Review of Image Segmentation and Its Various Techniques

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Abstract

Segmentation attempts to partition the pixels of an image into group that strongly correlate with the objects in an image. Some of the practical applications of image segmentation are content based image retrieval, Machine vision, Medical imaging, object detection, face recognition, finger print recognition, and video surveillances. Segmentation algorithms are based on one of two basic properties of image intensity value discontinuity and similarity. In this paper we discuss a number of approaches in the two categories and compare the advantages and disadvantages of different algorithm.

Key words: *Segmentation, Threshold, Region, Edge, Texture.*

I. INTRODUCTION

Digital image processing is an important research topic for many reasons. Actually Digital image processing is a recent subject in computer history. In 1960s; Bell Labs and University of Maryland, and a few other places started to develop several techniques for digital image processing. With application to satellite imagery, wire photo standards conversion, medical imaging, videophone, character recognition, and photo enhancement. But the cost of processing was fairly high with the computing equipment of that era. In the 1970s, image processing rapidly increased, when cheaper computers and dedicated hardware became available. Images could then be processed in real time, for some dedicated problems such as television standards conversion. As general-purpose computers became faster, they started to take over the role of dedicated hardware for all but the most specialized and compute-intensive operations.

Image segmentation is important part in many signal processing technique and its applications. The objective of image segmentation is to simplify the representation of a picture into something that is more genuine and simpler to understand. It is essentially used to discover the location of objects, boundaries, lines and so on in the digital images. More precisely, image segmentation is the process of assigning a label to every pixel in the image such that pixels with the same label share certain visual characteristics or features [1].

Essentially Image segmentation involves partitioning an image by grouping similar pixels together. Ideally these groups should represent the components that the image is comprised of. The image can then instead be interpreted using a small number of well-defined components as opposed to a large array of unrelated pixels. Image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics.

The output of image segmentation is a set of regions that together cover the entire image. There are many commonly used image segmentation algorithms. Some of the segmentation algorithms are discussed in [2]. Threshold segmentation is one of the most commonly used segmentation techniques in region-based segmentation algorithms. Its essence is to automatically determine the optimal threshold according to a certain criterion, and use these pixels according to the gray level to achieve clustering [3].

The basic idea of the regional growth algorithm is to combine the pixels with similar properties to form the region, that is, for each region, to be divided first to find a seed pixel as a growth point, and then merge the surrounding neighbourhood with similar properties of the pixel in its area. Edge detection segmentation algorithm refers to the use of different regions of the pixel gray or colour discontinuity detection area of the edge in order to achieve image segmentation. The next is the segmentation based on clustering.

The image is divided into several sub classed according to the internal structure of the sample set. the algorithm based on clustering is based on the similarity between things [4]. The segmentation based on weakly-supervised learning in CNN. It refers to the problem of assigning a semantic label to every pixel in the image and consists of three parts. 1. Give an image which contains which objects. 2. Give the border of an object. 3. The object area in the image is marked with a partial pixel [5].

At present, from the international image segmentation method, the specific operation of the process of segmentation method is very diverse and complex, and there is no recognized a unified standard

Aim of writing this paper is to arrange the detailed information in this field. The paper is planned in to three sections further; I section includes the detailed discussion about various image segmentation techniques. Section II describes the comparison between segmentation techniques along with their advantages and disadvantages and section III Concludes the overall study.

II. IMAGE SEGMENTATION TECHNIQUES

Segmentation algorithms have been developed to segment the image. They are based on the two basic properties, discontinuity and similarity. In discontinuity based partition the subdivision is carried out based on abrupt changes in intensity level the grey level of an image. In this method or interest mainly focuses on identification of isolated points, lines and edges. In similarity based group those pixels which are similar in some sense, it includes approaches like thresholding region growing, and region splitting and merging [6].

