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A Study On Image Segmentation Techniques

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Abstract—Image segmentation is very important step of image analysis which is used to partitioned image into several homogenous regions by classifying pixels of whole image into different regions that exhibit similar characters. The result of image segmentation is a set of sections that together cover the whole image. This paper has presented a review on various image segmentations techniques like thresholding, region based, clustering, and genetic algorithm based segmentation.
Keywords—Segmentation, Thresholding, Region Growing, Mean Shift, Clustering, Ant Colony Optimization.

I. INTRODUCTION

Image segmentation has been an area of active research for the past two decades resulting in several image segmentation techniques have been described in the image processing research literature. This rapid increase is in part due to the fact that there exist several problem domains and applications that need to process and interpret image data in a domain specific manner [1]. Moreover, depending on the problem domain or application, there are several types of images that could be processed and analyzed such as, light intensity (grayscale), color, range (depth), thermal (infrared), sonar, X ray (radiographic), nuclear magnetic resonance images (MRI), and so on. Image segmentation refers to the process of partitioning a digital image into multiple segments i.e. set of pixels, pixels in a region are similar according to some homogeneity criteria such as color, intensity or texture, so as to locate and identify objects and boundaries in an image [2].

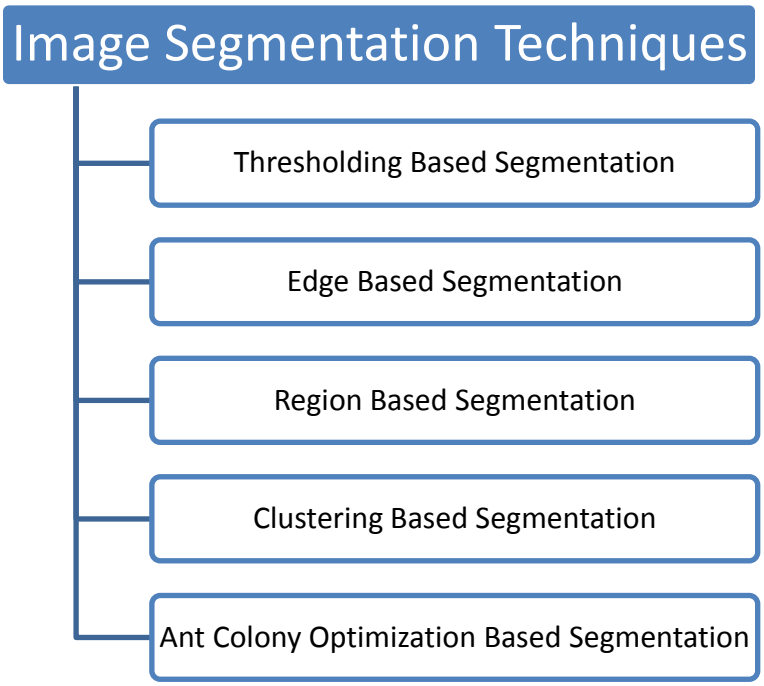

Figure 1 Image Segmentation Techniques

The property of a pixel in an image and information of pixels neighboring to that pixel are two basic parameters for any image segmentation algorithm. It can also be representing as similarity of pixels

in any region and discontinuity of edges in image [3]. Edge based segmentation is used to divide image on the basis of their edges. Region based methods used the threshold in order to separate the background from an image, whereas neural network based techniques used the learning algorithm to train the image segmentation process [4].

II. IMAGE SEGMENTATION TECHNIQUES

A. Thresholding based

Thresholding is one of the widely used methods used for image segmentation. It is widely used in numerous simple applications. It is useful in discriminating foreground from the background. By selecting an adequate threshold value T, the gray level image can be converted to binary image. The binary image should contain all of the essential information about the position and shape of the objects of interest (foreground)[5]. The advantage 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 common way to convert a gray-level image to a binary image is to select a single threshold value (T). Then all the gray level values below this T will be classified as black (0), and those above T will be white (1). The interesting object in the image is a foreground and the rest is a background. Threshold T is first finalized by analyzing all the pixel intensity. Consider a pixel f(x,y) classification is done as
If f(x,y) = {> T ; foreground
< T; Background}
Problem associated with the thresholding technique is that it will ignore the spatial information of the pixel values and hence they are inefficient for images that blur at object boundaries or for multiple image component segmentation [6].

