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A REVIEW ON VARIOUS IMAGE SEGMENTATION TECHNIQUES

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Abstract: ***Digital image processing is compatible with a solid research program in areas of image enhancement and image-based pattern recognition. Among the various image processing techniques, image segmentation plays a vital role in the step to analyze the given image. The segmentation of images is the fundamental step to analyze images and extract data from them. This paper deals with the basic principles about the methods used to segment an image. Segmentation has become a prominent objective in the analysis of images and computer vision. To segment the images, based on the segmentation techniques, the detection of borders, thresholds, the growth of the region and the grouping are taken for this study. Segmentation algorithms are based on two properties of similarity and discontinuity. This document focuses on the various methods that are widely used to segment the image.***
Keywords: Image Segmentation, Region Growing, Edge detection, Clustering, Thresholding.

1. INTRODUCTION

Digital image processing has many recent applications in the field of remote sensing, medicine, photography, film and video production, and security surveillance. New and innovative technologies are emerging in the field of image processing, particularly in the field of image segmentation.

Image segmentation is typically used to locate the boundaries of objects in images. More specifically, image segmentation is the process of assigning a label to each pixel in an image so that pixels with the same label share certain visual characteristics. A set of segments collectively covering the entire image or a set of outlines extracted from the image is the result of the segmentation of the image. Each pixel in a region is similar to a characteristic or calculated property, such as color, intensity, or texture. In computer vision, image processing is any form of signal processing for which the input is an image, such as photographs or video images. The result of the image processing may be an image or a set of features or parameters related to the image. In addition, segmentation refers to the process of partitioning a digital image into several segments (sets of pixels, also called super pixels). Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images.

The goal of segmentation is to simplify and modify the representation of an image into something more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries in images.

The most studied version of the group in artificial vision is the segmentation of images. Image segmentation techniques can be classified into two broad families: (1) region-based approaches and (2) advanced approaches. Region-based approaches attempt to find image pixel partitions in sets with consistent image properties, such as brightness, color, and texture. The contour approach usually begins with the first stage of contour definition, followed by the bonding process, which tends to use curvilinear continuity. In recent years, the task of interactive image segmentation has attracted a lot of attention. The image segmentation process can be seen in two categories. In the first category, the goal is to divide an image based on sudden changes in intensity, such as

edges. In the second category, the goal is to separate a close-up image from its background, known as the image threshold. Other examples in this category include the growth of the region and the division and fusion of the region.

2. IMAGE SEGMENTATION

Image segmentation is the initial or initial processing of image compression. The efficiency of the segmentation process is its speed, its good fit and a better form of connectivity with its segmentation result. Segmentation refers to the process of identifying and isolating the surface and areas of the digital image corresponding to the structural units. Segmentation can also depend on several functions contained in the image. It can be a color or texture.

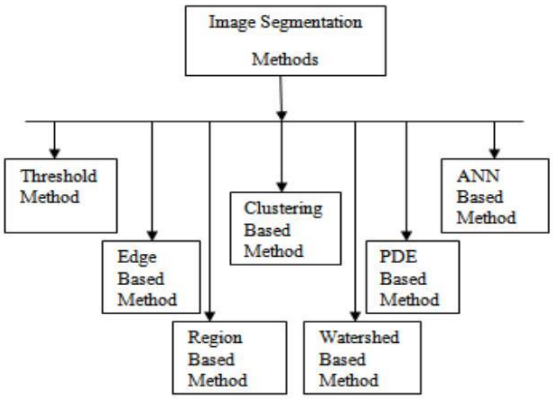

Figure 1: Image Segmentation Techniques

2.1 SEGMENTATION ALGORITHM

Segmentation algorithms have been developed for image segmentation; they are based on two basic properties, a rupture and similarity. In the partition based on discontinuity and subdivision is performed on the basis of abrupt changes in the intensity levels or gray levels of an image. In this method, our interest is mainly focused on the identification of isolated points, lines and edges. In the similarity-based group, pixels that are similar in some way include approaches such as thresholding, regional growth, and division and merging of regions.