Image segmentation methods

Image segmentation technique is used to partition an image into various segments and it is used to locate the objects and the boundaries. An effective segmentation is to select and separate the objects from the entire image with due importance to process the necessary feature of an area of interest with optimization of computation time and storage area for further processing. Image Segmentation is very basic problem in image analysis process. There are varieties of algorithms are developed by users according to the problem in their hand. These algorithms are based on one of the following approaches. 1. Satisfying homogeneity property in image features over all a large region. 2. Detecting abrupt change in image features within a small neighbourhood. In image segment category as depicted in Fig 1. Represent the different types of image segmentation methods.

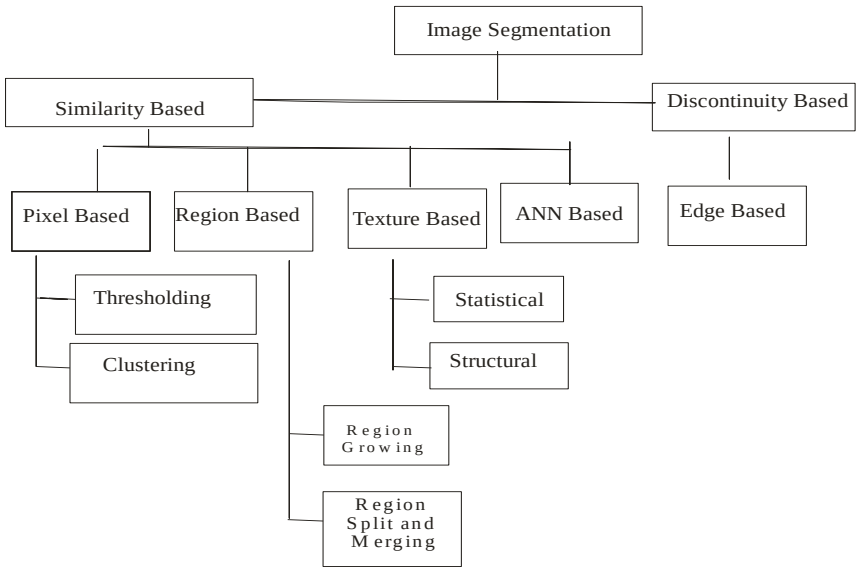

Fig. 1. Image segmentation methods

Image segmentation algorithms are mainly classified in to similarity base or discontinuity based approaches. The similarity based approach extracts the regions as a whole over which some measure shown the presence of homogeneity in feature value; while the Discontinuity based approach detect the border between two regions.

1. ***Pixel Based Methods***

Pixel represents the picture element, each and every picture element gives the necessary information it terms of its gray level, intensity, color, texture, shape, scale etc. for further processing like segmentation, classification retrieval etc. Each pixel's intensity in an image is represented as a single number between 0 and 255, the value of each pixel is converted into a grayscale, where 0 is black, 255 is white, and the intermediate values are shades of the gray level variations. The similarity of pixels is the base for

region based segmentation. The dissimilarity of pixel is the base for edge based segmentation.

a) Thresholds

The gray level image can be converted to binary image; by selecting the threshold value to the binary image should contain all the essential information of foreground. The advantage of obtaining a binary is to reduce the complexity of the data and simplifies the process of recognition and classification. First select a threshold values T to convert a gray level image to a binary image. If gray level value below thus T will be black (0) and value above this T will be white (1). The segmentation problem becomes one of selecting the proper value for the threshold T. 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 segmentation problem becomes one of selecting the proper value for the threshold T. A frequent method used to select T is by analyzing the histograms of the type of images that want to be segmented [8]. The ideal case is when the histogram presents only two dominant modes and a clear valley (bimodal). In this case the value of T is selected as the valley point between the two modes. In real applications histograms are more complex, with many peaks and not clear valleys.

i) Threshold Techniques

Threshold technique is one of the important techniques in image segmentation. This technique can be expressed as:

T=T[x, y, p(x, y), f(x, y] (1)

Where: T is the threshold value.

