Image Segmentation Methods For Artery/Vein Classification In Retinal Image

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Abstract*- This paper attempts to position light on the basic principles on the strategies used to segment an image. This paper concentrates on an the idea at the back of the primary techniques used. image segmentation can be widely be labeled as a semi-interactive method and completely computerized technique and the algorithms developed lies in either of this approaches. This paper introduces an a new interactive image segmentation algorithm. that is set of rules receives better result with fewer users interactive whilst segmenting a unmarried-item from images with complex foreground and background. computerized blood vessel segmentation inside the photographs can assist us for speed prognosis and improve the diagnostic performance of much less specialised physicians. Processing the screening picture could highlight the locations of anomalies and evaluating contemporary pix to the ones of previous assessments ought to even point out the evolutions of the retina robotically in order that the Artery/Vein magnificence in retinal imges is an important phase the detection of vascular adjustments and moreover for the calculation of characteristic signs and signs and symptoms related to various illnesses like diabetes, excessive blood stress and cardiovascular problems*

Keywords- Diabetic retinopathy, graph nodes, Segmentation Methods, Image, Threshold, Cluster, Graph-cut.

I. INTRODUCTION

An image is essentially an a two dimensional characteristic of spatial coordinates, f(x, y), and amplitude of this characteristic at a given coordinate offers the depth value of the photo. The image can be expressed as the made from features of illumination and reflection.

$$F(x,y) = i(x,y) \cdot r(x,y)$$

where i(x,y) is the function of intensity and r(x,y) is the function of reflectivity.

Digital picture processing is software of diverse algorithms on the picture to improve the high-quality of the image by means of doing away with noise & other unwanted pixels and additionally to attain more information at the picture. the various diverse picture processing techniques picture segmentation may be very critical step to analyze the given photo. This paper especially makes a speciality of this technique, the various techniques accompanied and few algorithms which can be broadly used. An attempt is made to provide the assessment on these methods via taking take a look at photographs. The images are operated the usage of MatLab software program

II. IMAGE SEGMENTATION

Image segmentation is a mid-stage processing technique used to investigate the picture and can be described as a processing technique used to classify or cluster an photograph into numerous disjoint elements by using grouping the pixels to form a vicinity of homogeneity based totally on the pixel characteristics like gray stage, color, texture, intensity and different functions. the primary reason of the segmentation method is to get more statistics within the vicinity of hobby in an picture which enables in annotation of the item scene.[3]. photo segmentation goals at domain-impartial partition of the photo into a fixed of visually distinct and homogeneous areas with appreciate to certain properties.[4]. The principle intention of segmentation is to simply differentiate the object and the background in an photo. Image segmentation is the fundamental step to research pix and extract facts from them. it is the field broadly researched and nonetheless offers various challenges for the researchers. Image segmentation is a crucial step because it immediately influences the overall success to understand the image. Vessel segmentation algorithms are the vital additives of circulatory blood vessel evaluation systems. We gift a survey of vessel extraction techniques and algorithms. We put the numerous vessel extraction methods and techniques in angle by way of a type of the prevailing studies. at the same time as we've especially centered the extraction of blood vessels, neurovascular structure in particular

Blood vessel delineation on clinical image paperwork an vital step in fixing several realistic programs consisting of prognosis of the vessels (e.g. stenosis or malformations) and registration of patient pics obtained at unique instances. Vessel segmentation algorithms are the key components of automatic radiological diagnostic systems. Segmentation methods vary relying on the imaging modality, utility domain, technique being automated or semi-automatic, and other particular elements. there's no single segmentation technique that may extract vasculature from every scientific image modality. While some techniques employ pure intensity-primarily based pattern popularity strategies

