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REVIEW ARTICLE

Review on "Image Segmentation Methods"

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Abstract— The objective of the image segmentation is to simplify the representation of pictures into meaningful information by partitioning into image regions. The aim of this paper is to review existing approaches to the segmentation of images and highlighting the key-points. Here we try to cover different recent approaches of segmentation techniques and try to cover maximum number of research papers.

Keywords— image segmentation; Thresholding; Region based methods; Clustering method; hybrid methods

I. INTRODUCTION

Image segmentation is a technique to locate certain elements or objects within an image. It represents an image into something that is more meaningful and easier to analyse. The result contains an image which is uniform in pixels present in that region, colours, intensity etc. Segmented images convey the very important information in the field of medical imaging. There are many different segmentation techniques available in literature. Some of them we are presenting in this paper. They are broadly categorized as Thresholding, Clustering methods, Edge based method, Region based methods, and Hybrid methods.

II. IMAGE SEGMENTATION METHODS

A. Thresholding

Threshold based image segmentation techniques discriminate regions on the basis of intensity value difference between pixels. This method convert greyscale image into binary image. The thresholding operation g is defined by:

$$g(v) = 0 \quad \text{if } v < t, \quad \text{for background image}$$
$$= 1 \quad \text{if } v > t, \quad \text{for foreground image}$$

Where v represents a grey value and t is the threshold value. After the thresholding operation, the image has been segmented into two segments, identified by the pixel values 0 and 1 respectively.

When several desired segments in an image can be distinguished by their grey values, threshold segmentation can be extended to use multiple thresholds to segment an image into more than two segments: all pixels with a value smaller than the first threshold are assigned to segment 0, all pixels with values between the

first and second threshold are assigned to segment 1, all pixels with values between the second and third threshold are assigned to segment 2, *etc.* If *n* thresholds (*t*1, *t*2… *tn*) are used:

$$g(v)=\begin{cases}0 & if\ v < t_1\\ 1\ if\ t_1 \le v < t_2\\ 2\ if\ t_2 \le v < t_3\\ \vdots\\ \vdots\\ n & if\ t_n \le v\end{cases}$$

After thresholding, the image has been segmented into n+1segments identified by the grey values 0 to n respectively.

Thresholds are either global or local. Global threshold is constant throughout the image. While local threshold is spatially varying in nature.

The threshold value can be calculated by Maximum entropy, interclass variation, and histogram. The limitation of threshold based segmentation technique is that it performs well for images, which have only two components. For complex images, it is calculated to support further processes

B. Clustering methods

The cluster analysis is to partition an image data set into a number of disjoint groups or clusters. A cluster is a collection of objects which are "similar" between them and are "dissimilar" to the objects belonging to other clusters. The clustering methods such as k means, improved k mean, fuzzy c mean (FCM) and improved fuzzy c mean algorithm (IFCM) have been proposed by the researchers.

The k mean algorithm is composed of the following steps:
1. Place K points into the space represented by the objects that are being clustered. These points represent initial group centroids.
2. Assign each object to the group that has the closest centroid.
3. When all objects have been assigned, recalculate the positions of the K centroids. Repeat Steps 2 and 3 until the centroids no longer move. This produces a separation of the objects into groups from which the metric to be minimized can be calculated.
K mean algorithm aims at minimizing an objective function. The objective function,

$$V=\sum_{i=1}^{k}\sum_{j=1}^{x}(x_i - c_i)^2$$

Where $(x_i - c_i)^2$ is a chosen distance measure between a data point x_i and the cluster center c_i.

Fuzzy algorithms are convenient when there is a fuzzy or discrete boundary in the region, and the leaking problem is inescapably appeared.

The K means image segmentation consumes less time but it provide poor result. The modified k means algorithm takes minimum numbers of iterations compare to k means. The conventional FCM consume more time and provide good result where as the improved FCM algorithm consume less time compare to traditional FCM and provide good result. Among the clustering algorithms the improved FCM algorithm performed better than others in terms of performance accuracy and better convergence rate

C. Edge based methods

To study a specific object in an image, its boundary can be highlighted by an image segmentation procedure. Edge based method is used to find boundary between two homogeneous regions. An Edge in an image is a significant local change in the image intensity, usually associated with a discontinuity in either the image intensity or the first derivative of the image intensity. Discontinuities in the image intensity can be Step edge, Ramp edge, Ridge edge, Roof Edge.

Types of Edges

- *Step edge*:
  The image intensity abruptly changes from one value to one side of the discontinuity to a different value on the opposite side.

- *Ramp edge*:
  A step edge where the intensity change is not instantaneous but occurs over a finite distance

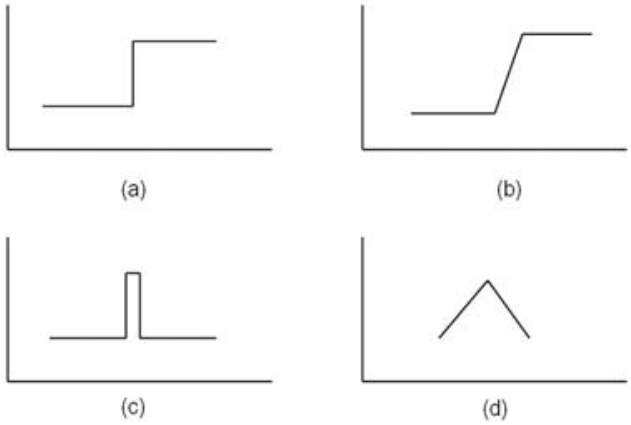

Fig.1 Type of Edges (a) Step Edge (b) Ramp Edge (c) Ridge Edge (d) Roof Edge

- *Ridge edge:*
  The image intensity abruptly changes value but then returns to the starting value within some short distance

(Generated usually by lines)

- *Roof edge*:
  A ridge edge where the intensity change is not instantaneous but occur over a finite distance (generated usually by the intersection of surfaces).

