



A Relative Study on the Segmentation Techniques of Image Processing

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Abstract: - The process of dividing a digital image into multiple segments i.e. Set of pixels is called segmentation. There is now a wide assortment of image segmentation techniques, some considered general purpose and some deliberate for specific classes of images. These techniques could be classified by detecting discontinuities and similarities. The success of image analysis depends on the reliability of segmentation, but an accurate partitioning of an image is a very challenging problem. Segmentation process also aids to find the region of interest in a particular image. This paper addresses the different techniques in image segmentation.

Keywords- Image Segmentation, Thresholding, Feature-based clustering, Region based segmentation, Model-based Segmentation, Graph-based Segmentation.

I. Introduction.

There are several images namely light intensity (visual) image, range image (depth image), nuclear magnetic resonance (MRI), thermal image and much more. A challenging problem is to the region with boundaries insufficiencies, i.e., missing edges or lack of texture contrast between regions of interest and background. Here, we focus on a specific category of segmentation techniques which are used in various fields. This review paper attempts to incorporate all these points to a limited extent. However, by no means is it an exhaustive survey.

II. Image Segmentation.

Image segmentation comments the process of separating a digital image into N number of fragments. The images are segmented by a set of pixels or pixels in a region that are alike by some consistency criteria such as color, intensity or texture, which aids to locate and classify objects or boundaries in an image. Regarding mathematical formulae, Image segmentation divides a digital image

$f(x, y)$ into continuous, disconnect, and nonempty subsets ($f_1, f_2, f_3, \dots, f_n$) after these subsets cutting-edge level information can be easily mined. Applied applications of image segmentation embrace object identification and acknowledgment, facial recognition, medical image processing, criminal investigation, airport security system, satellite images, quality assurance in factories, etc.

III. Current Segmentation Techniques.

The research on Image segmentation for many years has been a high degree of attention, Now several new problems concerns alike development of a unified approach to image segmentation which can be applied to all type of images, even the selection of an appropriate technique for a specific type of image is a challenging issue. Based on the following two properties of the image, different technologies are classified.

- Detecting Discontinuities
- Detecting Similarities
- Region Growing
- Region Splitting and Merging

Detecting Discontinuities

To partition an image based on abrupt changes in intensity [1], this includes image segmentation algorithms like edge detection. Signal rises with rapid evolution such as a transient signal in dynamic systems may undergo abrupt changes such as a sharp shift in the first or second derivative. However, Fourier analysis is usually not able to detect the events. The purpose of this example is to show how analysis by wavelets can detect the exact instant when signal changes and also the type and amplitude of the modification. In image processing, one of the major application is edge detection, which also involves detecting abrupt changes.

Detecting Similarities

In this section it exhibits about to partition an image into regions that are similar according to a set of predefined criterion [1], this comprises image division algorithms like region upward, region excruciating and merging thresholding,

Segmentation can be classified as follows:

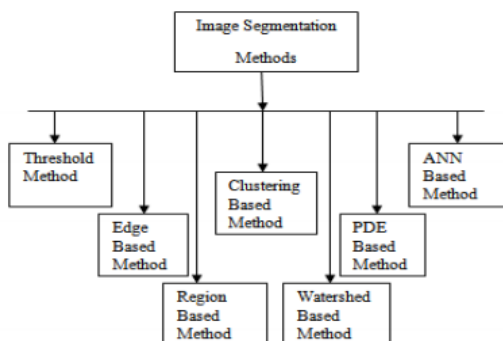


Figure 1: Classification of Segmentation Techniques

A. Region based segmentation

A region is a group of connected pixels with similar properties. For correct interpretation of an image, it must be partitioned into regions that correspond to objects or parts of an object. The partition into regions is often done by using gray values of the image pixels [6]. Region-based methods partition an image into regions that are similar according to a set of predefined criteria [4]. It further includes following two techniques that supportive in segmentation:

Region Growing :

Region growing is a procedure that group's pixels in the whole image into sub-regions or larger regions based on predefined criterion [7]. Region growing can be processed in four steps:-

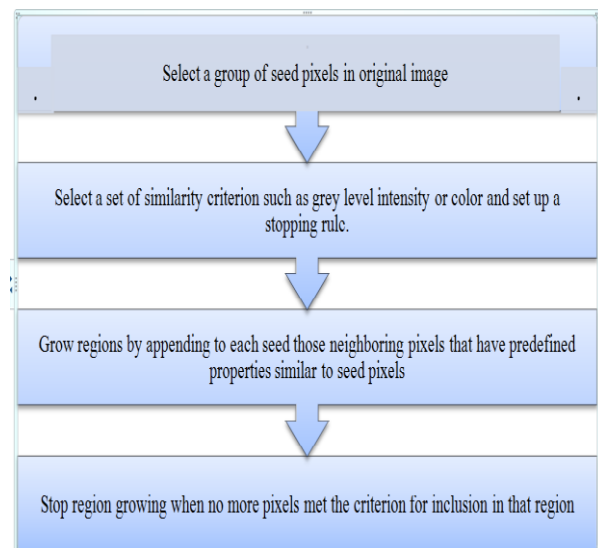


Figure 2: Steps of Region Growing

Region Splitting and Merging :

Somewhat selecting seed points, the user can split an image into a set of random separate regions and then merge the regions [8] in an attempt to satisfy the conditions of reasonable image segmentation. Region splitting and merging are usually applied with a theory based on quadtree data.