x, y are the coordinates of the threshold value point. p(x,y) ,f(x,y) are points the gray level image pixels. Threshold image g(x,y) can be define:

$$g(x,y)= \begin{cases} 1 & if \quad f(x,y) > T \\ 0 & if \quad f(x,y) \le T \end{cases}$$

In paper [9] the author compared five threshold techniques and concludes HDT (Histogram Department Technique) and EMT (Edge maximization Technique) are the best techniques.

b) Clustering Based Image Segmentation

Clustering based image segmentation is used to segment the images of grey level. This algorithm is based on the similarity between the things. Fig2. Represent the clustering based image segmentation along with original image.

Fig. 2 (a) Original Image (b) Segmented Image Using DP Clustering Based Segmentation.

There are two main methods in clustering.

i) K-Means

The principle of minimization of the sum of squared distances from all points in each cluster domain to the cluster center is used in K Means of clustering. This sum is also known as the within cluster as opposed to the between cluster distance which is the sum of distance between different cluster centre and the global mean of the entire data set. [10]

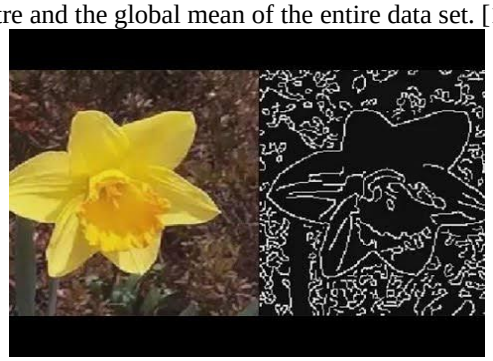

Fig. 3 a) Original image b) Cluster segmentation

ii) Fuzzy K-Means

This process is a two stage process, in which coarse segmentation and followed by a fine segmentation involves. The histogram of each of the color components are smoothed in coarse segmentation and using the first and second derivatives of the smoothed histograms to find the values which will then be the thresholds[11][12]. A safe area surrounding the thresholds is then determined, and every pixel not falling into any safe area is assigned to a cluster based on its red, green and blue values and cluster canters are calculated. The “fine” segmentation involves assigning each pixel which belongs to a safe area to its closest cluster by calculating fuzzy membership functions [13].

2. Region Based Segmentation

The similar subset of pixels of an image based on some criteria are grouped together to form image region in region based segmentation. Image regions are constellation of connected pixels with similar belongings [14]. So Region is an image consists of a

group of pixels having similar properties. This method is simple and more immune to noise.

The following Steps in Region Based Method

- The entire image is segmented into pattern cells
- Comparison of every pattern cell is done with its neighbouring cells to determine whether they are similar, using a similarity measure. In case they are similar, merge the cells to form a fragment and the property used in the comparison is updated.
- After comparison, continue growing the fragment by examining all its neighbours until no joinable regions remain. Then label the fragment as a completed region.
- Move to the next uncompleted cell, and repeat these steps until all cells are labelled [15].

Two basic techniques of region based segmentation are following.

a) Region growing

Region growing method involves the selection of initial seed points, after that the initial region begin as the exact location of these seeds, the regions are then grown from these seed points to adjacent points and grouping the pixels or sub regions into larger region based on pre-defined criteria. Region growing method is used to separate the regions correctly, which have the same properties and this method can provide the original image which have clear edges with good segmentation results. This method has some drawbacks like more computation time, due to noise, it produce holes or over segmentation. This method is failed to distinguish the shading of real image.

b) Region split and Merging

The splitting and merge techniques of the region starts with splitting of an image into number of small regions and this proves continues till region with mandatory degree of homogeneity are formed. The splitting of the phase has an impact on the overall segmentation of the image. Thus result in over segmentation of the image which is further followed by the merging phase. Thus a region splitting and methods technique is complex and consumes a lot of time.

