IMAGE SEGMENTATION BY USING EDGE DETECTION

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Abstract-In this paper, we present methods for edge segmentation of satellite images; we used seven techniques for this category; Sobel operator technique, Prewitt technique, Kiresh technique, Laplacian technique, Canny technique, Roberts technique and Edge Maximization Technique (EMT) and they are compared with one another so as to choose the best technique for edge detection segment image. These techniques applied on one satellite images to choose base guesses for segmentation or edge detection image.

Keywords: image segmentation; Discontinuity detection/Types of Discontinuity detection; Gradient operation; Edge Detection Techniques

I. INTRODUCTION

Edge detection is a fundamental tool used in most image processing applications to obtain information from the frames as a precursor step to feature extraction and object segmentation. This process detects outlines of an object and boundaries between objects and the background in the image. An edge-detection filter can also be used to improve the appearance of blurred image; to this cause more studies take this subject can be give some of these studies briefly:

Soft computing techniques have found wide applications. One of the most important applications is edge detection for image segmentation. The process of partitioning a digital image into multiple regions or sets of pixels is called image segmentation. Edge is a boundary between two homogeneous regions. Edge detection refers to the process of identifying and locating sharp discontinuities in an image. In this paper, the main aim is to survey the theory of edge detection for image segmentation using soft computing approach based on the Fuzzy logic, Genetic Algorithm and Neural Network[1].The Canny algorithm uses an optimal edge detector based on a set of criteria which include finding the most edges by minimizing the error rate, marking edges as closely as possible to the actual edges to maximize localization, and marking edges only once when a single edge exists for minimal response[2].The non-maximal suppression stage identifies pixels that are local maxima in the direction of the gradient using the magnitude and orientation of the pixels. The major orientation of the gradient, either horizontal or vertical, is obtained by comparing the individual components, dx and dy, which are the result of convolving the smoothed image with the derivative of the Gaussian. Since most edges are at an angle, it is possible to obtain further granularity in the orientation of the gradient by comparing the sign bit of the gradient [3].The designed fuzzy rules are an attractive solution to improve the quality of edges as much as possible. One past drawback of this type of algorithm was that they required extensive computation. These results allow us to conclude that:

i) The implemented fuzzy inference systems (FIS) system presents greater robustness to contrast and lighting variations, besides avoiding obtaining double edges.

ii) It is gave a permanent effect in the lines smoothness and straightness for the straight lines and for the curved lines it gave good roundness. In the same time the corners get sharper and can be defined easily [4].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 either Step edge, where the image intensity abruptly changes from one value on one side of the discontinuity to a different value on the opposite side, or Line Edges, where the image intensity abruptly changes value but then returns to the starting value within some short distance [5].Many points in an image have a nonzero value for the gradient, and not all of these points are edges for a particular application. Therefore, some method should be used to determine which points are edge points. Frequently, threshold provides the criterion used for detection [6].The Roberts Cross operator performs a simple, quick to compute, 2-D spatial gradient measurement on an image. It thus highlights regions of high spatial frequency which often correspond to edges. In its most common usage, the input to the operator is a greyscale 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. The prewitt edge detector is an appropriate way to estimate the magnitude and orientation of an edge. Although differential gradient edge detection needs a rather time consuming calculation to estimate the orientation from the magnitudes in the x and y-directions, the compass edge detection obtains the orientation directly from the kernel with the maximum response. The prewitt operator is limited to 8 possible orientations, however experience shows that most direct orientation estimates are not much more accurate. This gradient based edge detector is estimated in the 3x3 neighbourhood for eight directions. All the eight convolution masks are calculated. One convolution mask is then selected, namely that with the largest module [7].

II. IMAGE SEGMENTATION

The first step in image analysis is segment the image. Segmentation subdivides an image into its constituent parts or objects. The level to which this subdivision is carried depends on the problem being viewed. Some time need to segment the object from the background to read the image correctly and identify the content of the image for this reason there are two techniques of segmentation, discontinuity detection technique and Similarity detection technique. In the first technique, one approach is to partition an image based on abrupt changes in gray-level image. The second technique is based on the threshold and region growing. This paper discuses the first techniques using Edge Detection method.