For T=T [f(x, y)], threshold is global
For T=T [p(x, y), f(x, y)], threshold is local
For T=T[x, y, p(x, y), f(x, y)], threshold is dynamic or adaptive

B. Edge-Based Technique

Edge detection is the approach used most frequently for segmenting images based on abrupt changes in intensity. Edge based methods are based on edge information found in the image using edge detection operators. Edge plays a very important role in many image processing applications. They provide an outline of the object. An edge is a set of connected pixels that lies on the boundary between two regions that differ in grey value. These pixels on the edge are called edge points. There are four types of edge model that are classified according to their intensity profile. A step edge involves transition between two intensity levels occurring ideally over the distance of 1 pixel [7]. Ideal edges can occur over the distance of 1 pixel, provided that no additional processing is used to make them look real. Roof edges are model of lines through a region, with the base of a roof edge being determined by the thickness and sharpness of the line. Spike edge represents a quick change and immediately returns to original intensity level [8]. First and second order derivatives like gradient and laplacian are used for detection of edges in an image. A problem associated with this technique is that, edge detection algorithms need additional post processing by using linking procedures to assemble edge pixel into meaningful edges. The output may produce edges in locations where there is no border and may not where the border exists.

- **Steps in Edge Detection**

The idea is to detect the sharp changes in image brightness which can capture the important events and properties. This is done in 3 ways [9]. The edge detection process is shown in Fig 1

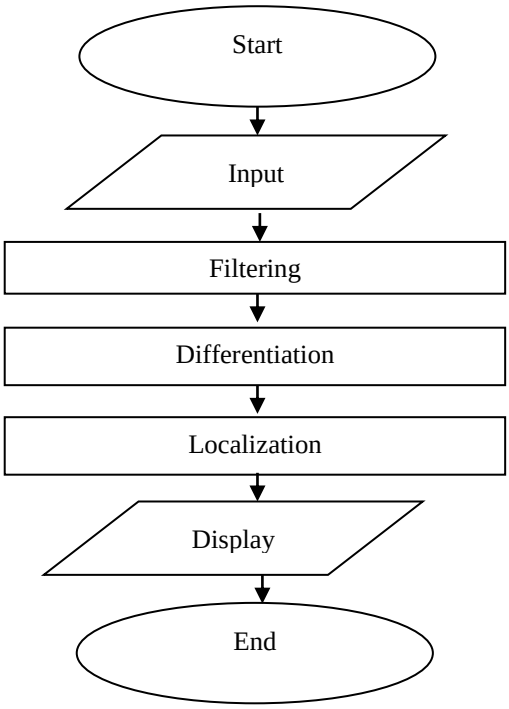

Figure 2 Edge Detection Process

Edge detectors have different operator for detection of edge such as sobel operator, laplace operator, canny operator, Log (Laplacian of Gaussian) operator and so on. Edge detection method require a higher image quality so its need to reduce or remove the noise. [9]

III. REGION BASED TECHNIQUES

The goal of segmentation is to partition the image into several disjoint regions. Region Based technique is used to determine the regions directly [10]. While performing region based segmentation, every pixel in an image should be grouped in a region. To perform this grouping initially some seed pixels are selected based on some criteria. After selecting the initial seeds a homogeneous region of an image is obtained by growth process it tries to find an accurate segmentation of images into regions with the property that each connected component of a region meets exactly one of the seed. This is said to be seeded region growing (SRG). The problem related with SRG is in selecting the initial seed to get more accurate segmentation of images. Region based technique are generally better in noisy images [11]. Homogeneity is used as the important criterion for region growing segmentation. In this approach, regions are constructed by merging or splitting the neighbor pixels. Regions are labeled separately.