B. Edge-Based Segmentation

An edge is a limit between two areas with relatively distinct gray-level properties. Edge is a basic feature of the image, in which image edges include rich information that is identical significant for obtaining the image characteristic by object recognition. With this technique, detected edges in a picture are assumed to represent object boundaries, and supportive in identifying these objects. The utmost commonly used discontinuity based edge detection techniques are Robert's 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 [9].

C. Thresholding

Thresholding is a method of transforming a grayscale input image to a bi-level image by using an optimal threshold. The technique which follows the simplest property that pixels in a region can share its concentration. So, a normal way to segment such regions is through thresholding, the separation of light and dark regions [10]. It is beneficial to separate out the regions of the image conforming to entities in which we are interested, from the regions of the image that correspond to the background. Thresholding often provides an easy and convenient way to perform this segmentation by the different concentrations or colors in the focus and background regions of an image [11]. Threshold techniques can be categorized into two classes:

- Global Threshold
- Local or adaptive thresholding Threshold

In Global Threshold a single threshold for all the image pixels is used. Once the pixel values of the components and that of the background are relatively consistent with their corresponding values over the entire image, global thresholding could be used. In the local threshold, a threshold value is allocated to each pixel to define whether it belongs to the foreground or the background pixel using local information around the pixel. Because of the advantage of simple and easy implementation, the global threshold has been a popular technique for many years [12].

In adaptive thresholding, different threshold values of the various local areas are used.

D. Feature-based clustering

The clustering in image segmentation is defined as the process of identifying groups of similar image primitive. Clustering techniques can be classified into following two categories:

- Supervised Clustering
- Unsupervised Clustering

1. **Supervised clustering:** This type of clustering includes human interaction to decide the clustering criteria. It includes hierarchical approaches such as relevance feedback techniques, Log-Based Clustering, Hierarchical

Clustering, Retrieval Dictionary Based Clustering, K-Means Algorithm. These clustering techniques are:

- Relevance feedback:** A relevance feedback methodology allows a user to interact with the retrieval algorithm by given that the information of which images user thinks are relevant to the query.
- Log-Based Clustering:** Images can be clustered based on the retrieval system logs maintained by an information retrieval process [13].
- Hierarchical Clustering:** this is the process of mixing unique images and building them as a cluster in the form of a tree and then developing step by step to form a small cluster.
- Retrieval Dictionary Based Clustering:** This is imagined through computing the space amongst two learned patterns, and these learned patterns are classified into different clusters followed by a recovery stage [13].
- K-Means Algorithm:** In K-means algorithm data vectors are grouped into a predefined number of clusters. At the beginning, the centroids of the predefined clusters are initialized randomly [14].

2. **Unsupervised clustering:** This type of clustering decides the clustering criteria by itself.

E. Model-based segmentation

Markov Random Field (MRF) based segmentation is known as Model-based segmentation [15]. An inbuilt region smoothness constraint is presented in MRF which is used for color segmentation.

F. Graph-based segmentation

In general, a graph-based segmentation method often follows the following pipeline. First, image features, which are signal responses from some filters describing relevant image properties, are extracted from an input image. These features serve as integral elements used to construct a graph often based on supervised learning algorithms. Once we have built a graph to represent the image segmentation problem,

then apply state-of-the-art graph-cut algorithms to solve the problem efficiently [19].

Let $G = (V, E)$ be an undirected graph with vertices $v \in V$, the set of elements to be segmented, and edges $(v_i, v_j) \in E$ corresponding to pairs of neighboring vertices. Each edge $(v_i, v_j) \in E$ has a corresponding weight $W(v_i, v_j)$, which is a non-negative measure of the dissimilarity between adjacent elements v_i and v_j [20]. 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. In the graph-based approach, a segmentation S is a partition of V into components such that each component (or region) $C \in S$ corresponds to a connected component in a graph $G = (V, E')$, where $E' \subseteq E$. [20]

IV. Comparison of Various Segmentation Techniques

Table 1. Comparison of Various Segmentation Techniques

Segmentation Technique	Description	Advantages	Disadvantages
Clustering Method	based on division into homogeneous clusters	fuzzy uses partial membership, therefore, more useful for real problems	determining membership function is not easy
Thresholding Method	based on the histogram peaks of the image to find particular threshold values	no need of previous information, the simplest method	highly dependent on peaks, spatial details are not considered
Edge-Based Method b	based on discontinuity detection	useful for images having a better contrast between objects	not suitable for wrong detected or too many edges
Region Based Method b	based on partitioning the image into homogeneous regions	more immune to noise, useful when it is easy to define similarity criteria	an expensive method regarding time and memory
PDE-Based Method	based on the working of differential equations	fastest method, best for time critical applications	more computational complexity

V. Conclusions and Future Scope

In this paper, we presented relative Study on the Segmentation Techniques of Image Processing which covers image classification, and segmentation algorithms, where image segmentation has a promising outlook as the universal segmentation algorithm and has become the focus of modern research. Image segmentation is pretentious by lots of factors, such as homogeneity of

pictures, Spatial characteristics of the picture continuity, texture, image content. Thus, there is neither distinct method which can be reflected suitable for all type of images nor all methods similarly useful for a particular category of image. Later the analysis of different techniques of image segmentation, it is pragmatic that a hybrid solution for image segmentation comprises of two or more techniques is being the best approach to solving the problem of image segmentation.

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