

A Survey and Evaluation of Edge Detection Operators: Application to Text Recognition

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Abstract

Edge detection, especially in image processing occupies a special position. How to accurately extract the edge information of object in images has been the hot research. One of the main objectives of image analysis is to extract the dominating information. Segmentation of image is defined as being major step in image processing that extracts and describes the presence of significant object in a scene, often in the form of region or edges. This paper describes several edge detection operators like Sobel, Prewitt, Canny, Roberts, Zero threshold and emergence of combination of different spatial edge detection method, and its matlab simulation studies and comparative analysis.

Index Terms—Image Processing, Edge Detection, Segmentation, Spatial Edge detection, Matlab Simulation

1. Introduction

Edge detection is a fundamental tool in image processing, machine vision and computer vision, particularly in the areas of feature detection and feature extraction, which aim at identifying points in a digital image at which the brightness changes sharply.

The purpose of detecting sharp changes in image brightness is to capture important events and changes in properties of the world. It can be shown that under rather general assumptions for an image formation model, discontinuities in image brightness are likely to correspond to

- Discontinuities in depth,
- Discontinuities in surface orientation,
- Changes in material properties and
- Variations in scene illumination.

In the ideal case, the result of applying an edge detector to an image may lead to a set of connected curves that indicate the boundaries of objects, the boundaries of surface markings as well as curves that correspond to

discontinuities in surface orientation. Thus, applying an edge detection algorithm to an image may significantly reduce the amount of data to be processed and may therefore filter out information that may be regarded as less relevant, while preserving the important structural properties of an image. If the edge detection step is successful, the subsequent task of interpreting the information contents in the original image may therefore be substantially simplified. However, it is not always possible to obtain such ideal edges from real life images of moderate complexity.

In recent years, edge detection technology has gradually been widely used in medicine, forestry, remote sensing, engineering, inspection of components, fault diagnosis and testing, and more. However, in practice, how to choose the right, a better image edge detection image processing and analysis focus of the study. This article describes several classical edge detection operators and the recent emergence of a new edge detection method, and its matlab simulation study and comparison analysis

2. Classical Edge Detection Operators

The separation of a scene into object and background is an essential step in image interpretation. This is a process that is carried out effortlessly by the human visual system, but when computer vision algorithms are designed to mimic this action, several problems can be encountered.

Classical edge detection can be divided into two types. One is by calculating the image gradient to detect the image edge to the first derivative-based edge detection, such as Roberts operator, Sobel operator, Prewitt operator. One is by seeking the second derivative of the zero-crossing to detect the edge of the second order derivative-based edge detection, such as the LOG operator, canny operator.

2.1 Roberts Operator

Roberts Operator is a differential operator is used to approximate the gradient of an image through discrete differentiation which is achieved by computing the sum of squares of the differences between diagonally adjacent pixels.

$$g(x, y) = \{ [\sqrt{f(x, y) - \sqrt{f(x + 1, y + 1)}}]^2 + [\sqrt{f(x + 1, y) - \sqrt{f(x, y + 1)}}]^2 \}^{\frac{1}{2}}$$

Which, $f(x, y)$ is an integer pixel coordinates (x, y) of the input image value.

The two convolution core, respectively are

$$\mathbf{G}_x = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} \quad \mathbf{G}_y = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$$

Using a norm to measure the magnitude of the gradient

$$|\mathbf{G}(x, y)| = |\mathbf{G}_x| + |\mathbf{G}_y|$$

The Roberts suffers greatly from sensitivity to noise.

2.2 Sobel Operator

Sobel Operator is a discrete differentiation operator, computing an approximation of the gradient of the image intensity function. At each point in the image, the result of the Sobel operator is either the corresponding gradient vector or the norm of this vector. The Sobel operator is based on convolving the image with a small, separable, and integer valued filter in horizontal and vertical direction.

Sobel Operator of two nuclear Convolution calculations were

$$\mathbf{G}_x = \begin{pmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{pmatrix} \quad \mathbf{G}_y = \begin{pmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{pmatrix}$$

Norm used to measure the magnitude of the gradient

$$|\mathbf{G}(x, y)| = \text{Max} (|\mathbf{G}_x|, |\mathbf{G}_y|)$$

Sobel operator and the noise of more shades of gray image processing better.

2.3 Prewitt Operator

Prewitt Operator is a differentiation operator, calculates the gradient of the image intensity at each point, Prewitt operator at an image point which is in a region of constant image intensity is a zero vector and at a point on an edge is a vector which points across the edge, from darker to brighter values.

Prewitt Operator of two nuclear Convolution calculations were

$$\mathbf{G}_x = \begin{pmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{pmatrix} \quad \mathbf{G}_y = \begin{pmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{pmatrix}$$

2.4 LOG Operator

Log operator is a second-order operator, will generate at the edge of a steep zero-crossing. Laplacian is a linear shift invariant operator, and its transfer function in the frequency domain origin is zero, so by the Laplace filtered image with a zero average over the gray. Log operator first low-pass filter with Gaussian pre-smoothing the image, and then find the image Laplacian edge of steep, and finally zero gray value generated binary closed, connected contours, to eliminate all internal points.

