ISSN (Online) : 2278-1021
ISSN (Print) : 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 3, Issue 4, April 2014

A REVIEW ON EDGE DETECTION METHODS AND TECHNIQUES

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Abstract: Edge detection is one of the most frequently used operations in image analysis, and there are possibly more methods and algorithms in the literature for detecting edges than any other single subject. The reason for this is that edges form the outline of an object. An edge is the boundary between an object and the background, and indicates the boundary between overlapping objects. For this paper we compare different edge detections methods using Remote Sensing images.

Keywords: Edge Detection, Image, Remote Sensing

I. INTRODUCTION

Edge is a part of an image that contains significant local variation and it naturally occurs on the boundary between two different regions in an image. Edges include some of the most useful information in an image. The edges provide important visual information and major physical, photometrical or geometrical variations in scene object. Edge is a vector variable with two components magnitude and orientation, Edge magnitude: gives the amount of the difference between pixels in the neighbourhood (the strength of the edge).Edge orientation: gives the direction of the greatest change, which presumably is the direction across the edge. We may possibly use edges to measure the size of objects in an image; to isolate particular objects from their background; to recognize or classify objects.

II. EDGE DETECTION

Edge detection is a process that detect the presence and location of edges constitute by sharp changes in color intensity (or brightness) of an image. It also refers to the process of identifying and locating sharp discontinuities in an image. The discontinuities are rapid changes in pixel intensity which distinguish boundaries of objects in a scene. Since it is verified that the discontinuities in image brightness are likely to correspond .The edge detection process serves to simplify the analysis of images by significantly reducing the amount of data to be processed, while at the same time preserve useful structural information about object boundaries. Edge detection, segments the object while filtering the noise while preserving the structural properties of the image. Edge detection becomes difficult in case of noisy images as noise is also a high frequency content According to John canny the following three criterions should be well taken care of while edge detection 1.High probability of marking the real edge point and low probability of marking non edge points.2. The points marked as edge points should be as close as possible to the centre of the true edge.3. There should be only one response to a single edge i.e. double line for edges should not be detected.

STEPS IN EDGE DETECTION

Edge detection include five steps namely**-** Smoothing, Filtering, Enhancement, Detection and Localization. The overviews of the stepladder in edge detection are as follow.

Smoothing: it contain as much noise as possible, without destroy the true edges.

Filtering*:* Images are frequently degraded by random variations in intensity values, called noise. Some common types of noise are salt and pepper noise, impulse noise and Gaussian noise. Salt and pepper noise contains indiscriminate occurrences of both black and white intensity values. On the other hand, there is a trade-off between edge strength and noise reduction. More filtering to reduce noise results in a loss of edge strength.

Enhancement*:* In order to facilitate the detection of edges, it is essential to determine changes in intensity in the neighbourhood 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.

Detection*:* Many points in an image have a nonzero value for the gradient, and not all of these points are edges for a particular application. Hence, some method should be used to determine which points are edge points. As a rule, thresholding provides the criterion used for detection.

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

III.EDGE DETECTION METHODS

Edge detection methods may be used to find the difference between light and dark, and thus the edge of a part. An important property of the edge detection method is its ability to extract the accurate edge line with good orientation, and much literature on edge detection has been published. An edge detection method can be divided into three stages

- A noise reduction process is performed
- A high-pass filter such as a differential operator is usually employed to find the edges

ISSN (Online) : 2278-1021
ISSN (Print) : 2319-5940
IJARCCE
International Journal of Advanced Research in Computer and Communication Engineering
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- An edge localization process is performed to identify the genuine edges, which are distinguished from those similar responses caused by noise.

IV. EDGE DETECTION TECHNIQUES

Sobel Operator

The operator consists of a pair of 3×3 convolution kernels. One kernel is simply the other rotated by 90°. These kernels are designed to respond maximally to edges running vertically and horizontally relative to the pixel grid, one kernel for each of the two perpendicular orientations.

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

Gx

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

Gy

The kernels can be applied separately to the input image, to produce separate measurements of the gradient component in each orientation (call these *Gx* and *Gy*).This operator works by calculating the gradient of intensity of the frame at each point, finding the direction of the change from light to dark and the magnitude corresponds to how sharp the edge is to find out the absolute magnitude of the gradient at each point and the orientation of that gradient. The gradient magnitude is given by:

$$|G| = \sqrt{Gx^2 + Gy^2}$$

In general an approximate magnitude is computed using:

$|G| = |Gx| + |Gy|$ this is much faster to compute. The angle of orientation of the edge (relative to the pixel grid) giving rise to the spatial gradient is given by:

$$\theta = \arctan(Gy/Gx)$$

Robert's Cross Operator

The Roberts Cross operator performs a simple, quick to compute, 2-D spatial gradient measurement on an image. 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 operator consists of a pair of 2×2 convolution kernels as shown in Figure. One kernel is simply the other rotated by 90°. This is very similar to the Sobel operator.