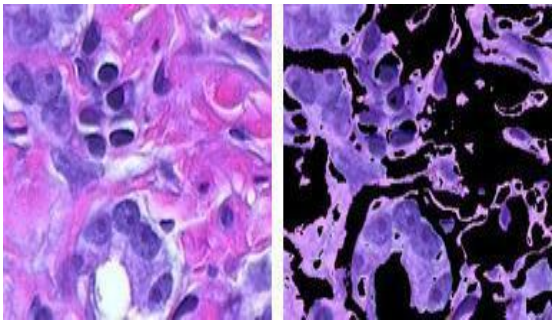

Fig.4 a) Input Image b) Segmented Image

3. Texture based segmentation

The textural properties of texture images carry more useful information for the discrimination purposes so the image texture can be used as a descriptor for segmenting the regions. Different texture has regularity in different perceptual features. Some textures have regular primitives, which repeat themselves. The image texture can be used along with and help to solve segmenting problem in an image.

An image texture is described by the number and type of its tonal primitives and the spatial organization or layout of its tonal primitives and the spatial organization or layout of the primitives. Gabor filters are used for the texture analysis with different tuning parameters.

Texture filters are used to control how the texture is rendered to the screen. At each pixel of the screen where the texture shape is rendered, a texture read is performed for finding the pixel's feature depending on its texture co ordinates.

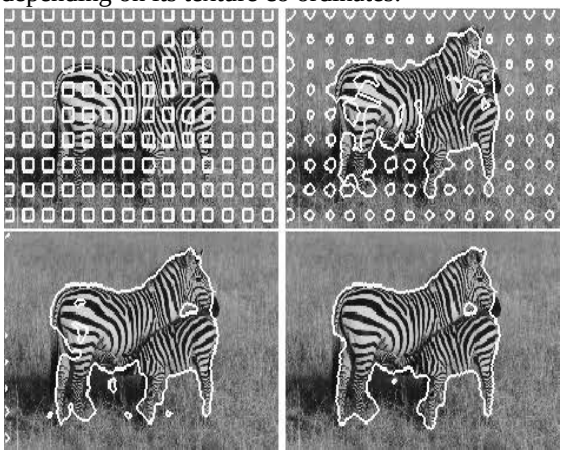

Fig. 5 Texture based Segmentation.

Three statistical texture filters namely Range filter, Standard Deviation filter and Entropy filters are used frequently for the following purpose.

1. Range filter calculates the local range of an image.
2. Standard deviation filter calculates the local standard deviation of an image.
3. Entropy filter calculates the local entropy of a greyscale image.

They defined a neighbourhood around the pixel of interest and calculate the statistic for that neighbourhood [16]. These statistical can characterize the texture of an image because they provide information about the local variability of the intensity values of pixel of an image.

a) Statistical

Statistical methods are used to analyze random texture and compute different properties when the texture primitive size is comparable with the pixel

and sizes. These methods also analyze the spatial distribution of gray values and compute the local feature of all pixels and derive a set of statistics from the distribution of the local features since the spatial distribution of gray values defined the texture's qualities.

b) Structural or Spectral methods

Structural or Spectral methods are used to analyze regular texture, repeating pattern primitives or words or equality describes Regular texture [17]. In structure approach, if a region has a constant texture and the local properties of the image also are constant, then it is said to be textured region.

4. ANN based

Artificial neural networks have come to be used as a different approach for image segmentation. Their properties, such as graceful degradation in the presence of noise, their ability to be used in real time application and the ease of implementing them with VLSI processor led to a booming of ANN based method for segmentation. Almost all type of neural networks has been applied with a different degree of success. The mostly used being kohonen and Hopfield ANNs.

