Pre-Processing and Image Segmentation Techniques

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Abstract

image are known as image analysis. First step in image analysis is to segment an image. Image segmentation is a key step for partioning an image into several segments to find objects, borders &meaningful objects for an image. In image processing for any application when the work is done on an image, the initial step is to divide the image in order to solve the difficulty. Divided images are widely used in a multitude of different applications like density of tissue volumes, pathology, Satellite imaging, Extracting features & recognizing objects, treatment planning & few computer integrated surgeries etc.

This paper gives an overview of different image pre-processing techniques& image segmentation techniques. Before we do segmentation of an image, we need to pre-process an image to ***remove noise.***

Index Terms— *Image segmentation, Pre-processing technique, image analysis,*

Introduction

Digital image processing is common subject in today's period. Digital image processing basically refers to processing of 2-D picture by digital computer. Sujatasaini et.al. [8] Proposed, several image segmentation Techniques, significantly on edge-based and region- based segmentation. Segmentation action means segmenting image into parts that relate different parts of object. Each pixel in an image is given a number from the below categories.

Well quality segmentation has, Pixels in the same classification are of same grayscale of different values & shape a related area. Adjacent pixels in complicated groups have dissimilar values [14].

If the segmentation component procedure had done well, then all other stages in the analysis of the image becomes simple.

Image Segmentation is separated into two forms, specifically considering the properties of an image [8].

Discontinuity method: Approach of this method is, image is separated focused on few sudden variations depending on the intensity level of images. The key highlighting in the approach is to distinguish isolated points, lines and edges in image.

Similarity based method: In this approach, Principle is focused on partioning an image into related regions based on set of prewritten rule (on similarity). Types of methods are

Thresholding

Region growing

Region splitting & merging

Clustering

Procedure in this method is, image is divided into set of groups having similar features based on some predefined rule [6].

Method

Pre-processing methods

Pre-processing an image spots at selectively removing the redundancy present in the captured images without affecting the overall process [7].

Steps in Pre-Processing

Image Resizing

This is done by performing the process of interpolation. It is a process which re-samples the image

to determine values between defined pixels. Thus, resized image consists more (or) less pixels contrast to original image. The intensity values of added pixels are obtained through interpolation if resolution of image is increased.

Filtering

Due to the movement of camera some disturbances are created in the image such as random image noise, intensity non-uniformity traces.

Low pass Filtering

LPF resists the edge and sharp details in an image. They are achieved by placing the rate of each pixel in an image with neighborhood mean of gray levels identified by filter mask.

By employing linear low pass filter, the edges are not maintained, but noise reduction is achieved by blurring an image, which results in loss of fine details. Filter mask used for LPF is

$\frac{1}{9}$

1	1	1
1	1	1
1	1	1

LPF Mask

High Pass Filter

Purpose of HPF is to restrict the slowly varying characteristics like background and sharp details. This filter mask includes negative coefficients at the center and positive coefficients in the outer part. Sum of entire coefficients in HPF mask is '0'. Mask for HPF is

1	1	1
1	-8	1
1	1	1

HPF Mask

When the above mask passes over a constant (or) slowly varying region, output is '0' (or) very small. Result of this is an edge enhanced image over a dark background.

Detection of discontinuities in a digital image

Point Detection

Finding of isolated points in image due to noise is done by the following mask.

-1	-1	-1
-1	8	-1
-1	-1	-1

Mask for point detection

When the above mask is placed on an image it covers 9 pixels in an image. Average response of the mask is calculated as

$$R=\frac{1}{9}\ [W_1Z_1+W_2Z_2+\ldots\ldots\ldots\ldots\ldots\ldots+W_9Z_9]$$
$$=\frac{1}{9}\ \sum_{i=1}^{9} W_iZ_i$$