- **Region Growing**

The approach starts with a set of seed pixels and from these grows regions by appending to each seed pixel those neighboring pixels that satisfy a certain criteria. Region growing is an approach to image segmentation in which neighboring pixels are examined and added to a region class of no edges are detected. Small regions of far away values were merged to neighboring regions while regions of similar value were also merged [12]. Homogeneity functions are introduced for both grey scale and colored images. First pixel of the image is considered as the seed pixel. This seed pixel is compared with the all the 8-neighbouring pixels and which satisfies the homogeneity function is grouped to the first region and its pixel value is changed as that of the seed pixel. This neighbor comparison step can be is repeated for every new pixel assigned to the first region until the region is bounded by the

edge of the image or by pixels that do not satisfy the homogeneity function .The next seed pixel for the second region is determined by choosing the first unassigned pixel.

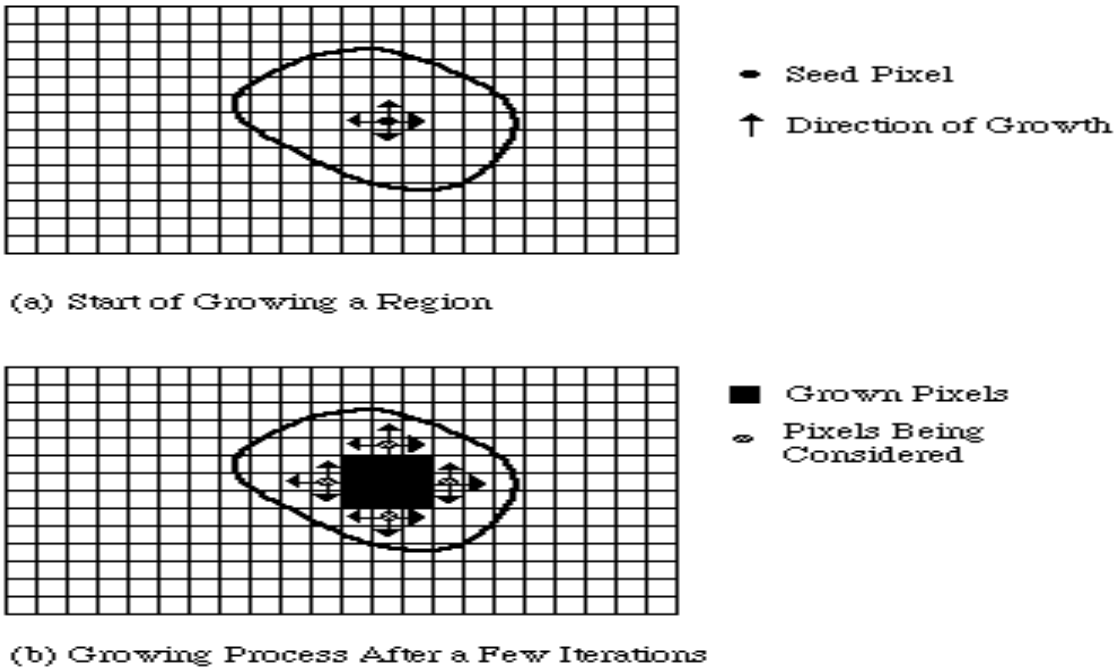

Figure 3 Process of Region Growing

- **Region Splitting and Merging**

Split and merge technique is the opposite of the region growing. This technique works on the whole image. Region splitting is a top-down approach. It begins with a whole image and divides it up such that the segregated part are more homogenous than the whole. Hence, a merging phase after the splitting is always desirable, which is termed as the split-and-merge algorithm. Any region can be split into sub regions, and the appropriate regions can be merged into a region. Rather than choosing seed points, user can divide an image into a set of arbitrary unconnected regions and then merge the regions [13] in an attempt to satisfy the conditions of reasonable image segmentation. Region splitting and merging is usually implemented with theory based on quad tree data.

