentation based on region processing, has many advantages. The result of watershed algorithm is global segmentation, border closure and high accuracy. It can achieve one-pixel wide, connected, closed and exact location of outline. The basic concept of watershed is based on visualizing a gray level image into its topographic representation, which includes three basic notions: minima, catchment basins and watershed lines.

The watershed transform has been widely used in many fields of image processing, including medical image segmentation, due to the number of advantages that it possesses: it is a simple intuitive method, it is fast and can be parallelized and an almost linear speedup was reported for a number of processors up to 64) and it produces a complete division of the image in separated regions even if the contrast is poor, thus avoiding the need for any kind of contour joining. It is appropriate to use this method to segment the high-resolution remote sensing image

2.1.1 WATERSHED IMPLEMENTATION METHODS

There are mainly three methods to implement watershed. They are listed below:

- Distance Transform Approach
- Gradient method
- Marker Controlled Approach

Distance Transform Approach: A tool used commonly in conjunction with the watershed transform for segmentation is the distance transform. It is the distance from every pixel to the nearest nonzero-valued pixel. The distance transform can be computed using toolbox function bwdist, whose calling syntax is D=bwdist(f) A binary image can be converted to a gray level image, which is suitable for watershed segmentation using different DT. However, different DT functions produce different effects. Euclidean DT has a higher possibility of “salt and pepper” over segmentation. City Block DT has a higher possibility of over segmentation for the components in the image. The reason is that City Block DT propagates to the neighbourhood in the shape of diamond. Chessboard DT has a better pruning effect due to its square shape propagation. It can effectively remove the jaggedness formed in the Euclidean DT and avoid the components over segmentation caused by City Block DT.

Gradient Method: The gradient magnitude is used to pre process a gray-scale image prior to using the watershed transform for segmentation. The gradient magnitude image has high pixel values along object edges and low pixel values everywhere else. Watershed transform would result in watershed ridge lines along object edges[2]. There is a problem of over segmentation in this method. The topological gradient provides a global analysis of the image then the almost unwanted contours due to the noise added to a given image can be significantly reduced by our approach. The experimental results show that the over segmentation problem, which usually appears with the watershed technique, can be attenuated, and the segmentation results can be performed using the topological gradient approach. Another advantage of this method is that it splits the segmentation process into two separate steps: first we detect the main edges of the image processed, and then we compute the watershed of the gradient detected[1][2].

Marker Controlled Methods: Direct application of watershed transform to a gradient image can result in over segmentation due to noise. Over segmentation means a large number of segmented regions. An approach used to control over segmentation is based on the concept of markers. A marker is a connected component belonging to an image. Markers are used to modify the gradient image. Markers are of two types internal and external, internal for object and external for boundary[7]. The marker-controlled watershed segmentation has been shown to be a robust and flexible method for segmentation of objects with closed contours, where the boundaries are expressed as ridges. Markers are placed inside an object of interest; internal markers associate with objects of interest, and external markers associate with the background. After segmentation, the boundaries of the watershed regions are arranged on the desired ridges, thus separating each object from its neighbours.

2.2 EDGE DETECTION GMENTATION

An edge may be regarded as boundary between two dissimilar regions in an image . The edges for an image are the significant characteristics that put forward an indication for a higher frequency. Edge detection is a terminology in image processing and computer vision , mainly in field of feature detection and feature extraction that plays an important role in segmentation of an image for identification of objects. The process of detecting edges for an image may facilitate in image segmentation, data compression, and also help for image reconstruction.

The purpose of edge detection is to mark the points in a digital image at which the luminous intensity changes sharply. In Image analysis process to interpret an image, one first must be able to detect the edges of each object in the image. Edge representation of an image significantly reduces the amount of

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data to be processed, yet it retains useful information about the shapes of objects in the scene.
Edge-based segmentation techniques rely on discontinuities in image values between distinct regions, and the objective of the segmentation algorithm is to precisely distinguish the boundary separating these regions .Edge-based segmentation is the process of locating pixels in the image that match up to the boundaries of objects seen in an image .It is also assumed that since it is a boundary of a region then it is closed and that the number of interesting objects is equal to the number of boundaries in an image. There are an exceptionally large number of edge detection operators available, each of which are designed to be sensitive to certain edge types.
There are many edge detection techniques in the literature for image segmentation. The most commonly used discontinuity based edge detection techniques are reviewed in this section. Those techniques are Roberts edge detection, Sobel Edge Detection, Prewitt edge detection, Kirsh edge detection, Robinson edge detection, Marr-Hildreth edge detection, LoG edge detection and Canny Edge Detection.

2.2.1 Roberts Edge Detection

The Roberts edge detection is introduced by Lawrence Roberts (1965). It performs a simple, quick to compute, 2-D spatial gradient measurement on an image. This method emphasizes regions of high spatial frequency which often correspond to edges. The input to the operator is a grayscale image the same as to the output is the most common usage for this technique. Pixel values in every point in the output represent the estimated complete magnitude of the spatial gradient of the input image at that point.

-1	0
0	+1

Gx

0	-1
+1	0

Gy

2.2.2 Sobel Edge Detection

The Sobel edge detection method is introduced by Sobel in 1970 (Rafael C.Gonzalez (2004)). The Sobel method of edge detection for image segmentation finds edges using the Sobel approximation to the derivative. It precedes the edges at those points where the gradient is highest. The Sobel technique performs a 2-D spatial gradient quantity on an image and so highlights regions of high spatial frequency that correspond to edges. In general it is used to find the estimated absolute gradient magnitude at each point in n input grayscale image. In conjecture at least the operator consists of a pair of 3x3 complication kernels as given away in under table. One kernel is simply the other rotated by 90o. This is very alike to the Roberts Cross operator.