Where Wi = coefficient in the mask

Zi = gray level value of pixel in the image under

-1	2	-1
-1	2	-1
-1	2	-1

Vertical Mask

-1	-1	-1
2	2	2
-1	-1	-1

Horizontal Mask

-1	-1	2
-1	2	-1
2	-1	-1

$+45^0$ ***Slanting line***

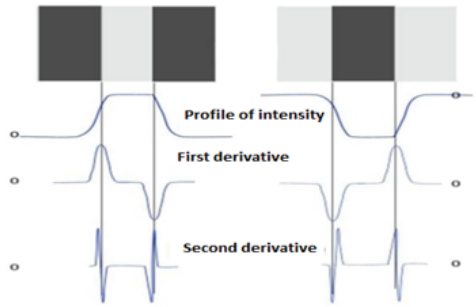
2	-1	-1
-1	2	-1
-1	-1	2

-45^0 ***Slanting line***

If the horizontal mask is shifted around an image, the response value is larger to lines that are oriented horizontally. If all the masks are applied to an image and the responses calculated are denoted as R_1, R_2, R_3 and R_4 For all $j \neq i$, at some point, the particular point is additional accurately connected with the line in the path of mask.

Edge Detection

Edges located as considerable local distortions in the intensity of an image. They occur on the borderline in the middle of two different portions in image. The result of edge detection is to know main types like corners, lines and curves in image. Intensity changes in an image are due to assorted material events.



Dark Background having Light Stripe ***Light Background having Dark Stripe***

Fig: 1. Detection of edges using derivatives.

Gray level sketch is negative at the foremost edge of the change, positive at the trailing edge and zero in the area of constant gray area in first derivative.

For the part of the change associated with the light side of the edge, the second derivative is negative, positive for the portion of the transition in cooperated along the dark side of the edge and zero for pixels lying exactly at the bottom.

On observation the first derivative calculation is used to detect the presence of edge in the image and second derivative shows whether the edge pixel are positioned along dark side (or) light side of the edge .

Edge detection with Gradient Operator

Gradient is a vector that has certain magnitude and direction. It is measurement of change in image function f(x,y) in X(across/columns) and Y (down/rows). This is the first derivative for enhancement of an image. Gradient operator is represented as

$$\nabla f = \begin{pmatrix} G_x \\ G_y \end{pmatrix} = \begin{pmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial y} \end{pmatrix}$$

$$\text{Mag}\,(\nabla f) = [G_x^2 + G_y^2]^{1/2}$$

$$\text{Dir}\,(\nabla f) = \tan^{-1}(G_y/G_x)$$

Angle relative to x-axis is measured

The direction of an edge at (x, y) is at right angles to the gradient vector direction at the particular point.

Robert Cross-Gradient operator

In [1] it is proposed that Robert is 2-D mask which can be used when there is a need of diagonal edge direction.

$$G_x = \frac{\partial f(x,y)}{\partial x} = W_9\text{-}W_5$$
$$G_y = \frac{\partial f(x,y)}{\partial y} = W_8\text{-}W_6$$

W_1	W_2	W_3
W_4	W_5	W_6
W_7	W_8	W_9

3X3 Image Region

-1	0
0	1

0	1
-1	0

Roberts Cross Masks [1]

Roberts Cross Masks [1]

Edge detection using Prewitt operator

For edge detection Prewitt is used which can be also called as discrete differentiation operator. It finds two types of edges.

a) Horizontal edges

b) Vertical edges

Masks for edge detection are well-known as derivative masks. Derivatives masks should have the following properties.

1) Inside the mask will be opposite symbol
2) Size of mask is zero
3) Higher value means better edge detection

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

Vertical Direction Mask

The above mask finds the edges in vertical direction and it is because of the zero columns in the vertical direction, when we convolve mask on an image, it will give vertical edges in an image.

Working Procedure

By adding to an image this mask highlights the vertical edges. It just functions like the first derivative and measures the pixel intensity difference in an edge field. As the middle column is zero it will not be the original value of the image, but the difference between the right and left pixel values around the edge is calculated.

