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Image Segmentation Methods: A Survey Approach

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***Abstract* -- Image Segmentation is one of basic problem and is an important step in image processing to distinguish important object that is of our interest from unnecessary background substrates. So, quality of this step also affects the subsequent steps of recognition. In this paper, we have compiled Edge detection method, Thresholding method, Region based method, and Clustering.**

Keywords* – *Image Segmentation, Digital Image Processing, Edge Detection, Thresholding, Region based Segmentation, Clustering.

I. INTRODUCTION

An image is a two dimensional light intensity function f(x, y), where (x, y) are spatial coordinates and the value of f at any point (x, y) is proportional to the brightness or intensity or gray level of the image at that point. When x, y, and the amplitude values of f are all finite, discrete quantities, we call the image a digital image[1]. An image is a projection of a three dimensional scene into a two dimensional projection plane. Analog image can be mathematically represented as a continuous range of values representing position and intensity. An analog image is characterized by a physical magnitude varying continuously in space. Digital image is composed of picture elements called pixels. A pixel represents the picture element. Pixels are the smallest sample of an image. A pixel represents brightness at one point. Digital image processing is the use of computer algorithms to perform image processing on images. The digital image processing has been applied in several areas, especially where it is necessary to use tools for feature extraction and to get patterns of the studied images. The different elements of an image processing systems are image acquisition element, image storage devices, image processing elements and image display devices.

Digital images play an important role in daily applications such as satellite television, magnetic resonance imaging, computer tomography as well as in areas of research and technology such as geographical information systems and astronomy. Digital image processing is widely used in different fields like medicine, forensics, remote sensing, communications and automobiles.

II. SEGMENTATION

Segmentation is a process of partitioning an image into regions or extracting an object of interest. At the output of this stage, each object of the image, represented by a set of pixels, is isolated from the rest of the scene. Usually segmentation process stops when the object of interest isolated from rest of the background [1].

Image Segmentation broadly classified into two types:

a. Local Segmentation: It deals with sub-images which is a small part of whole image
b. Global Segmentation: It is concerned with segmenting a whole image.

For the monochrome image, image segmentation algorithms based on two properties: discontinuity and homogeneity. Methods based on discontinuities are called as boundary based methods and methods based on homogeneity are called Region based methods [2].

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III. IMAGE SEGMENTATION METHODS

Various methods mentioned in literature. There are no general method exists that works well on all type of images, so the choice of method are totally depends on the type of input image and application. Some of the methods are-

A. Edge Detection

Edge detection method is most commonly used method to detect discontinuity in image. It is popular way to detect edge pixels and link them to create edges in image. Edge pixels are pixels at which there is transition in intensity value. Edges are set of connected edge pixels [1] and represent boundary between two regions having distinct intensity levels.

Most of the Edge Detection algorithm are grouped in two categories: Gradient and Laplacian.

a) Gradient based Edge Detection: It is most commonly used method in Image Processing for finding the first derivative of an image. A gradient is a two dimentional vector that point to the direction in which the image intensity grows fastest. The two functions that can be expressed in terms of the directional derivatives are the gradient magnitude and the gradient orientation. The gradient magnitude is defined by-

$$g(x,y) = (\Delta x^2 + \Delta y^2)^{1/2}$$

where,

$$\Delta x = f(x+n,y) - f(x-n,y)$$

and $\Delta y = f(x,y+n) - f(x,y-n)$

This quantity gives the maximum rate of increase of f(x, y) per unit distance in the gradient orientation of g(x, y). The gradient orientation is also an important quantity. The gradient orientation is given by-

$$\Theta(x,y) = \text{atan}(\Delta y/\Delta x)$$

Here the angle is measured with respect to the x-axis. The direction of the edge at (x, y) is perpendicular to the direction of the gradient vector at that point[4].

b) Laplacian based Edge Detection: The Laplacian based methods search for zero crossings in the second derivative of the image in order to find edges, usually the zero-crossings of the Laplacian or the zero-crossings of a non-linear differential expression[4].

Figure 1: Original Image of Tiger

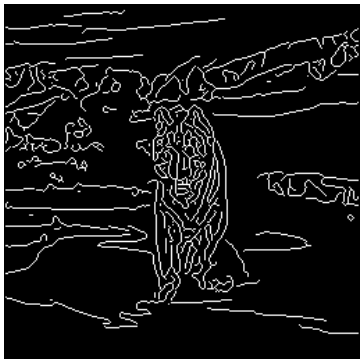

Figure 2: Segmented Image using Canny [8] operator

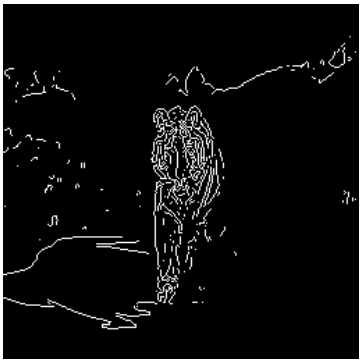

Figure 3: Image Segmentation using Sobel operator

A thresholded image g(x,y) is defined as

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

Figure 4: Segmented image using Otsu thresholding [5].