5. Segmentation Based on Edge Detection

Edge can be defined as the boundary between two regions with definite properties of grey level. Edge detection can be defined as that each object is surrounded by a closed border, which is visible and can be detected in the intensity value of the image. It plays very important role in image analysis and pattern recognition as it describes the physical extent of objects. Edge detection methods are following:

a) Roberts Edge Detection

Roberts edge operator is used in image processing for edge detection. It was proposed by Lawerence Roberts in 1963[18]. It was the first edge detector. The Roberts operator performs a simple, quick to compute, 2-D spatial gradient measurement on an image. It thus highlights regions of high spatial gradient which often correspond to edges. In its most common usage, the input to the operator is a grayscale image, as is the output. Pixel values at each point in the output represent the estimated absolute magnitude of the spatial gradient of the input image at that point. [19].

b) Sobel Edge Detection

Sobel edge detector named after Irwin Sobel and it sometimes called as Sobel filter. Sobel edge detector is having two masks, one is vertical and other is horizontal. These masks are generally used 3*3 metrices. Standard Sobel operators, for a 3×3 neighbourhood, each simple central gradient estimate is vector sum of a pair of orthogonal vectors [1]. Each orthogonal vector is a directional derivative estimate multiplied by a unit vector specifying the derivative's direction. The vector sum of these simple gradient estimates amounts to a vector sum of the 8 directional derivative vectors. Thus for a point on Cartesian grid and its eight neighbours having density values as shown. [20]

a	b	c
d	e	f
g	h	i

Density values

c***) Prewitt Edge Detection***

Prewitt Edge Detector is used with edge detection algorithms in image processing. It is also called as Discrete Differentiation operator. It is used to calculate the gradient of the image intensity function. The Prewitt Edge filter is use to detect edges based applying a horizontal and vertical filter in sequence. Both filters are applied to the image and summed to form the final result. The two filters are basic convolution filters of the form: [21]

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

Horizontal Filter

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

Vertical Filter

III. COMPARISON BETWEEN SEGMENTATION TECHNIQUES

S.No	Segmentation Techniques	Method Description	Advantages	Disadvantages
1.	Thresholding Method	Depends on the histogram of an image	A simple approach in which there is no any requirement of prior knowledge of image.	It doesn't work well if too many edges are present or not fit for flat valleys.

2.	Region Based Method	Grouping of pixels having similar properties and form the region.	Work well when the region homogeneity criteria are easily defines and more immune to noise.	This technique consists of dual segmentation which takes time and memory.
3.	Texture Based Method	It is typically probe for the aforementioned characteristics like regularity, coarseness, and directionality.	Easy to solve complex problem using training data. Could entirely exploit the parallel nature of neural net.	Extended training period. Initialization might affect the outcome.
4.	ANN Based Method (Artificial Neural Network)	It is used the neural network consist of node.	Use training data to solve complex problem and easily detect error.	Training process consumes more time and it required over training.
5.	Edge Based Method	Based on discontinuity of pixel or pixel having different intensities.	Easily detection of the edges	It is less immune to noise and not work if the edges are not defined perfectly.

IV. CONCLUSION AND FUTURE SCOPE

Image Segmentation is a process of image processing and understanding. It is defined as the process of dividing the image into parts based on homogeneity. The purpose of image segmentation is to make the representation of an image simpler into something that is more meaningful and easier to understand. The survey has shown that of the existing techniques, main focus is on complex regions. Therefore not much work has been done for the images with mixed regions. The effect of the regions on the segmentation has been neglected by many researchers.

REFERENCE

[1] Santanu Bhowmik, Viki Datta," A Survey On Clustering Based Image Segmentation", International Journal Of Advanced Research In Computer Engineering & Technology Volume 1, Issue 5, July 2012.

[2] Kalavathi P, "An Image Spatial Alignment Method for Computing Region Overlapping Measures", International Journal of Emerging Trends & Technology in Computer Science (IJETTCS), Volume 3, Issue 5, September-October 2014, ISSN: 2278-6856, Pg. 251-255.

[3] Marr D, Hildreth E. "Theory of edge detection". Proceedings of the Royal society of London B. Biological sciences,1980,207(1168):187-217.