Calculation of Anterior venular ratio may be very an awful lot important to stumble on the abnormality within the blood vessels. However, it's time-prohibitive to manually calculate this worldwide AVR due to the huge quantity of vessels that want to be measured. Consequently, computerized or semi-automatic strategies are wished to overcome the time constraints of guide class. Historically, maximum laptop-aided vessel analysis has targeted on segmenting the vessels within the photograph. Artery-vein (AV) category, then again, goes one step in addition and seeks to categorize the segmented vessels into both arteries or veins. but, even assuming an excellent segmentation, the before mentioned ambiguity of small and midsized vessels makes mechanically classifying arteries and veins a totally tough computational challenge. To address this problem, we've used the tree topology to categorize the arteries and the vessels within the fundus image of the retina

If R represents an image, then the image segmentation is simply division of R into sub regions R1,R2…..Rn , such that and is governed by following set of rules:

$$R = \bigcup_{i=1}^{n} R_i$$

a) Ri is a connected set, i=1,2,…..n.
b) Ri ∩ Rj = Ø for all i and j, i ≠ j
c) Q (Ri) = True for i= 1,2,…n.
d) Q (Ri U Rj) = False for adjoint regions, Ri and Rj

Where Q (Rk) is a logical predicate**[8].** The rules described above mentions about continuity, one-to-one relationship, homogeneity and non-repeatability of the pixels after segmentation respectively.

There are many knowledge based approaches to segment an image and can be listed as

1. Intensity based methods
2. Discontinuity based methods
3. Similarity based methods
4. Clustering methods
5. Graph based methods

III. METHODS FOR RETINAL VESSEL SEGMENTATION

The segmentation of the picture is very useful in medical packages to diagnose the abnormalities in the image [27][26], satellite imaging and in pc vision in addition to in ANN. The standards for segmenting the photo may be very hard to determine because it varies from picture to picture and additionally varies drastically on the modality used to capture the image. there is massive quantity of literature available to understand and examine the segmentation techniques. In [1] the clustering strategies have been discussed for clinical photo segmentation in in particular for MR photographs of mind and are a success in combining fuzzy c way and ok-approach to get novel fuzzy-k approach algorithm. Few limitations of the acquired set of rules were also stated. Hybrid technique for medical image segmentation is suggested in [2] and mainly works on fuzzy-c means and otsu‟s method after applying on vector median filter, for segmentation and have tried to prove the robustness of their method few kinds of noise have been added to image and have obtained satisfactory results. A new technique for general purpose interactive segmentation of N-dimensional images using graph-cut method has been proposed by Yuri and Jolly [25]. In their proposed method the user marks certain pixels as "object" or "background" to provide hard constraints for segmentation.

They claim that their method offers excellent balance of boundary and place properties compared to different segmentation techniques and additionally that it affords foremost solution for N-dimensional segmentation. The listing of associated works performed in the field of photo segmentation is very massive and might hardly ever be stated. there are numerous survey and evaluations [11] [13][9] executed on those methods periodically. The following sections offers quick precept accompanied to segment photographs.

IV. INTENSITY BASED SEGMENTATION

One of the only processes to phase an photo is based totally on the intensity tiers and is referred to as as threshold based method. Threshold primarily based strategies classifies the photograph into two classes and works on the postulate that pixels belonging to sure range of depth values represents one elegance and the relaxation of the pixels inside the picture represents the alternative elegance. Thresholding can be implemented either globally or locally. international thresholding distinguishes object and history pixels with the aid of evaluating with threshold fee selected and use binary partition to section the picture. The pixels that pass the edge test are considered as object pixel and are assigned the binary price "1" and different pixels are assigned binary fee "0" and dealt with as background pixels. the threshold based totally segmentation strategies are cheaper, computationally speedy and may be used in real time programs with resource of specialised hardware [15].

$$g(x,y) = \begin{cases} 1 & \text{for } i(x,y) \geq t \\ 0 & \text{for } i(x,y) < t \end{cases}$$

where g (x,y) is the output image; i (x,y) is the input image and t is the threshold value.