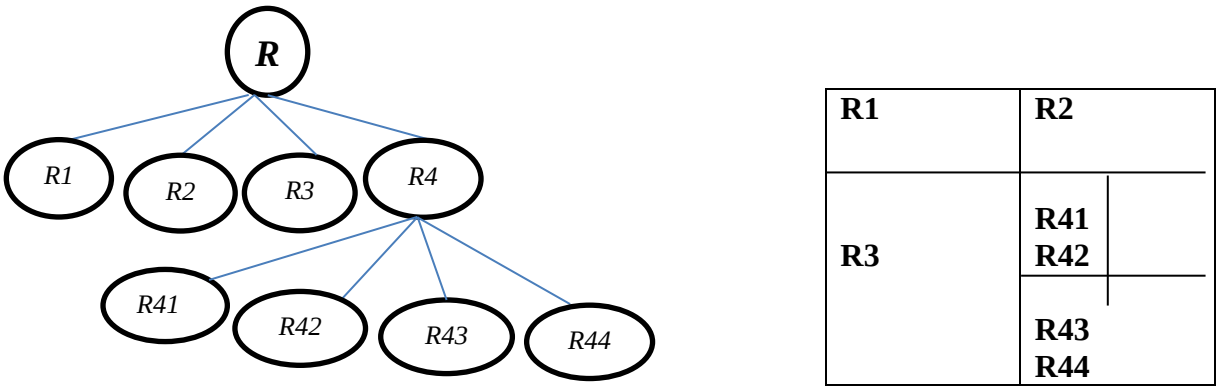

Fig 4 : Region Split and Merge method

Region splitting Method:

1. Let R represent the entire image. Select a predicate P
2. Split or subdivide the image successively into smaller and smaller quadrant regions.

The splitting technique has a convenient representation in the form of structure called a quad tree shown in figure 3. In a quad tree, the root of the tree corresponds to the entire image and each node corresponds to subdivision.

Region Merging Method:

Merge any adjacent regions that are similar enough. The procedure for split and merge is given.

1. Start with the whole image
2. If the variance is too large, break it into quadrants.
3. Merge any adjacent regions that are similar enough.
4. Repeat step (2) and (3) iteratively until no more splitting or merging occurs.

This technique requires the input data to be organized into a pyramidal grid structure of regions, with each region organized in groups of four in case of 2D, and of eight in case of 3D.

IV. ACO BASED SEGMENTATION

ACO is a method cast off for image processing such as edge detection, image segmentation etc. The ACO algorithm is a probabilistic method for explaining several difficulties which can be summary to discover decent routes through graphs. Complex continues difficulties which enthused by the pheromone path leaving performance of physical ant gatherings are resolved by a common search method called ACO [14].

Following stages of a humble Ant Colony System Algorithm :

1. ACO algorithm resolves continues glitches in distinct way and signified by a graph through N nodes and R routes.
2. According to the number of nodes in the section the number of nodes is clear.
3. Node transition rule is stated for ant probabilistic conversion among nodes.
4. At the completion of respectively cycle once every single ant has accumulated a solution at that time by using pheromone trail updating rule the strength of pheromone is rationalized.

At last ant system has mainly work on two methods:

1. Desirability
2. Trail update

This figure shows that at initial state ant can move in any direction.

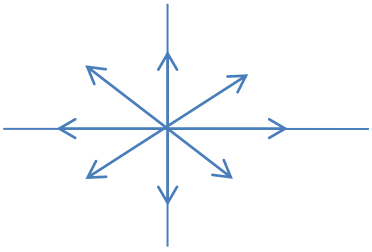

Fig 2.7: Initial state of Ant Colony Optimization.

V. CONCLUSION

This paper has presented a comparative study on various well known image segmentation techniques. The study has shown that region growing based segmentation is quite accurate over the other techniques. But it still suffers from various limitations like complex background and low intensity images. This paper has not considered any improvement in the existing techniques, so in near future we will improve multispectral image segmentation further by using fuzzy based modified mean shift and minimum spanning tree.

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