2.2 CLASSIFICATION OF SEGMENTATION TECHNIQUE

Segmentation can be classified into the following categories.

A. Segmentation by Edge detection
B. Segmentation by Thresholding
C. Segmentation by Region
D. Segmentation by Clustering
E. Segmentation by Watershed
F. Segmentation by PDE
G. Segmentation by AAN

A) SEGMENTATION BY EDGE DETECTION

In the image segmentation process, the basic step is contour detection. Divide an image into an object and its background. Edge detection divides the image by observing the change in intensity or the pixels of an image. The gray histogram and the gradient are two main methods for detecting edge detections in image segmentation. Contour detection operators are divided into two categories: first-order derivation operators and second-order derivation operators. Second-order operators provide reliable results. The canny edge detector is a second derivative operator.

a) SOBEL EDGE DETECTION

The Sobel edge detection method is presented by Sobel in 1970. Sobel calculates not only the magnitude of the edges, but also their direction. The operator uses a 3x3 template horizontally and then vertically. One core is simply the other rotated by 900.

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

G_x

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

G_y

Figure 2 : Sobel Convolution Masks

b) **Canny Edge Detection**

Initially, an image is taken and segmented using the intelligent edge detection technique. For this, the image is first converted from RGB to gray. The first step is to filter any noise in the original image before trying to locate and detect the edges. The Gaussian filter is used in the Canny algorithm. It can be calculated using a simple mask.

After smoothing the image and removing noise, the next step is to find the edge resistance by taking an image gradient. Further, the approximate edge of the magnitude of the absolute gradient is one of each direction and the other estimating the gradient in the rows of the y direction.

After finding the edge resistance, the direction of the edge is found using the x and y directions gradient. The non-maximal deletion is used to draw along the edge in the direction of the edge and remove any pixel value that sets it to 0 and is not considered an edge. This will give a fine line in the output image.

Hysteresis is used as a means of eliminating streaks. The flute is the breaking of an edge contour caused by the exit of the operator that fluctuates above and below the threshold. To prevent the border from appearing dotted, the hysteresis uses two thresholds, a high and a low. Therefore, an image is segmented using edge detection.

B. SEGMENTATION BY THRESHOLDING

One of the simplest approaches to segment an image is based on intensity levels and is called as threshold based. The threshold can be implemented globally or locally. Global thresholds distinguish the object and background pixels from the chosen threshold value and use a binary partition to segment the image. Local thresholding is also called adaptive thresholding. In this technique, the threshold value varies according to the image as a function of the local characteristic of the subdivided regions. The Histogram threshold is used to segment the given image. Some pre-processing and post-processing techniques are required for threshold segmentation. The main thresholding techniques proposed by different researchers are the Mean method, the P-tile method, the histogram-dependent technique, the Edge Maximization technique and the visual technique.

C. SEGMENTATION BY REGION

Growth area methods are primarily based on the assumption that adjacent pixels in an area have similar values. The usual procedure is to compare the pixel with its neighbors. If the similarity criterion is satisfied, the pixel can be configured to belong to the cluster as one or more of its neighbors. The choice of the similarity criterion is important and the noise results are affected in all cases.

In this technique, pixels associated with the same object are grouped together for segmentation. The thresholding technique is related to segmentation by region. The zone detected for segmentation must be closed. Region-based segmentation is also known as similarity-based segmentation. There will be no space due to the lack of edge pixels in this segmentation depending on the region, the boundaries are identified for segmentation. After identifying the change in color and texture, the edge flow becomes a vector. From there, the edges are detected for further segmentation.

D. SEGMENTATION BY CLUSTERING

Clustering-based techniques are techniques that segment the image into clusters that have pixels with similar characteristics. Data grouping is the method that divides the data elements into clusters so that elements of the same cluster are more similar to each other than the others. There are two basic categories of grouping methods: the hierarchical method and the partition-based method. Hierarchical methods are based on the concept of trees. In this, the root of the tree represents the whole of the database and the internal nodes represent the clusters. On the other hand, partition-based methods use iterative optimization methods to minimize an objective function. Between these two methods, there are several algorithms to find clusters. There they are two types of basic grouping.