Local thresholding is also called as adaptive thresholding. In this technique the threshold value varies over the image depending on the local characteristic of the subdivided regions in the image. The algorithm followed for adaptive thresholding can be stated in general as:

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

In case of global thresholding the threshold value chosen remains the same for the entire image and acts as a 'cut off ' value. In case of local thresholding the image is to be subdivided in to subimages and the threshold is to be chosen depending on the properties of local pixels in that subimage.
Threshold value can be modified and are categorized as band thresholding, multi-thresholding and semi-thresholding. Either the global thresholding or local thresholding yield the result depending on the value of threshold chosen. Hence the choice of threshold is crucial and complicated. There are several methods employed for detection of threshold value to name a few mean method, p-tile- thresholding, bimodal histogram, optimal thresholding, multispectral thresholding, edge maximization method.**[24]** Of the available techniques for threshold based segmentation, threshold selection based on the histograms suggested by Nobuyuki Otsu in 1979 is most used with minor modifications.[21]. Otsu method is optimal for thresholding large objects from the background. This method provides an optimal threshold (or set of thresholds) selected by the discriminant criterion by maximizing the discriminant measure η (or the measure of separability of the resultant classes in gray levels).**[23]** The other approaches employed to select threshold value are histogram based methods, clustering based methods, mutual information based methods, attribute based methods and local adaptive segmentation based methods. The following results compare these techniques

Pros of threshold based methods:

1. Computationally inexpensive
2. Fast and simpler to implement
3. Can work in real-time applications [24]

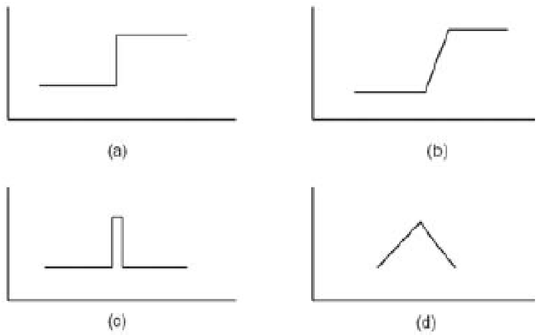
Cons of threshold based algorithms:

1. Neglects the spatial information of the image.
2. Highly noise sensitive

V. DISCONTINUITY BASED METHODS

These methods are based on the principle of intensity variations among the pixels. If the image consists two or more objects boundaries exists and hence can be applied to segment the image. The boundaries of the objects lead to formation of edges. The significant abrupt changes in the intensity levels among neighboring pixels in certain direction are termed as edges and results in the discontinuity in the pixels. Edge detection basically involves the following steps: smoothing the image, edge detection and edge localization. **[6]** A suitable smoothing filter is applied on test image to remove the noise from the image to make it suitable for segmentation. Then the „possible" edges are grouped together to check for candidature and finally the „true" edges are found by localizing the edge „candidates". There are four different edge types that may be present in the image (a) step-edge (b) ramp edge (c) ridge edge and (d) ramp edge and are shown in the fig correspondingly.**[14].**

Edges are usually found by applying masks over the image. The gradient or the zero crossing techniques are employed to find the edges in the given image. The convolution operation between the mask and the image determines the edge set for the image. Edge detection operators can be broadly classified into two categories as: First order derivative operators and Second order derivative operators



A. **First order derivative operators:**

There are two methods for first order derivative edge detection. 1) One of the methods is evaluating the gradients generated along two orthogonal directions. 2) The second approach is utilizing a set of discrete edge templates with different orientations. [**tzu_lee**]The first derivative operator uses gradient method to find the edges by using the maximum and minimum value of the gradient. The gradient is a measure of change in a function

$$\nabla f = G[f(x,y)] = \begin{bmatrix} G_x \\ G_y \end{bmatrix} = \begin{bmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial y} \end{bmatrix}$$

Direction of gradient is given by

$$\alpha = \tan^{-1}\left[\frac{g_y}{g_x}\right]$$

α is measured with respect to x axis.

