Review on Recent Image Segmentation Techniques

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Abstract: **Image Segmentation refers to the process of partitioning an image into non-overlapping different regions with similar attributes, for gray level images, the most basic attribute used is the luminance amplitude, and for color or multispectral images, color or information components are used, so as to provide more details of an image .Segmentation has become a prominent objective in image analysis and computer vision. This letter Reviews some of the Technologies used for image segmentation for different images and survey of recent segmentation techniques.**

Keywords: Segmentation, image processing, threshold, Clustering.

I. INTRODUCTION

Primary objective of digital image processing is extracting useful information from images without human assistance, Segmentation is an important task of image processing for satellite images, medical images [2]. Sometime image de-noising is done before the segmentation to obtain more accurate details because noise may leads to false information extraction [1]. Purpose of this letter is to provide review on segmentation techniques .Remainder of this letter is organized as below; Section II describes the term image Segmentation, Section III shows the recent segmentation techniques and Section IV concludes the study.

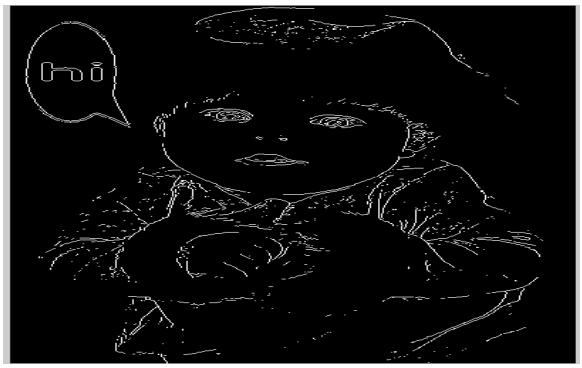
II. IMAGE SEGMENTATION

Image Segmentation is a process of subdividing an image into its constituent's parts or objects in the image i.e set of pixels, pixels in a region are similar according to some homogeneity criteria such as colour, intensity or texture so as to locate and identify boundaries in an image [1]. Purpose of dividing an image is to further analyze each of these objects present in the image to extract some high level information. Application of image segmentation consists of airport security system, object recognition, criminal investigation, computer graphics, medical imaging, MPEG-4 video object (VO) segmentation, satellite images (roads, forests, etc.) [1].Different Segmentation Techniques or algorithms have been proposed in the literature. Selection of a particular technique or algorithm over another is based on the image type and nature of the problem.

III. RECENT SEGMENTATION TECHNIQUES

In recent years, plenty of efforts have been focusing on the segmentation process. Numbers of different segmentation techniques are viewed in the literature, but there is not even a one single method to be considered as a best method for different kind of images, only suitable for one specific type of images. The objective of segmentation is dividing an input image into different regions or edges with similar properties as in fig 1(a) and (b). Many methods have been developed to segment the color images, many of them are based on the basic two properties [2]. Discontinuity based and Similarity based, In discontinuity based partition and sub-division is carried out based on abrupt changes in intensity levels or grey levels of an image, in this method our interest mainly focus 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, region splitting and merging [4].

(a)



(b)

Fig.1: Image segmentation

A. Thresholding Method:

Thresholding is used to separate foreground from background by selecting a threshold value T, any pixel(x, y) is selected as a part of foreground if its intensity is higher than or equal to threshold value i.e f(x, y) ≥T, else pixel points to background [1].Method used to select T is by observing histograms of particular image considered for segmentation. Selection of T automatically for each image by system without human involvement is termed as automatic threshold. Threshold technique can be viewed as:

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

Where: T is a threshold value, (x, y) are the coordinates of threshold point, p(x, y), f(x, y) are points the grey level image pixels, threshold image g(x, y) can be defined as:

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

when T depends only on f(x ,y) it refers to as global threshold, if T depends on f(x ,y) and p(x ,y) then it is called as local threshold and if T depends on x ,y along with p(x ,y) and f(x ,y) then it is called as adaptive threshold [4].Automatic thresholding can be done using an iterative thresholding scheme.

1. Select an initial value of threshold T.
2. Threshold the image using T, get two sets C1 and C2.
3. Find the mean intensity m1 and m2 for the pixels in two sets.
4. Find new threshold T=1/2(m1+m2).
5. Repeat the whole process till the value of T converges.

