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An Awareness Study about Image Segmentation Methods

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Abstract: ***An image is the group of pixels and it is placed in rows and columns. It is the mechanism to get several information from an image by changing it in to digital form. After converting it in to digital form it divided the digital image in to multiple region. The aim of this paper is to provide the notes on different techniques used for image segmentation for young researchers.***

Keywords**:** Filtering**,** Enhancement, Thresholding, Segmentation, Segmentation technique

1. Introduction

Image is the group of pixels. Processing of image to get more information is called image processing. For image processing the image is firstly converted to its digital form and the image processing on the digital form of image is called digital image processing [10],[27]. The digital image processing is done by arranging the pixels on a separate lattice and fixed by using quantization. The image is converted in to its analog form firstly for further its conversion to the digital form. The main application of image processing is in computer graphics and computer vision. Image processing uses complex algorithms for processing of the image which is not accomplished by other methods. Fig 1 indicates the different types of image processing. Edge detection and enhancement are the main image processing techniques [20].

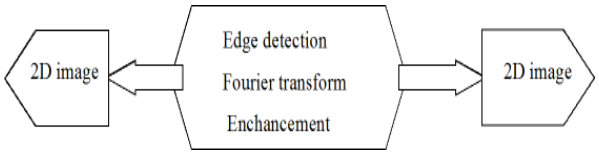

Figure 1: Types of image processing

In Figure1 the input is the 2D image and three main processing is done in the input image. Edge detection method is used to locate the pixels in the image that correspond to the edges of the objects seen in the image. Fourier Transform is an important image processing tool which is used to decompose an image into its sine and cosine components [15]. Image enhancement, one in general attempts to improve the interpretability of the image in any number of ways. Output is also an image, which contain needed information [2]. It is used in space research, military reconnaissance and weaponry, astronomy, meteorology, satellite resource monitoring, and medical technology. Flexibility, the accessibility of digitally stored data and the rapidly decreasing cost of digital computation are the advantages of digital approach [18].

2. Image Segmentation

Image Segmentation is the main part of Image Processing. Image segmentation is used to express the image as a physically meaningful connected region. Image Segmentation is the first step in Image Analysis and Pattern Recognition. In image segmentation, the image is partitioned in to different regions. It helps to gain information about the objects in the image based on certain characteristics like color, intensity or texture [18]. Image Segmentation is based on two basic properties of the pixels in relation to their positions: Discontinuity and Regularity. It is very important to study the data of a processed image. One can identify the objects in an image by simply looking at it but it is difficult to be done by a computer algorithm [10].

The process of Image Segmentation is described in three stages

a) Image processing- removal of useless information from the image.
b) Initial object discrimination- objects are separated into groups with similar attributes.
c) Object boundary clean up- object boundaries are reduced to single pixel widths [18].

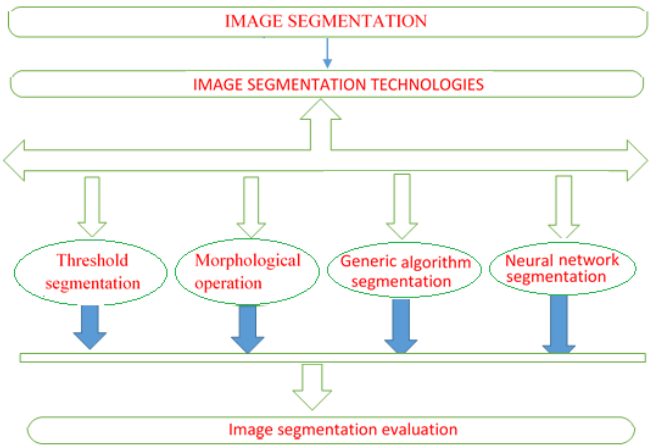

Figure 2: Image segmentation architecture [16]

Image segmentation architecture is shown in Figure 2. The input to an image segmentation process is an image and the

image segmentation is done using image processing technique likes thresholding, morphological segmentation etc [10]. After that evaluate the segmented image because the quality of segmentation depends mainly on subjective assessment of the observer. To directly observe the image effects is a qualitative approach, and the evaluation results have some uncertainty. With the development of fuzzy mathematics, people can use fuzzy comprehensive evaluation method to minimize the subjective factors impact on the achievement of approximate quantitative evaluation [26].

3. Segmentation Techniques

The image segmentation is the partitioning of image into various regions having different properties. Various segmentation techniques like edge, threshold, region, clustering are discussed here

3.1 Clustering Methods

It organizes the region of segmented image using its color, texture etc. There are two natural algorithms for clustering:[11] hierachical algorithms and partitional algorithms.