The operators used in this category are Robert‟s operator, Prewitt‟s operator and Sobel‟s operator.

i. Robert's operator: It is the simplest first derivative operator that can be used to find the edges in the given images. It finds the edges in row and columns separately and are put together to find the resultant edge. The masks used to solve the purpose along x and y direction respectively are

-1	0
0	1

0	-1
1	0

ii. Prewitt's operator: This operator uses 3 X 3 mask to find the edges. The mask used along x and y direction correspondingly are

-1	-1	-1
0	0	0
1	1	1

-1	0	1
-1	0	1
-1	0	1

iii. Sobel's Operator: This is widely used first derivative operator to find edges and is modification of Prewitt‟s operator by changing the centre coefficient to „2‟. The sobel operators are given as

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

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

iv. The Frei-Chen mask: is another operator used to find the edges in the image and its corresponding masks are given as

0	0	-1
$\sqrt{2}$	0	$\sqrt{2}$
0	0	-1

-1	$\sqrt{2}$	-1
0	0	0
1	$\sqrt{2}$	1

B. Second Order Derivative operators:

These operators work on zero crossing detection of the second derivative of the gradient. It detects the local maxima in gradient values and treats them as edges. The Laplacian operator is used with the second derivative operator. The Laplacian operator for any function f(x, y) is given by

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

Where,

$$\frac{\partial^2 f}{\partial x^2} = f(x, y+1) - 2f(x, y) + f(x,, y-1)$$

$$\frac{\partial^2 f}{\partial y^2} = f(x+1, y) - 2f(x, y) + f(x-1, y)$$

The frequent used second derivative operators for edge detection are Laplacian of Gaussian (LoG) operator and Canny edge operator

i. Laplacian of Gaussian Operator:

The Laplacian of an image highlights regions of rapid intensity change. The operator normally takes a single gray level image as input and produces another gray level image as output. **[raman_maini].** The kernels used for approximation of second derivatives Laplacian operations are

1	1	1
1	-8	1
1	1	1

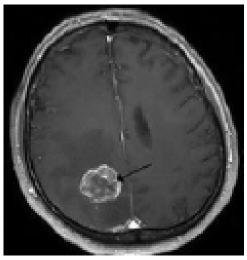
-1	2	-1
2	-4	2
-1	2	-1

0	1	0
1	-4	1
0	1	0

ii. Canny Edge Operator:

Canny edge operator is considered as superior edge detection operator among the available operators based on the experimental results as it determines strong and weak edges in the image. Image is first smoothed by using circular two-dimension Gaussian function, computing the gradient of the result and then using the gradient magnitude and direction to approximate edge strength and direction at every point. The gradient magnitude array so obtained consists of undesirable ridges around local maxima and are to be suppressed to get discrete orientations of the edge normal by the process of nonmaxima suppression. Then the technique of double thresholding is employed to reduce false fragments. Two thresholds are used to solve the purpose T1 and T2 where T2 ≈ 2T1. The following results compare the above said methods to segment image using edge operators.

Original image



Roberts edge

Sobel edge

Prewittts edge

Laplacian of Gaussian edge

Canny edge

Pros:

1. Second order operators give reliable results.
2. Useful in calculating the number of different objects present in the given image.

Cons:

1. No single operator can fit for all variety of images and the computational complexity increases with the size of operator.
2. Many a times the edges obtained are not continuous.

VI. REGION BASED SEGMENTATION

This method works on the principle of homogeneity by considering the fact that the neighboring pixels inside a region possess similar characteristics and are dissimilar to the pixels in other regions.

The objective of region based segmentation is to produce a homogeneous region which is bigger in size and results in very few regions in the image. The regions though treated as homogeneous in nature but there is provision to note any considerable changes in the characteristic of the neighboring pixels. **[7]**.

The simplest approach to segment image based on the similarity assumption is that every pixel is compared with its neighbor for similarity check (for gray level, texture, color, shape)[24]. If the result is positive, then that particular pixel is "added" to the pixel and a region is "grown" like-wise. The growing is stopped when the similarity test fails.

