International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

A Review Paper on Image Segmentation and its Various Techniques in Image Processing

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Abstract: ***Image segmentation can be defined as in which we divide the image into multiple parts in the form of pixels. In segmentation, we simply represent the image into more understandable form. Segmentation basically used to detect the objects, boundaries and other relevant data in the digital images. There are different approaches to implement segmentation like threshold, clustering and transform methods etc. After performing these approaches, the resultant segmented image is a collective pixel set of the entire image. Pixels in the image corresponds to some characteristics of image like color, texture etc.***

Keywords: MIA, Fuzzy, Threshold, Segmentation, Clustering, Sobel, Prewitt

1. Introduction

Image segmentation is an important topic in the field of digital image processing. The purpose of image segmentation is to partition the image into essential regions with respect to the appropriate locations. For the segmentation we need the Images. But the images are either in form of black and white or color. Color images are due to the grey level [1]. As the grey level contrast changes the color of color image also changes. Image segmentation plays important role in segmentation of medical images. Medical images play vital role in assisting health care which provides health care access patients for treatment. For the medical images, segmentation is crucial as a follows by first step in Medical Image Analysis (MIA) [2]. Digital image segmentation is an important and recent domain in computer history and digital image processing. Several techniques of it has been developed by Bell Labs, University of Maryland and few other places in 1960. Concept of image segmentation is applicable to medical imaging, video phone, photo enhancement, satellite imagery etc. in the field of medical imaging, is difficult to implement proper segmentation because of facing some problems like size of brain, head, leg, type of disease etc. so, to solve these problems, we need different algorithm to segment these image to acquire accurate results.

The concept of fuzzy logic, pattern recognition and machine learning has been combined with artificial intelligence in digital image processing. Image techniques can be clubbed together in a general framework called Image Engineering. Image Engineering can be defined as that which contains three layers as:
a) Image understanding
b) Image Analysis
c) Image Pr**ocessing**

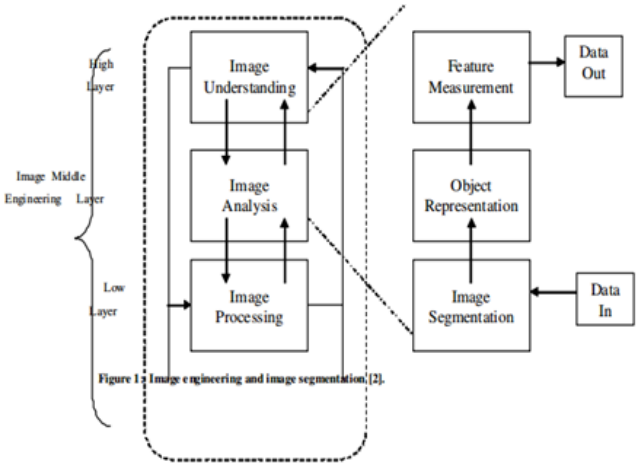


Figure 1.1: Layers of Image Engineering [2]

2. Different Techniques of Image Segmentation

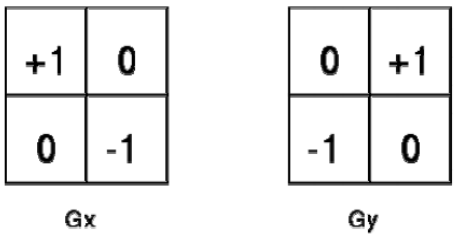
There are different techniques of image segmentation. Some of which are following:

2.1 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. 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. [4]

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Roberts cross convolution masks [4]

b) SOBEL EDGE DETECTION

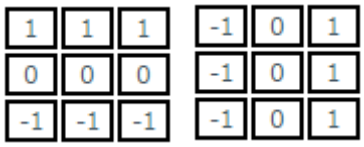
Sobel edge detector named after Irwin Sobel and it sometimes called as Sobel filter. Sobel edge detector is having two masks, one is vertical and other is horizontal. These masks are generally used 3*3 metrices. Standard Sobel operators, for a 3×3 neighborhood, each simple central gradient estimate is 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 neighbors having density values as shown: [5]

a	b	c
d	e	f
g	h	i

Density values [5]

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 verticle 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: [6]



Horizontal Filter Vertical Filter [6]

2.2 Threshold Method

Threshold method is the mostly used technique in image segmentation. It is used to discriminate foreground from background. In this method, a grey scale image is converted into binary image. The binary image contains the whole necessary data regarding location and shape of the objects. Conversion to binary image is useful because it reduces the complexity of data. Threshold methods are following:

a) Global Thresholding

In the global threholding, the intensity value of the input image should have two peak values which correspond to the signals from background and objects. It tells the degree of intensity separation between two peaks in an image. Global thresholding, using an appropriate threshold T:

$$g(x,y) = \begin{cases} 1, & \text{if } f(x, y) > T \\ 0, & \text{if } f(x, y) \leq T \end{cases} \quad [8]$$

B) Variable Thresholding

In variable thresholding, we separate out the foreground image objects from the background based on the difference in pixel intensities of each region. Variable thresholding, if T can change over the image.

→Local or regional thresholding, if T depends on a neighborhood of (x, y).

→Adaptive thresholding, if T is a function of (x, y). [8]

c) Multiple Thresholding

Multiple thresholding can be defined as that segments a grey level image into several distinct regions. It defines more than one threshold for the given image and divides the image into certain brightness regions and it correspond to the background and several objects. Multiple thresholding:

$$g(x,y) = \begin{cases} a, & \text{if } f(x, y) > T2 \\ b, & \text{if } T1 < f(x, y) \leq T2 \\ c, & \text{if } f(x, y) \leq T \end{cases}$$

2.3 Region Based Segmentation

Region Based segmentation can be defined as that in which we segment the similar image into various regions. It is used to determine the region directly. Partioning is done by using grey values of the image pixels. Two basic techniques of region based segmentation are following:

a) REGION GROWING METHODS

Region growing is a technique that groups pixels or sub regions into larger regions based on predefined criteria. The pixels aggregation starts with a set of seed points in a way that the corresponding regions grow by appending to each seed points those neighboring pixels that have similar properties like grey scale, color, texture, shape etc. [9]

b) REGION SPLITTING AND MERGING

In case of region splitting, the whole image is taken as a single region and then this region is being break into a set of disjoint regions which are coherent with themselves. Region merging opposes Region Splitting. A merging technique is used after each split and compares adjacent regions and merges them. It starts with small regions and merge the regions which have similar characteristics like grayscale, variance etc.

2.4 Clustering Based Image Segementation

Clustering based image segmentation is used to segment the images of grey level. Grey level methods can be directly apply and easily extendable to higher dimensional data. Clustering is also applicable in color and multispectral images. There are two main methods in clustering:

a) K-Means

The k-means methods of clustering are obtained based on the principle of minimization of the sum of squared distances from all points in each cluster domain to the cluster centre. 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]

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b) Fuzzy K-Means

The Fuzzy K-means method is a two stage process involving a "coarse" segmentation followed by a "fine" segmentation. The "coarse" segmentation involves smoothing the histogram of each of the color components and using the first and second derivatives of the smoothed histograms to find the valleys which will then be the thresholds. 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 centers are calculated. The "fine" segmentation involves assigning each pixel which belongs to a safe area to its closest cluster by calculating fuzzy membership functions. [10]

3. Conclusion

In this paper, I have discussed about the image segmentation, the various techniques of it and image engineering. These techniques are applicable in different fields like medical imaging, object recognition, pattern recognition etc. by studying this topic in depth, I got to know that, image segmentation is having vital use and challenging future in image processing.

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