3.1.1 Hierarchical clustering*:*

It groups each pixel in to a cluster and then it merges the clusters based on the distance from the center cluster point. Agglomerative Hierarchical clustering is an example for hierarchical clustering [12].

Algorithm

Step 1. Select the biggest similarity value from the input similarity matrix and its session is Si,Sj and combine and form its composition Si,j.
Step 2. Form a matrix with Si,j.
Step 3. Find the cell value of matrix as Similarity(Si,j, Sk) = min { similarity (Si,Sk), Similarity(Sj,Sk)}
Step 4. Repeat step 2 until single cluster in matrix cell.

3.1.2 Partitional clustering*:*

Partitional clustering divides the data points into clusters such that the total distance of data points to their respective cluster centers is minimal. An algorithms to achieve this is called Kmeans clustering and Fuzzy c-means algorithm. The partitional clustering results in one single partition of the image [13].

(a) K-means algorithm

This algorithm clusters the point nearest to the centroid. The centroid is basically the average of all the points in that cluster and has coordinate as the arithmetic mean over all points in the cluster, separately for each dimension [13].

Algorithm

Step 1. Select the number of desired clusters k. Arbitrarily place the k cluster centers at different initial locations in the image.
Step 2. Assign each data point to the cluster whose center is closest.
Step 3. Recomputed the cluster centers; the cluster center should be at the average coordinates (center of gravity) of the data points that make up the cluster
Step 4. Go to step 2 until no more changes occur or a maximum number of iterations is reached.

This algorithm minimizes the total distance of data points to the cluster center, of the cluster they are assigned to. Also it does not require the actual computation of distances. A drawback of k-means algorithm is that the number of desired clusters needs to be set before.

(b) Fuzzy C-Means [FCM] Algorithm:

In this algorithm the test pixel is allowed to be member of two or more clusters with different membership coefficient. The values for cluster centre and objective function are updated for every single iteration and are stopped when the difference between two successive object function values is less than some predefined threshold value [11].

3.2 Thresholding Methods

It converts the original image in to binary image. It is mainly used for classifying the foreground image from the background image. It is done based on a threshold value. It gives zero value to the pixel intensity value which less than the threshold value and gives one for the pixel intensity value which greater than the threshold value. Threshold value is varying or constant based on the thresholding methods. If the threshold value is constant it is called global thresholding and if the threshold value is varying then it is called global thresholding.[26].Segmented image using threshold segmentation is shown in Figure 3.

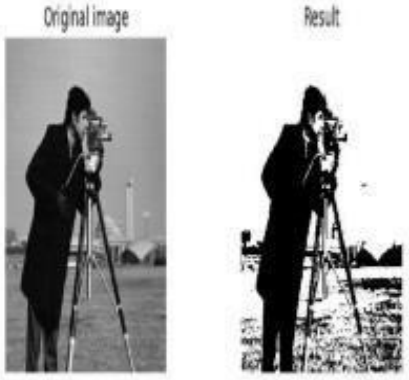

Figure 3: segmented image using threshold segmentation

3.2.1 Binary thresholding

It is used to convert the grey image in to binary image. It is done based on the threshold value. The pixel intensity value greater than threshold value is taken as white and the pixel intensity value less than threshold value is taken as black [26],[21].

Algorithm

Step 1. Divide the image into sub image.
Step 2. Choose a local threshold for sub image considered.
Step 3. Compare the pixels in that sub image and segment the region.
Step 4. Consider all sub images individually and choose corresponding threshold values
Step 5. Stop segmentation when all the sub images are

processed.

The binary thresholding is done using the formula as

$g(x,y) = 1$ for $i(x,y) \geq t$

$g(x,y) = 0$ for $i(x,y) < t$

where i(x,y) is the input image, g(x,y) is the output image and t is the threshold value the input pixel of an input image is greater than the threshold value then assign the binary value 1 for the output pixel g(x,y) and the input pixel value is less than the threshold value the assign the binary value 0 for the output pixel. If the binary value is 1 then it is foreground pixel and if it is 0 then it is background pixel. threshold value the assign the binary value 0 for the output pixel. If the binary value is 1 then it is foreground pixel and if it is 0 then it is background pixel.

3.2.2 Global *t*hresholding

In this thresholding method threshold value is constant. It is used mainly for the image which contain various intensity distribution for the foreground and background pixels [12].

3.2.3 Local thresholding*:*

For all image, global thresholding is not working. so we use local thresholding for the images where global thresholding doesn't work. It done thresholding by dividing the image in to sub images and it thresholded separately [12].

3.3 Region Based segmentation Methods

Region-Based methods [19] are pixel-based methods that depict the splitting of an image into standardized areas of connected pixels through the application of homogeneity criteria among applicant groups of pixels. In Region Growing Algorithm the regions are grown up from the seed points to adjacent points depending on a region membership condition (pixel strength, grey level,or color) . Region Growing and Region Splitting and Merging are the two steps in region – based methods. Region growing [22] is ability for removing a region of the image that is connected based on some predefined criteria and Region Merging and Splitting involves breaking the image into quadrants.