Hard Clustering: Hard Clustering is a simple clustering technique that divides the image into a set of clusters so that the pixel can belong to only one group. In other words, it can be said that each pixel can belong exactly to a cluster. These methods use membership functions with values of 1 or 0, that is, one of the pixels may belong to a certain cluster or not. An example of a technique based on hard clustering is a technique based on the k-means clustering known as HCM. In this technique, the centers are first calculated and then each pixel is assigned to the nearest center. It stands out by maximizing intra-cluster similarity and also minimizing equality between clusters.

Flexible grouping: Flexible grouping is a more natural type of grouping because in reality, an exact division is not possible because of the presence of noise. Therefore, flexible cluster techniques are more useful for segmenting images in which the division is not strict. The example of this type of technique is the c-means diffuse clustering. In this technique, the pixels are divided into partial membership-based clusters, ie one pixel, can belong to more than one cluster and this degree of membership is described by the membership values. This technique is more flexible than other techniques.

E. SEGMENTATION BY WATERSHED

Watershed-based methods use the concept of topological interpretation. In this, the intensity represents the basins that have a hole in their minimum from which the water flows. When the water reaches the edge of the basin, the adjacent basins merge. To maintain the separation between basins, dams are needed and are the edges of the segmentation region. These dams are constructed using dilation. Basin methods consider the gradient of the image as a topographic surface. Pixels that have more gradient are represented as continuous boundaries.

F. SEGMENTATION BY PDE

Methods based on the partial differential equation are the rapid methods of segmentation. They are suitable for time-critical applications. There are two basic methods of PDE: the non-linear isotropic diffusion filter (used to improve the edges) and the non-quadratic convex variation restoration (used to eliminate noise). The results of the PDE method are fuzzy outlines and boundaries that can be moved using nearby operators. The fourth-order PDE method is used to reduce image noise and the second-order PDE method is used to better detect edges and boundaries.

G. SEGMENTATION BY ANN

Segmentation methods based on artificial neural networks simulate the learning strategies of the human brain in order to make decisions. Today, this method is mainly used for the segmentation of medical images. It is used to separate the required image from the background. A neural network consists of a large number of connected nodes and each connection has a particular weight. This method is independent of PDE. In this, the problem becomes problems that are solved using net neuronal. This method has two basic steps: feature extraction and neural network segmentation.

Table 1: COMPARISON OF VARIOUS SEGMENTATION TECHNIQUES

Segmentation technique	Description	Advantages	Disadvantages
Edge Based Method	Based on discontinuity detection.	Good for images having better contrast between objects	It is not suitable for wrong detected or too many edges
Thresholding Method	based on the histogram peaks of the image to find particular threshold values	no need of previous information, simplest method	highly dependent on peaks, spatial details are not considered
Region Based Method	based on partitioning image into homogeneous regions	more immune to noise, useful when it is easy to define similarity criteria	expensive method in terms of time and memory
Clustering Method	based on division into homogeneous clusters	fuzzy uses partial membership therefore more useful for real problems	determining membership function is not easy
Watershed Method	based on topological interpretation	results are more stable, detected boundaries are continuous	complex calculation of gradients
PDE Based Method	based on the working of differential equations	fastest method, best for time critical applications	more computational complexity
ANN Based Method	based on the simulation of learning process for decision making	There is no need to write hard and complex programs	wastage of time in training

CONCLUSION

In a computer vision (an application of artificial intelligence), segmentation refers to the process of dividing a digital image into several segments (sets of pixels, also called super pixels). This document attempts to study some categories of image segmentation in image processing.

In this review of image segmentation techniques, various image segmentation techniques are detailed and described. These all techniques are suitable for checking objects and borders, medical field, object detection, face recognition, pattern recognition fields. But from the study, it is clear that for each type of image there is no single method, and all the methods are not adapted to a particular type of image. Due to the need for image segmentation in many applications, it has a complex future.

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