[4] Wn Z. Leahy R. "An optimal graph theoretic approach to data clustering. Theory and its application o image segmentation". IEEE conference on Patten analysis and machine intelligence, 19993,15(11):1101-1113.

[5] Lin D, Dai J, Jia J, et al. Scribblesup "Scribble-supervised convolution network for segmantic segmentation"/Proceeding of the IEEE conference on computer vision and pattern Recognition. 2016: 3159-3167.

[6] Gurjeet kaur Seerha, Rajneet kaur, "Review on Recent Image Segmentation Techniques", International journal on computer science and engineering, Vol 5 No.02 Feb 2013.

[7] Salem Saleh, N.V Kalyankar and Khamitkar S.D "Image segmentation by using Thershod Techniques" vo 2 , may 2010.

[8] Verma, Om Prakash, Madasu Hanmandlu, Seba Susan, Muralidhar Kulkarni, and Puneet Kumar Jain. "A simple single seeded region growing algorithm for color image segmentation using adaptive thresholding" IEEE International Conference on Communication Systems and Network Technologies (CSNT), pp. 500-503., June, 2011.

[9] Siddheswar Ray, rose H. Turi and peter E. Tischer, clustering based color image segmentation An evaluation study.

[10] N. R. Pal and S. K. Pal, "A Review on Image Segmentation Techniques", Pattern Recognition, vol. 26, no. 9, pp. 1277-1294, 1993. [6] T. Kanungo, "A Methodology for Quantitative Performance Evaluation of Detection Algorithms", IEEE Transactions on Image Processing, vol.4, no. 12, Dec. 1995.

[11] S. Z, H. Majeed, H. Irshad, "Image segmentation using Fuzzy clustering: A survey" International conference on ICET PP. 181-186, 2010.

[12] Santanu Bhowmik, Viki Datta," A Survey On Clustering Based Image Segmentation", International Journal Of Advanced Research In Computer Engineering & Technology Volume 1, Issue 5, July 2012.

[13] Zhensong Chen et al, "Image Segmentation via Improving Clustering Algorithms with Density and Distance", Procedia Computer Science 55 (2015) Pg. 1015-1022, ELSEVIER.

[14] Hawraa Haj-Hasan et all, "Comparison Of Segmentation Techniques for Histopathological Images" Fifth International Conference on Digital Information and Communication Technology and it's Application(DICTAP), Beirut Lebanon, April 2015, Pg. 80-85 ISBN: 978-1-4799-4129-2 IEEE.

[15] Umarani. C, Ganesan. L, Radhakrishnan.S.,Combined "Statistical and structured approach for unsupervised texture classification", international journal of image science and Engineering, Vol. 2 No 1, pp.162-165. 2008.

[16] Srinivasan, G.N., Shobha.G, 2008 combined statistical texture analysis, proceeding of world academy of science engineering and technology, ISSN 2070-3740, Vol.36,1264-1269.

[17] R. M. Haralick, "Digital Step Edges from Zero Crossing of Second Directional Derivatives", IEEE

Transactions on Pattern Analysis and Machine Intelligence, vol. Pami-6, no. 1, Jan. 1986.

[18] J. F. Canny, "A computational approach to edge detection", IEEE Trans. Pattern Anal. Machine Intell., vol. PAMI-8, no. 6, pp. 679-697, 1986.

[19] N. Senthilkumaran and R. Rajesh, "A Study on Edge Detection Methods for Image Segmentation", Proceedings of the International Conference on Mathematics and Computer Science (ICMCS-2009), 2009, Vol.I, pp.255-259.

[20] M. Abdulghafour,"Image segmentation using Fuzzy logic and genetic algorithms", Journal of WSCG, vol. 11, no.1, 2003.

[21] P. S. Liao, T.-S. Chen and P.-C. Chung, "A fast algorithm for multilevel thresholding," J. Inf. Sci. Eng., vol. 17, no. 5, pp. 713–727, Sep. 2001.