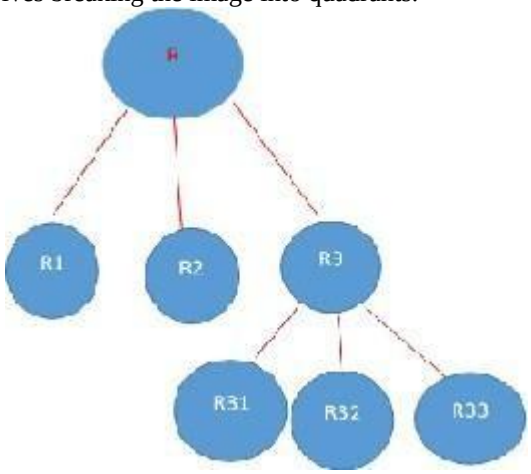

Figure 5: Hierarchical classification of region growing

For this, a quad tree with root as the main image and child as subdivided regions are used as shown in Figure 5. Then, merging of any adjacent regions that are similar enough is done. This entire process is repeated till no more splitting takes place. A region denoted by R of an image is explained as a connected homogenous subset of the image regarding some criterion such as gray level or texture. The algorithm for region growing as

Algorithm

Step 1. Firstly select seed pixels within the image
Step 2. Then from each seed pixel grow a region:
Step 3. After that Set the region prototype to be seed pixel;
Step 4. Calculate the similarity between the region prototype and the candidate pixel;
Step 5. And calculate the similarity between the candidate and its nearest neighbor in the region;
Step 6. Include the candidate pixel if both similarity measures are higher than experiment all set thresholds;
Step 7. After that update the region prototype by calculating the new principal component;
Step 8. At last go to the next pixel to be examined;

Regions in an image are a group of connected pixels with similar properties. In the region approach, each pixel is assigned to a particular object or region. Compared to edge detection method, segmentation algorithms based on region are comparatively manageable and more immune to noise [23]. This algorithm presents several advantages over other color image segmentation algorithms [14].

3.4 Edge based segmentation Methods

Edge is the set of points on the boundaries of the regions in an image. Edge based segmentation is done on the boundary pixel of each object in an image. Filtering, Differentiation, Localization are the three main steps in edge based segmentation. Edge-Based Segmentation methods are classified as follows in Figure 4 [7].

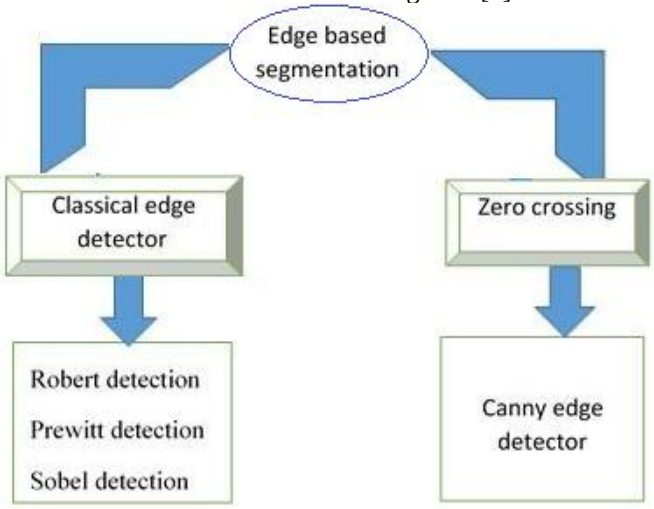

Figure 4: classification of edge based segmentation [4]

The Canny Edge detector is described as a standard benchmark against which other edge detection algorithms are compared [9]. It involves four steps:

(a) Smoothing by Gaussian convolution
(b) Finding edge strength and edge directions
(c) Non-maximal suppression
(d) Hysteresis

Edge based segmentation uses two thresholds high and low for the segmentation. It classify the edges based on the

thresholds. The intensity values which is greater than the high threshold value and the intensity value which is between the high and low intensity value is classified as edges. It takes the near pixels as edges. It is the disadvantage of this method. This method is not possible for the images which are edgeless [9]. Edge detection contains three steps namely Filtering, Enhancement and Detection. Filtering is the tradeoff between edge strength and noise reduction. Enhancement is the emphasizes pixels where there is a significant change in local intensity values and Detection is the determining of which points are edge points [5] [6].

4. Conclusion

The image segmentation techniques can be used in many research works for faces, images and to recognition of pattern. Various types of image segmentation techniques were discussed in this paper.

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