Horizontal Direction Mask

The mask shown above will find edges in horizontal direction. Due to the presence of these zero columns in horizontal direction, when convolving the above horizontal mask onto image given, it tells us horizontal edges in image.

-1	-1	-1
-1	8	-1
-1	-1	-1

Sobel operator

This is same as prewitt operator, can be called as derivative mask and the purpose is for edge detection. For prewitt's operator the response to diagonal elements is weak but it is not so weak for sobel operator since it gives better weights to the points nearer to the point (x,y) which we had considered[12]. A Sobel operator provides both differencing and smoothing effect

1	2	1
0	0	0
-1	-2	-1

Mask for computing G_x

Component using sobel operator

-1	0	1
-2	0	2
-1	0	1

Mask for computing G_y

Component using sobel operator

$G_x = (W_7+2W_8+W_{9)}- (W_1+2W_2+W_3)$

$G_y= (W_3+2W_6+W_{9)}- (W_1+2W_4+W_7)$

Where W's are the gray pixels rates of covered by the masks at any position in image.

Laplacian operator

The former operators are named the first difference operator. Laplacian then again, is a second differential operator [12]. Laplacian operator is given by

$$\nabla^2 f = \frac{\partial^2 f}{\partial^2 x} + \frac{\partial^2 f}{\partial^2 y}$$

$$\nabla^2 f = 4W_5 - (W_2 + W_4 + W_6 + W_8)$$

For a 3X3 mask, regularly used practice is

0	-1	0
-1	4	-1
0	-1	0

Laplacian Operator

The vital necessity in identifying the Laplacian

is, it knows about coefficient presence .Presence of coefficient related with the center pixel is positive and the coefficient related with the external pixel is negative. Kernel that are regularly utilized are

-1	-1	-1
-1	8	-1
-1	-1	-1

Laplacian Operator

With diagonal components

Region-based segmentation

Edges based method searches the object borders and then locate the object itself by packing them in. This region based technique is a reverse approach it starts in the image and starts expanding outward until it go off to the object boundaries. Two strategies are explained under this Region-based segmentation.

1) Region Growing

2) Region splitting and merging

Region Growing

This method gives explanation about pixels which are close together which have comparative gray level values.

Procedure: This approach develops the information that pixels which are close together have similar gray values [6][9].

Procedure begins with a single (seed) & adds new pixels slowly

1. Select pixels for seed.

2. Find neighboring pixels which are very similar to the seed and add them

3. Continue with the step 2 for every recently new pixels and conclude the method if no further pixels are added.

Region splitting & Merging

The Procedure for this method is to partition the image initially into random collection; unconnected areas until the region become small enough for segmentation. Region splitting &merging visually is executed using the theory based on quad-tree data.

Following diagram shows division based on quad tree.

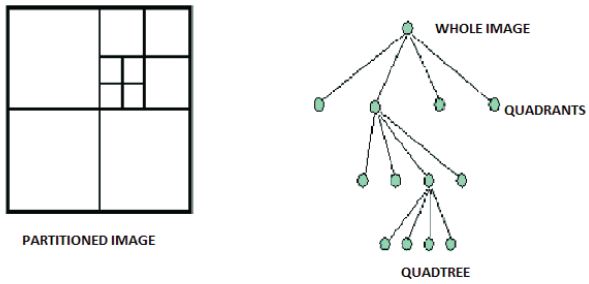


Fig: 2 Division of region w.r.to quad tree

Steps for region splitting and merging are.

Let A signify complete region of image & pick a predicate P.

1. Each region is divided into four disjoint quadrant which satisfy the condition P (Ai) =false.

2. Join any adjacent regions Aj & A_k which follows

P (Aj &A_k) = true.

3. Stop the method if no more merging or splitting is likely to happen.

Conclusion

Various segmentation methods are mentioned in this paper. These techniques can be used in different fields like restorative picture applications, for object recognition & detection. Depending on the application, distinctive segmentation strategy can be selected.

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