Region based methods are fundamentally divided as

1. Region growing methods
2. Region split and merge methods

Further there are several segment approaches based on regional analysis of the image proposed by [7] Similarity measures among the neighbors, comparing the pixel to original seed, comparing the pixel to neighbor in region, comparing the pixel to the region statistics, considering multiple seeds, calculating the cumulative differences and counter examples.

A. Region growing methods*:*

Region growing method gives reliable output compared to its other counterparts. It is basically extracting a region from the image using some pre-defined criteria.[27]. The simplest procedure is to compare the candidate pixel to its neighbors to check the homogeneity criteria allocated to the class to which its neighbor belongs. It can be further classified as seeded region growing method (SRG) and unseeded region growing method (UsRG). The main difference between SRG and UsRG is that SRG is semi-automatic in nature whereas UsRG is fully automatic in nature. **[17]**

i. Seeded Region Growing method:

It was initially proposed by Rolf Adam **[18]** and is found to be reliable since then. SRG has characteristics like robustness, rapidness and is also free of tuning parameters which makes it suitable for large range of images. In this approach initially the seeds are to be specified by the user. A seed is a test pixel with ideal characteristic that belongs to the region interested in and should be the part of region of interest. The choice of seed is very crucial since the overall success of the segmentation is dependent on the seed input.

The seed set may have one or more members and is user"s choice. For the given set of seeds, each step in the SRG adds pixels to one of the seed sets. In some approaches of SRG these seeds may be replaced by centroids of the segmented regions. The allocated pixels of same region are labeled with same value and other unallocated pixels with different value.

There are several algorithms available for SRG approach. They all differ in the sense of adding pixels to a region and/or comparing the pixel with the seed. The general steps in SRG algorithm can be as follows:

1. Determine seeds to start the segmentation process.
2. Determine the criteria to grow the region. In case of multiple regions, clearly the characteristic of regions should be mentioned. So that no ambiguity exists to place the pixel in particular region.
3. The candidate pixels to include in the region it should be 8-connected to at least` one of the pixel in the region.
4. Cross-check is to be done to ensure all the pixels are tested for allocation and then label has to be given to all regions.
5. If two different regions get same label then they have to be merged.

ii. Unseeded Region Growing method:

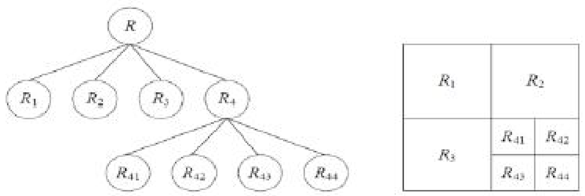
Unseeded region growing method is flexible, automatic segmentation approach and is based on postulate of pixel similarities within regions. UsRG does not rely on tuning parameters and is also independent of manual inputs. This approach readily incorporates the high-level knowledge of the image and is very crucial for the choice of region statistics. The incorporation of basic adaptive filtering techniques have shown some good results in practical [17]. The following are general considerations:

1. 1.Segmentation process is initialized with region A1 containing single pixel and eventually results in several regions (A1, A2, A3…..An) after the completion.
2. Difference measure of the test pixel with the mean value of the region statistics considered decides the pixel to be allocated or unallocated to that region.
3. If the difference value between the test pixel and the region statistics is less than certain threshold considered the pixel is allocated to that specific region, say Aj
4. If the condition is not satisfied than the pixel considered should be allocated to new region, say Ai which has regional characteristic similar to the test pixel.

5. If for any test pixel if the conditions for Ai and Aj are not satisfied then it implies that the test pixel belongs to a new third region and so on and so forth

B. Region split & merge methods:

This method is the most similar method to segment the image based on homogeneity criteria **[19].** This method works on the basis of quadtrees and main objective is to distinguish the homogeneity of the image. It initially considers the entire image as one single region and then divides the image into four quadrants based on certain pre-defined criteria. It checks the quadrants for the same defined criteria and divides it further into four quadrants if the test result is negative and the process continues till the criteria is satisfied or no further division is possible. The figure given below illustrates the process and also the algorithm is given



Algorithm:

Let R represent the entire image region and let P be any predicate.