III. DISCONTINUITY DETECTION

Discontinuity detection is partition an image based on abrupt changes in gray-level image by using three types of detection:

A. Point Detection

The detection of isolated points in an image is straight forward by using the following mask; we can say that a point has been detected at the location on which the mask is centered, if:

$$|R|>T$$

Where T is the threshold and

$$R = -(x_1+x_2+x_3+x_4+x_5+x_6+x_7+x_8+x_9)+8*x_5$$

x_i is an image pixel.

x_1	x_2	x_3
x_4	x_5	x_6
x_7	x_8	x_9

Image Pixels

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

The Mask

Figure 1: The sub image and the point detection mask.

The idea is that the gray level of an isolated point will be quite different from the gray level of its neighbors.

B. Line Detection

The next level of complexity involves the detection of lines in an image. Consider the following masks:

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

0,180°
R_1

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

45°,225°
R_2

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

90,270°
R_3

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

135°,315°
R_4

Figure 2: The line detection masks.

If the first mask were moved around an image, it would respond more strongly to line (one pixel thick) oriented horizontally. With constant background, the maximum response would result when the line passed through the middle row of the mask. Let *R1*, *R2*, *R3*, and *R4* denote the responses of the above masks, and they run along the same image. Then at a certain point, we can say that the mask which has the maximum response, will make the line into its direction, i.e. if *R2> R1*, *R3*, *R4* then the line has the direction *45°*.

C. Edge Detection

Edge detection is more common for detecting discontinuities in gray level than detecting isolated points and thin lines because isolated points and thin lines so not occur frequently in most practical images.

The edge is the boundary between two regions with relatively distinct gray level properties. It is assumed here that the transition between two regions can be properties. It is assumed here that the transition between two regions can be determined on the basis of gray level discontinuities alone.

D.Gradient Operator

The gradient of an image *f(x,y)* at location *(x,y)* is the vector:

$$\nabla f = \begin{bmatrix} G_x \\ G_y \end{bmatrix} = \begin{bmatrix} \partial f / \partial x \\ \partial f / \partial y \end{bmatrix}$$

The gradient vector points in the direction of maximum rate of change of f at *(x,y)*. In edge detection, an important quantity is the magnitude of this vector:

$$|\nabla f| = \sqrt{G_x^2 + G_y^2}$$

The gradient takes it's maximum rate of increase of *f(x,y)* per unit distance in the direction of ∇f.

The gradient magnitude is commonly approximated by:

$$|\nabla f| = |G_x| + |G_y|$$

This is simpler to implement. The direction of the gradient vector is also important and is given by:

$$\alpha(x,y) = \tan^{-1}\left(\frac{G_y}{G_x}\right)$$

IV. EDGE DETECTION TECHNIQUES

A. Sobel Operators

The computation of the partial derivation in gradient may be approximated in digital images by using the *Sobel operators* which are shown in the masks below:

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

1	2	1
0	0	0
-1	-2	1

Figure 3: The Sobel masks

These two masks together with any of the equations:

$$|\nabla f| = \sqrt{G_x^2 + G_y^2}$$

$$|\nabla f| = |G_x| + |G_y|$$

are used to obtain the gradient magnitude of the image from the original.

B. Roberts Cross Edge Detector

The Roberts Cross operator performs a simple, quick to compute, 2-D spatial gradient measurement on an image. It thus highlights regions of high spatial frequency 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.

1	0
0	-1

0	+1
-1	0

Figure.4.Roberts cross convolution mask

C.Laplacian Operator

The Laplacian of an image *f(x,y)* is a second order derivative defined as:

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

The digital implementation of the Laplacian function is usually made through the mask below:

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

Figure 5: The Laplacian masks

The Laplacian is usually used to establish whether a pixel is on the dark or light side of an edge.

D. Prewitt Operator

The prewitt operator uses the same equations as the Sobel operator, except that the constant c = 1. Therefore:
Note that unlike the Sobel operator, this operator does not place any emphasis on pixels that are closer to the centre of the masks.
The Prewitt operator measures two components. The vertical edge component is calculated with kernel Gx and the horizontal edge component is calculated with kernel Gy. |Gx| + |Gy| give an indication of the intensity of the gradient in the current pixel.