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

Gx

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

Gy

2.2.3 Prewitt Edge Detection

The Prewitt edge detection is proposed by Prewitt in 1970 (Rafael C.Gonzalez [1]. To estimate the magnitude and orientation of an edge Prewitt is a correct way. Even though different gradient edge detection wants a quite time consuming calculation to estimate the direction from the magnitudes in the x and y-directions, the compass edge detection obtains the direction directly from the kernel with the highest response. It is limited to 8 possible directions; however knowledge shows that most direct direction estimates are not much more perfect. This gradient based edge detector is estimated in the 3x3 neighborhood for eight directions. All the eight convolution masks are calculated. One complication mask is then selected, namely with the purpose of the largest module.

-1	-1	-1
0	0	0
+1	+1	+1

Gx

-1	0	+1
-1	0	+1
-1	0	+1

Gy

2.2.4 LoG edge detection

The Laplacian of Gaussian (LoG) was proposed by arr(1982). The LoG of an image f(x,y) is a second order derivative efined as,

$$\nabla^2 f = \frac{\partial^2 f}{\partial x^2} \quad \frac{\partial^2 f}{\partial y^2}$$

It has two effects, it smoothes the image and it computes the Laplacian, whch yields a doubleedge image. Locating edges then consists of finding the zero crossings between the double edges. The digital implementation of the Laplacian function is usually made through the mask below,

0	-1	0
-1	4	-1
0	-1	0

Gx

-1	-1	-1
-1	8	-1
-1	-1	-1

Gy

Canny Edge Detection

In industry, the Canny edge detection technique is one of the standard edge detection techniques. It was first created by John Canny for his Master's thesis at MIT in 1983, and still outperforms many of the newer algorithms that have been developed. To find edges by separating noise from the image before find edges of image the Canny is a very important method. Canny method is a better method without disturbing the features of the edges in the image afterwards it applying the tendency to find the edges and the serious value for threshold.

The algorithmic steps are as follows:

• Convolve image f(r, c) with a Gaussian function to get smooth image f^(r, c).f^(r, c)=f(r,c)*G(r,c,6)
• Apply first difference gradient operator to compute edge strength then edge magnitude and direction are obtain as before.
• Apply non-maximal or critical suppression to the gradient magnitude.
• Apply threshold to the non-maximal suppression image.

Unlike Roberts and Sobel, the Canny operation is not very susceptible to noise. If the Canny detector worked well it would be superior.

2.3 CLUSTERBASED SEGMENTATION

Clustering is a method to divide a set of data into a specific number of groups. It's one of the popular method is *k*-means clustering. In *k*-means clustering, it partitions a collection of data into a *k* number group of data. It classifies a given set of data into *k* number of disjoint cluster. *K*-means algorithm consists of two separate phases. In the first phase it calculates the *k* centroid and in the second phase it takes each point to the cluster which has nearest centroid from the respective data point. There are different methods to define the distance of the nearest centroid and one of the most used methods is Euclidean distance. Once the grouping is done it recalculate the new centroid of each cluster and based on that centroid, a new Euclidean distance is calculated between each center and each data point and assigns the points in the cluster which have minimum Euclidean distance.

2.3.1 K-Means Clustering Algorithm

There are always K clusters. There is always at least one item in each cluster. The clusters are non-hierarchical and they do not overlap. Every member of a cluster is closer to its cluster than any other cluster because closeness does not always involve the 'centre' of clusters.[9]. *K*-means clustering in particular when using heuristics such as Lloyd's algorithm is rather easy to implement and apply even on large data sets. As such, it has been successfully used in various topics, ranging from market segmentation, computer vision and astronomy to agriculture. It often is used as a preprocessing step for other algorithms, for example to find a starting configuration. In statistics and data mining, *k*-means clustering is a method of cluster analysis which aims to partition *n* observations into *k* clusters in which each observation belongs to the cluster with the nearest mean.

3. MATLAB

To implement all these methods we use MATLAB R2013a.
The name MATLAB stands for MATrix LABoratory. MATLAB was written originally to provide easy access to matrix software developed by the LINPACK (linear system package) and EISPACK (Eigen system package) projects. MATLAB [1] is a high-performance language for technical computing. It integrates computation, visualization, and programming environment. Furthermore, MATLAB is a modern programming language environment: it has sophisticated data structures, contains built-in editing and debugging tools, and supports object-oriented programming. These factors make MATLAB an excellent tool for teaching and research. MATLAB has many advantages compared to conventional computer languages (e.g., C, FORTRAN) for solving technical problems. MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. The software package has been commercially available since 1984 and is now considered as a standard tool at most universities and industries worldwide.

It has powerful built-in routines that enable a very wide variety of computations. It also has easy to use graphics commands that make the visualization of results immediately available. Speci¯c applications are collected in packages referred to as toolbox. There are toolboxes for signal processing, symbolic computation, control theory, simulation, optimization, and several other ¯elds of applied science and engineering.

3.1 M-File Scripts

A *script file* is an external file that contains a sequence of MATLAB statements. Script files have a filename extension .m and are often called M-files. M-files can be *scripts* that simply execute a series of MATLAB statements, or they can be *functions* that can accept arguments and can produce one or more outputs.

3.2 Input and output arguments

As mentioned above, the input arguments are listed inside parentheses following the function name. The output arguments are listed inside the brackets on the left side. They are used to transfer the output from the function file. The general form looks like this

function [outputs] = function_name(inputs)

Function file can have none, one, or several output arguments.

4. CONCLUSION

In this paper we use various image segmentation techniques like "watershed image segmentation", "Edge detection based segmentation" and "graph based image segmentation" to analyse the images. In this paper we give only the overview of all these methods. In next we give the output of all these methods.

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