B. Thresholding

Image thresholding is the simplest way to segment an image into regions. The intensity value of each pixel is compared to a suitable threshold value. Depending on the result of comparison, the pixel is assigned to one of the class labels[3]. This method is used when image consist of light objects and dark background[1]. If intensity value of any pixel f(x,y) is greater than or equal to threshold value T then pixel belongs to object otherwise it refers to background. Classification of thresholding methods can be summarizied according to the following concept :

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

where, f(x,y) is gray level of point (x,y) and p(x,y) denotes some local neighbourhood property at (x,y).

When T depends only on f(x,y), then the threshold is called global. If T depends on both f(x,y) and p(x,y), the threshold is called local. Local thresholding is computationally more expensive than global thresholding. It is very useful for segmenting structures from varying background, and for extraction of regions that are small and sparse. If T depends on (x ,y) along with p(x ,y) and f(x ,y) then it is called as adaptive thresholding. In non-uniform illumination, it is tedious task to find out the global value of threshold .In such cases, image is partitioned into sub image and adaptive thresholding is applied to each of the sub image and then result is combined.

C. Region Oriented Segmentation

Region detection methods are used to partition an image into regions that are similar in characteristics like color, texture etc. It group pixels into homogeneous regions. It includes region growing and region split-merge methods:

a) **Region growing method:** In this approach, initially a seed pixel is selected and region grows by merging neighboring pixel of seed with satisfying similarity criteria like color, intensity value. This process continues until no pixel meets the similarity criteria.

b) **Region spilt-merge method:** In this method [7], initially whole image is treated as seed region .If it does not meet predefined similarity criteria then image is split into quadrant .This splitting continues so on till homogeneous sub region is obtained. Subdivided homogeneous regions are then merged to extract interesting object within image according to similar characteristics. Stop this method when no further merging is possible[1].

D. Clustering

Clustering is a dividing of data into groups of similar objects. Each group consists of objects that are similar between themselves and dissimilar to objects of other groups. Clustering techniques can be categorized into supervised clustering and unsupervised clustering. Supervised clustering involves human interaction and the unsupervised clustering decides the clustering criteria by itself. Clustering methods can also be classified as either hard or fuzzy depending on whether a pattern data belongs exclusively to a single cluster or several clusters with different values[2].

K- Mean clustering [6] is popular method of hard clustering which partition an image into k clusters.

1. Select k pixel intensity as initial centroid.
2. Form k clusters by assigning all pixels to the closest centroid.
3. Recomputed the centroid of each cluster by taking mean of pixel intensity values within cluster and reassign the pixels.
4. Repeat the same process till centroid does not change further.

Figure 5: Original Color Image of Tiger

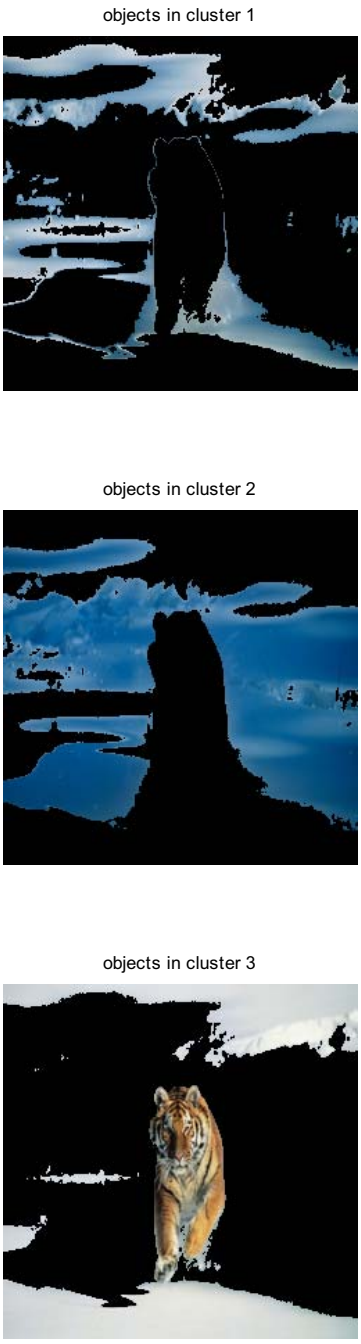

Figure 6: Image Segmentation using K-Mean Algorithm with k =3

IV. CONCLUSION

Segmentation is an important process in advance image analysis and computer vision and it is an ongoing research area although a dense literature is available. In this paper, we classify and discuss the

traditional and popular image segmentation techniques including Gradient based image segmentation, Laplacian based image segmentation, thresholding, region growing method, region split-merge method, clustering, k-mean clustering. Ostu methods are reasonably good thresholding methods if one demands more uniformity and better shape of the object in the binary image. Although number of techniques are available, each technique works on specific concept hence it is important which image segmentation techniques should be used as per application domain.

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