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

Gx

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

Gy

Figure 6: Prewitt Mask

E.Kiresh Operator

Kiresh operator represented by the templates:

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

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

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

1	**1**	**0**
1	**0**	**-1**
0	**-1**	**-1**

Figure 7: Kiresh Mask

F.Canny edge detector technique

Canny technique is very important method to find edges by isolating noise from the image before find edges of image, without affecting the features of the edges in the image and then applying the tendency to find the edges and the critical value for threshold.
The algorithmic steps for canny edge detection technique are follows:

1. Convolve image f(r, c) with a Gaussian function to get smooth image f^(r, c).
   f^(r, c)=f(r,c)*G(r,c,6)
2. Apply first difference gradient operator to compute edge strength then edge magnitude and direction are obtain as before.
3. Apply non-maximal or critical suppression to the gradient magnitude.
4. Apply threshold to the non-maximal suppression image.

H.Edge Maximization Technique (EMT)

In images when there is more than one homogenous region (e.g. an image has many objects with different gray levels) or where there is a change on illumination between the objects and its background. In this case, portion of the objects may be merged with the background or portions of the background may appear as an object.
Form the above fact, any of the automatic threshold selection techniques performance becomes much better in images with large homogenous separated regions.
These conditions are fully satisfied for edge-enhanced image where most of the areas are homogenous (including the areas inside the objects plus the areas inside the background), and also having a well separated with areas that fall between the objects and the background (edges).
This improve technique make use of the previous idea and works on edge-enhanced image.

IV. EXPERIMENTS VERIFICATIONS

A. Testing Procedure

The edge detection segments were implemented using (MATLAB R2007a, 7.4a) and tested one satellite image (Saturn) illustrated in the Figure 1**.**

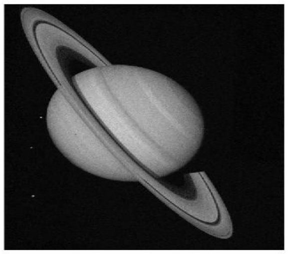
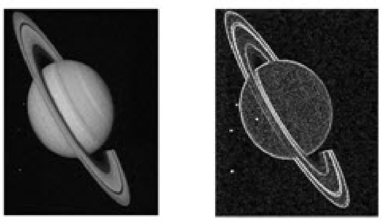


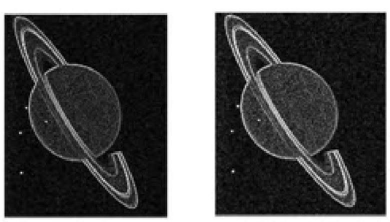
Figure.1.Saturn image

B) SIMULATION RESULTS

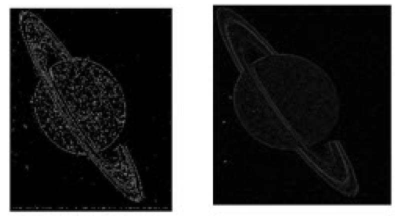
The performance results applied by Seven Techniques illustrated in the Figure.2.



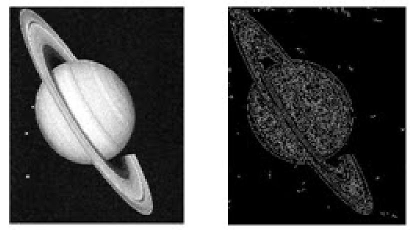
Original Sobel



EMT Kiresh



Laplacian Roberts



Prewitt Canny

Figure.2 Edge Detection Techniques

CONCLUSION

In this paper, the comparative studies applied by using seven techniques of edge detection segment: Sobel, Roberts, Canny, Laplacian, Kirsh, and Edge Maximum Technique (EMT) on the Saturn original image Figure.1.A comparative study are explained & experiments are carried out for different techniques Kiresh, EMT and Perwitt techniques respectively are the best techniques for edge detection this result can be seen in the Figure.2.

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