If P(R) == False
Divide the image into quadrants
If P if false for any subquadrant
Subdivide that quadrant into subquadrant..
Stop dividing when P is true.
Merge the regions Rj & Rk (j ≠ k; j=1,2,3…n, k=1,2,3…n) if P(Rj U Rk) == true

VII. CLUSTERING METHODS

Clustering techniques is the collective name for methods that attempt to group together measurements points ('patterns'). For an off-topic example, let's say we measure the weight and length of a population of rabbits. We can then plot the measurements of each rabbit together as shown in figure When looking at the figure, it will be clear that three clusters can be identified –there are very likely three types of rabbit in the population. The object of clustering techniques is to identify such clusters in data. The relation to segmentation will be clear; when viewing the rabbit plot as an image, the most intuitive segmentation would be to divide the image into segments equal to the three clusters and the background. Clustering techniques are often formulated for data of arbitrary dimension (not just two as in our rabbit example), but many clustering methods can readily be applied to two or three-dimensional images. The images best suited for applying clustering techniques to are those similar in appearance to the rabbit plot, *i.e.*, of a very sparse nature, the dark pixels forming quasi-coherent clouds. The rabbit data consists of a list of pairs of measurements. This data representation is the most natural for clustering techniques. If we wish to apply clustering to a binary image, we therefore use a similar representation: each pixel with value one is included in a data list of coordinate pairs. For grey-valued images there may not be a natural conversion to a list of data points. For some types of grey-valued images, it is possible to consider the grey value as the number of data points measured at a certain location. The heart of most clustering techniques is the distance matrix D. An entry D(i, j) gives the distance between two data points i and j. If there are N data points, then D is an
N × N symmetric matrix

i) Agglomerative clustering:

This approach starts out by calling each data point a separate cluster, and then proceeds to merge appropriate clusters into single clusters. The dissimilarity matrix is used to decide which clusters are to be merged; the smallest entry gives the data points that are least dissimilar and hence are the most likely candidates to be merged. After merging, the next smallest entry is selected, supplying two new merging candidates, etc.

Algorithm:

Given n data points and a dissimilarity matrix D:

1. Initialize by defining each data point to be a separate cluster. Set an iteration counter c = 0.
2. Select the smallest entry in D: D(a, b) = min (i,j) D(i, j).
3. Merge the clusters a and b.
4. Update D: (a) Update row b and column b by setting D (k, b) = min{D(k, a),D(k, b)} and D(b, k) = D(k, b), both for all possible k, k = a, k = b. (b) Delete row a and column a
5. Increase c by one, and go to step 2 if c < n.

This algorithm will merge clusters if there are member data points that are closest considering all data point pairs. A variation on this algorithm is to merge two clusters if the largest distance between its member data points is the smallest when considering all clusters. This can be achieved by a simple modification of the above algorithm: the ‘min’ in the update step 4 must be replaced by ‘max’.

ii) Partitional clustering. The most frequently used form of partitional clustering is to divide the data points into clusters in such a way that the total distance of data points to their respective cluster centers is minimal. An algorithm to achieve this is called K means clustering.

Algorithm: *K*-means clustering

This algorithm minimizes the total distance of data points to the cluster center of the cluster they are assigned to. Note that it does not require the actual computation of distances.

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

A drawback of this algorithm is that the number of desired clusters needs to be set beforehand. An addition to the above algorithm is therefore to embed it into an outer loop that modifies the number of clusters, or, more precisely, removes irrelevant clusters, and splits existing clusters where appropriate. After this modification, the entire new algorithm is iterated until stable. A criterion for removal of a cluster is when the number of contained data points falls below a set threshold. When this happens, the data points are probably outliers and can usually be safely ignored in the rest of the process. A criterion for splitting a cluster can be when a distance can be found of a contained data point to the cluster center that is relatively large compared to the average distance of the data point to all cluster centers. The splitting can then be implemented by setting this data point to be the center of a new cluster.