+1	0
0	-1

Gx

0	+1
-1	0

Gy

These kernels are designed to respond maximally to edges running at 45° to the pixel grid, one kernel for each of the two perpendicular orientations. The kernels can be applied separately to the input image, to produce separate measurements of the gradient component in each orientation (call these *Gx* and *Gy*). These can then be combined together to find the absolute magnitude of the gradient at each point and the orientation of that gradient. The gradient magnitude is given by:

$$|G| = \sqrt{Gx^2 + Gy^2}$$

An approximate magnitude is computed using:

$$|G| = |Gx| + |Gy|$$

This is much faster to compute. The angle of orientation of the edge giving rise to the spatial gradient (relative to the pixel grid orientation) is given by:

$$\theta = \arctan(Gy/Gx) - 3\pi/4$$

Prewitt's Operator

Prewitt operator is similar to the Sobel operator and is used for detecting vertical and horizontal edges in images.

$$h_1 = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{bmatrix} \quad h_3 = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

Laplacian of Gaussian

The Laplacian is a 2-D isotropic measure of the 2nd spatial derivative of an image. The image highlights regions of rapid intensity change and is therefore often used for edge detection. The Laplacian is often applied to an image that has first been smoothed with something approximating a Gaussian Smoothing filter in order to reduce its sensitivity to noise. The operator normally takes a single gray level image as input and produces another gray level image as output. The Laplacian *L(x,y)* of an image with pixel intensity values *I(x,y)* is given by:

$$L(x,y) = \frac{\partial^2 I}{\partial x^2} + \frac{\partial^2 I}{\partial y^2}$$

Since the input image is represented as a set of discrete pixels, we have to find a discrete convolution kernel that can approximate the second derivatives in the definition of the Laplacian. Three commonly used small kernels are shown in Figure 1.

0	1	0
1	−4	1
0	1	0

1	1	1
1	−8	1
1	1	1

−1	2	−1
2	−4	2
−1	2	−1

Figure 1 Three commonly used discrete approximations to the Laplacian filter.

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International Journal of Advanced Research in Computer and Communication Engineering
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Because these kernels are approximating a second derivative measurement on the image, they are very sensitive to noise. To counter this, the image is often Gaussian Smoothed before applying the Laplacian filter. This pre-processing step reduces the high frequency noise components prior to the differentiation step.

V. EXPERIMENTAL RESULTS

The following images represent sample output of edge detection methods and technique

Fig-1 Original Image

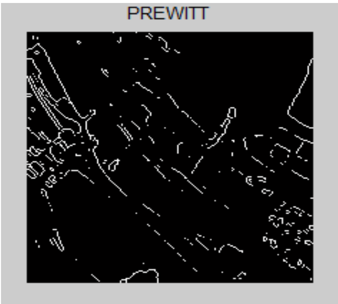

Fig-2 Results of Prewit Operator

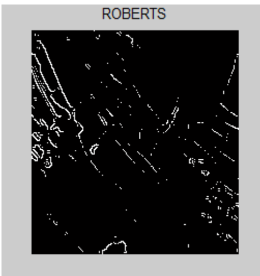

Fig-3 Results of Robert Operator

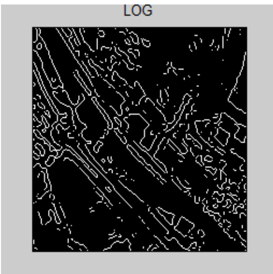

Fig-4 Results of log Operator

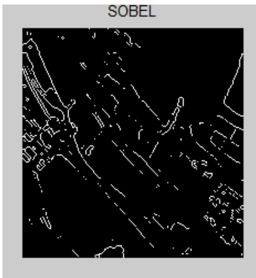

Fig-5 Results of sobel Operator

V1. CONCLUSION

Edge based techniques try to find the places of rapid transition from one to the other region of different brightness or color value. The basic principle is to apply some of the gradient operators convolving them with the image. High values of the gradient magnitude are possible places of rapid transition between two different regions, called edges. This paper presents a study on edge detection methods for Remote sensing image processing techniques.

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