Log operator function is defined as:

$$\log(x, y) = \frac{1}{\pi\sigma^4} \left(\frac{2(x^2 + y^2)}{\sigma^2} - 1 \right) e^{-\frac{x^2 + y^2}{2\sigma^2}}$$

The two nuclear Convolution calculations are

$$\mathbf{G}_x = \begin{pmatrix} 0 & -1 & 0 \\ -1 & -4 & -1 \\ 0 & -1 & 0 \end{pmatrix} \quad \mathbf{G}_y = \begin{pmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{pmatrix}$$

2.5 Canny Operator

Canny edge Operator is an edge Operator that uses a multi stage algorithm to detect a wide range of edges in images. Canny's aim was to discover the optimal edge detection algorithm. An "optimal" edge detector means:

- *Good detection* – the algorithm should mark as many real edges in the image as possible.
- *Good localization* – edges marked should be as close as possible to the edge in the real image.
- *Minimal response* – a given edge in the image should only be marked once, and where possible, image noise should not create false edges.

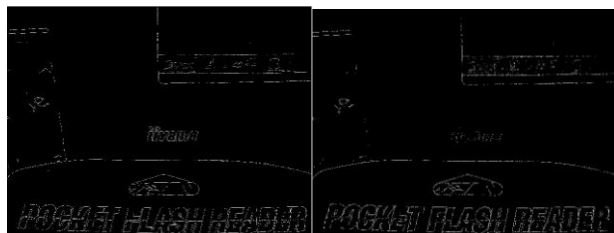
Canny operator detects the edges of the basic idea is to use Gaussian function as a filter, the filtered image to find the local maximum gradient; the gradient is the derivative filter calculation. Canny operator was to use strong edges and weak edge detection, but only to weak edges and strong edges, the weak edge in the output. Therefore, this method susceptible to noise interference, noise suppression and edge detection balance between the effects of a high signal to detection accuracy.

2.5 Matlab – Based Comparative analysis of Experimental Results



Original Image

Roberts



Sobel

Prewitt



Canny

LOG

From the simulation results can directly see with advantages of various algorithms.

Classical differential operator theory and template easy to operate, can detect more accurate position edge, but the details are far from complete. The Sobel operator represents a rather inaccurate approximation of the image gradient, but is still of sufficient quality to be of practical use in many applications. Canny Method will work, but detect other edges which are unnecessary in the context of Text Detection. Zero Cross method like LOG lead to double edge, so it is not good choice. For Text detection, single edge detection method like Sobel, prewitt, Roberts will not work properly if we trying to extract connected components for all the images.

3. Combination of Spatial Edge Detection Operator

Due to the presence of noise and quantization of the image, during edge detection it is possible to locate intensity changes where edges do not exist. For similar reasons, it is also possible to completely miss existing edges. The degree of success of an edge-detector depends on its ability to accurately locate true edges. Edge localization is another problem encountered in edge detection. The addition of noise to an image can cause the position of the detected edge to be shifted from its true location. The ability of an edge-detector to locate in noisy data an edge that is as close as possible to its true position in the image is an important factor in determining its performance. Another difficulty in any edge detection system arises from the fact that the sharp intensity transitions which indicate an edge are sharp because of their high-frequency components.

There is no edge detection method which works perfectly for all the applications. In this we describe a combination of different edge detection algorithm to extract the text from natural images. We can find the difference between following image and images in 2.5 section. Combined Edge detection method is combination of Sobel, Prewitt and Roberts which leads to better extraction of Connected Components.



Original Image

Combine Edge detection

4. Conclusion

As a conclusion, the ideal segmentation method doesn't exist. Being given an image, there exist several possible segmentation methods. Therefore, a good method will be that which provide the best interpretation of the resulting edges without losing the important details. Combine Edge Detection method locates the edges better compare to other classical edge detectors when extraction of connected component.

5. References

- [1] R. C. Gonzalez and R. E. Woods: “*Digital Image Processing*”, Third Edition. Prentice Hall, 2008.
- [2] Wilhelm Burger and Mark J Burge, “*Digital Image Processing: An Algorithmic Introduction using Java*”, Springer; 2008 edition.
- [3] Anil K Jain, “*Fundamentals of Digital Image Processing*”, Prentice Hall, First edition, 1988.
- [4] Hanene Trichili, Mohamed-Salim Bouhleb, Nabil Derbel and Lotfi Kamoun, “*A survey and Evaluation of Edge Detection Operators Application to Medical Images*” IEEE, ISBN: 0-7803-7437-1.
- [5] L. M. Kennedy and M. Basu, “Image enhancement using a human visual system model,” *Pattern Recognition.*, vol. 30, no. 12, pp. 2001–2014, 1997.
- [6] W. K. Pratt, “*Digital Image Processing*”, New York, Wiley-InterScience, 1978.
- [7] Liu Cai, “A kind of advanced Sobel image edge detection algorithm”, Guizhou Industrial College Transaction (Natural Science Edition), 2004, 77-79.