VIII. GRAPH BASED METHODS

Graph based methods for image segmentation has several good features in practical applications. It explicitly organizes the image elements into mathematically sound structures, and makes the formulation of the problem more flexible and the computation more efficient.**[19]**.

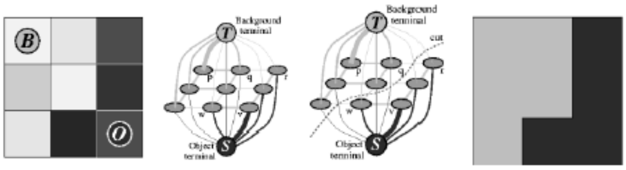
Let $G = (V, E)$ be a graph where $V = \{ v1 ,..., vn \}$ is a set of vertices corresponding to the image elements, which might represent pixels or regions in the Euclidean space. E is a set of edges connecting certain pairs of neighboring vertices. Each edge $(vi,vj) \in E$ has a corresponding weight $w(vi,vj)$ which measures a certain quantity based on the property between the two vertices connected by that edge. 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 (e.g., the difference in intensity, color, motion, location or some other local attribute).

An image can be partitioned into mutually exclusive components, such that each component A is a connected graph $G = (V, E)$, where $V' \subseteq V$, $E' \subseteq E$ and E' contains only edges built from the nodes of V'. In other words, nonempty sets $A1, \ldots, Ak$ form a partition of the graph G if $Ai \cap Aj = \varphi$ ($i,j \in \{1, 2, \ldots, k\}$, $i \neq j$) and $A1 \cup \ldots \cup Ak = G$. The graph based methods are categorized into five classes : the minimal spanning tree based methods, graph cut based methods with cost functions, graph cut based methods on Markov random field models, the shortest path based methods and the other methods that do not belong to any of these classes.[19]

Among the available techniques graph cut methods are widely used and was initially proposed by yuri and marie**[22]**. Using the definition of graph theory, the degree of dissimilarity between two components can be computed in the form of a graph cut. Graph cut formalism is well suited for segmentation of images. **[22]**. A cut is a subset of edges by which the graph G will be partitioned into two disjoint sets A and B and the cut value is usually defined as:

$$cut\ (A, B) = \sum_{u \in A, v \in B} w(u, v)$$

where u and v refer to the vertices in the two different components. The cost function is defined in terms of boundary and region properties of the segments. These properties can be viewed as soft constraints for segmentation. Image courtesy [22]



(a) (b) (c) (d)

Consider an image as shown in the above fig (a). Using the object and background seeds create a graph with two terminals as shown in (b) and by using the edge weights, boundary terms of cost function and positions of seeds in the image separate two terminals by computing optimal minimum cut (c). This cut would give the segmentation result as shown in (d). There are various other methods that are used to obtain desired image segmentation using the graph theory. A detailed survey on graph based techniques is done by ping et.al [19] and the reader can refer for more detailed information. The advantage of the segmentation using a graph based approach is that it might require no discretization by virtue of purely combinatorial operators and thus incur no discretization errors.

X. DISCUSSIONS

Image segmentation is a process of dividing an image into its constituent homogeneous regions to extract data from the attributes of the image. As a result, a good segmentation should result in regions in which the image elements should have uniform properties in terms of brightness, color or texture etc. Though the image is to be portioned into regions, the considerable changes within the regions should be observable visually. The measurement of quality of segmentation is that the elements of the same region should be similar and should have clear difference between elements of the other regions. The segmentation process can be divided into various category based on the parameter selected for segmentation like pixel intensity, homogeneity, discontinuity, cluster data, topology etc. Each approach has its own advantages and disadvantages. The result obtained using one approach may not be the same as compared with other approach.

Basically the segmentation can be semi-interactive or fully automatic. The algorithms developed for segmentation lies in either of this category. With the major difficulty of ill-posed nature of segmentation it is hard to obtain single answer for segmentation of given image as the interpretation varies from individual approaches

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