Edge detection contains four steps which are given below:

i. Smoothing
   Image is usually associated with variation in intensity value. This change in intensity value is called noise. In this step we have to suppress as much noise as possible, without destroying the true edges.

ii. Enhancement
   It enhances the quality of image. In order to facilitate the detection of edges, it is essential to determine changes in intensity in the neighborhood of a point. Enhancement emphasizes pixels where there is a significant change in local intensity values and is usually performed by computing the gradient magnitude

iii. Detection
   Determine which edge pixels should be discarded as noise and which should be retained, usually thresholding provides the criterion used for detection.

iv. Localization
   Determine the exact location of an edge (*sub-pixel* resolution might be required for some applications, that is, estimate the location of an edge to better than the spacing between pixels). Edge thinning and linking are usually required in this step.

The edge detection techniques are gradient operator, sobel edge detector, canny edge detector, Prewitt's operator, Laplacian, which generally are named after their inventors. Fig 2 shows the comparison of the edge detection methods for the satellite image of Pentagon.

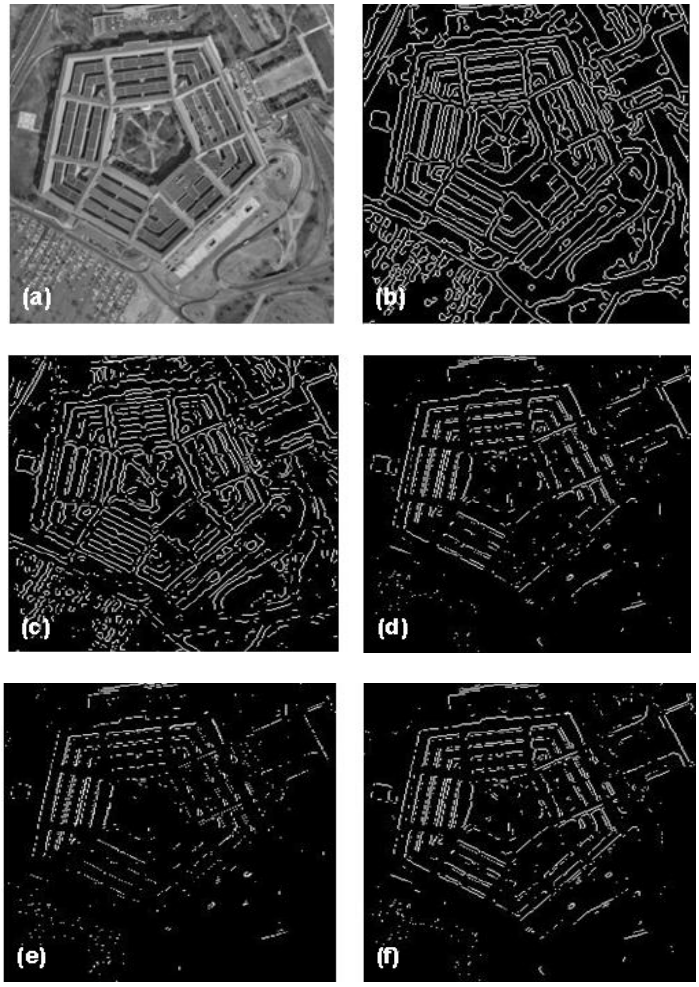

Fig 2 (a) Original image (b) Using Canny edge detector (c)Using Laplacian detector (d) Using Prewitt's Detector (e)Using Robert Detector (f) Using Sobel Detector

D. Region based methods

A region based technique takes the opposite approach of edge based technique, by (*e.g.*) starting in the middle of an object and then "growing" outward until it meets the object boundaries. Region based methods rely on postulate that neighbouring pixels within the one region have similar value. Region-based methods can be categorized into:

- Those which **merge** pixels,
- Those which **split** the image into regions, and
- Those which both **split-and-merge** in an iterative search scheme.

Seeded region growing algorithm (SRG) can be classified as a region-based segmentation approach. SRG was introduced by Rolf Adams and Leanne Bischof. They presented a new method for segmentation of intensity images, which is robust, rapid and free of tuning parameters. SRG perform segmentation of an image with respect to set of points know as seeds. This method, however, requires selection of seed regions, what has to be done manually and it classifies this approach to the class of semiautomatic algorithms. The algorithm grows these seed regions until all of image pixels have been processed. This problem is solved by Andrew Mehnert and Paul Jackway in their improved version of algorithm. If we want to do the segmentation completely automatic, which is needed in many applications, as one of main disadvantages appears manual selection of the seed pixels or regions.

In Region growing approach seeds are grouped into n sets, say A1, A2----An. Any random seed is chosen and it compared with neighbouring pixels. If pixel is similar then add it to the region. When growth of one

region stops another seed is chosen which does not yet belong to any other region and whole procedure is followed again.

E. Hybrid methods

It is combination of edge based and region based methods. This category includes watershed segmentation, variable order surface fitting, the easy path wavelet transform (EPWT) etc. Watershed algorithm is flexible and rapid but its drawback is over segmentation. A combination of K-means, watershed segmentation method, and Difference in Strength (DIS) map can be used to perform image segmentation and edge detection tasks.

III. CONCLUSION

Images are considered as one of the most important medium of conveying information. Understanding images and extracting the information from them such that the information can be used for other tasks is an important aspect of Machine learning. One of the first steps in direction of understanding images is to segment them and find out different objects in them. In this paper we have presented review on most of segmentation method.

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