Drawback of this method time consuming, calculate the means at every iteration due to this time complexity increases with the size of the image [5]

B. Otsu's Method:

This method is used to overcome the drawback of iterative thresholding i.e calculating the mean after each step. In this method identify the optimal threshold by making use of histogram of the image [6], find the threshold that minimizes the weighted within-class variance .Some assumptions of this method are:

1. Histogram (image) is bimodal.

2. Assume uniform illumination.

The weighted within-class variance is:

$\sigma_w^2(t) = q_1(t)\ \sigma_1^2(t) + q_2(t)\ \sigma_2^2(t)$ (1)

Weights q_1 are the probabilities of the two classes separated by threshold t and σ_i^2 variances of these classes.
Where the class probabilities are estimated as:

$q_1(t) = \sum_{i=1}^{t} p(i)$ $q_2(t) = \sum_{i=t+1}^{I} p(i)$ (2)

And the class means are given by:

$\mu_1(t) = \sum_{i=1}^{t} \frac{ip(i)}{q_1(t)}$ $\mu_2(t) = \sum_{i=t+1}^{I} \frac{ip(i)}{q_2(t)}$ (3)

Finally the individual class variables are:

$\sigma_1(t) = \sum_{i=1}^{t} [i - \mu_1(t)]^2 \frac{p(i)}{q_1(t)}$ (4)

$\sigma_2(t) = \sum_{i=t+1}^{I} [i - \mu_2(t)]^2 \frac{p(i)}{q_2(t)}$ (5)

Now, we could actually stop here. All we need to do is just run through the full range of t values [1,256] and pick the value that minimizes $\sigma_w^2(t)$ [7].

Various thresholding techniques are:

1. Mean Technique:

In this method mean value of the pixels are used as the threshold value.

2. P-Tile Technique:

This method is considered as one of the earliest method of threshold based on grey level histogram and it uses area size of the desired object to threshold an image.

3. Histogram Dependent Technique:

This technique is based on the success of finding the threshold value that distinguishes the two homogeneous regions of the foreground and background of an image.

4. EMT Technique:

Edge Maximization Technique is applied when having more than one homogeneous region in an image.

5. Visual Technique:

This method improves people's ability to accurately search for target item [3].

C. Segmentation using Watersheds:

Watershed techniques considered the gradient of an image (GMI) as a topographic surface. Pixels having the highest GMI correspond to watershed lines, which represents region boundaries [8] some positive points of watersheds are by this method segmentation results are stable, they do not depend on any threshold and secondly the region boundaries are formed naturally out of the process. The boundaries are continuous and there are no gaps. Negative point considered over segmentation [9].

D. Mean Shift Method

Mean Shift is considered a robust technique used for image segmentation, visual tracking etc. [shen &Brooks, 2007]. Mean shift method is an iterative mode detection algorithm in the density distribution space or a tool for finding modes in a set of data samples. Mean shift procedure is as follows:

1. Find a window around each data point.
2. Compute the mean of data with in the window.
3. Translate density estimation window.
4. Shift the window to the mean and repeat till convergence [10].

E. Clustering

Clustering is a process of organizing the objects into groups based on its attributes. An image can be grouped based on keyword or its contents. Keyword describes the similar features of an image, whereas content refers to shape, texture etc. Both supervised and unsupervised clustering techniques are used in image segmentation. Commonly used techniques are:

*Log Based Clustering***:** Images can be clustered based on the retrieval system log maintained by an information retrieval process. This technique is difficult to perform in case of multidimensional images [11].

Fuzzy Clustering: In this technique pixel values are divided into clusters on the basis of some similarity criteria and classify pixels values with great extent of accuracy and suitable for decision oriented applications i.e tumor detection. It also involves FCM (fuzzy C means) algorithm, GK (Gustafson-Kessel), FCV (Fuzzy C varieties), among all FCM is the most accepted method since it can preserve much more information than other approaches [11].

F. Use of Motion in Segmentation

If sequence of images are given considered it as a video in that case we make a use of motion for segmenting regions. Motion information can be used in different ways to segment objects in a video for e.g one can compute motion vectors for every pixel in the image. Since pixels which belong to moving object will have motion in more or a less similar direction, we can group such pixels by applying clustering techniques to the pixel motion vectors [9].

G. Color Image Segmentation

Three phases in the color images Segmentation:

Phase 1: preprocessing: Morphological methods are applied to remove the noises away from images which applied to smooth some spots on uniformed patterns.

Phase 2: Transformation: Color space transformed methods are used to transform other color space to RGB. The average intra-cluster distance based method is a traditional method applied for transformation.

Phase 3: Segmentation: Applying clustering algorithm like K-means algorithm for finding the appropriate cluster numbers and segment images in different color spaces. The cluster with the maximum average variance is split into new clusters [2].

IV. CONCLUSION

In this study, the overview of various segmentation methodologies applied for digital image processing is explain briefly. The study also reviews the research on various research methodologies applied for image segmentation and various research issues in this field of study. This study aims to provide a simple guide to the researcher for those carried out their research study in the image segmentation.

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