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Denoising and Edge Detection Using Sobelmethod

P. Sravya[1], T. Rupa devi[2], M. Janardhana Rao[3], K. Sai Jagadeesh[4], K. Prasanna Kumar[5]

[1,2,3,4] *IV-ECE, Lendi institute of engineering and Technology*
[5]*Assistance professor, Lendi institute of engineering and Technology*

ABSTRACT: *The main aim of our study is to detect edges in the image without any noise , In many of the images edges carry important information of the image, this paper presents a method which consists of sobel operator and discrete wavelet de-noising to do edge detection on images which include white Gaussian noises. There were so many methods for the edge detection, sobel is the one of the method, by using this sobel operator or median filtering, salt and pepper noise cannot be removed properly, so firstly we use complex wavelet to remove noise and sobel operator is used to do edge detection on the image. Through the pictures obtained by the experiment, we can observe that compared to other methods, the method has more obvious effect on edge detection.*

Keywords: *sobeloperator, complexwaveletdenoising,white gaussian noise.*

I. Introduction

Image processing is any form of signal processing, in which the input is an image such as a video, photograph, the output of an image processing may be either an image or set of characteristic related to the image. Edge detection is one of the foremost techniques in image processing. Edges carry important information of the image ,it contains a wealth of internal information of the image. Therefore edge detection is one of the key research works in the image processing. Edge detection is the name for a set of mathematical methods which aim at identifying points in a digital image at which the image brightness changes sharply. The point at which image brightness changes sharply are typically organized into a set of curved line segments termed edges. 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.

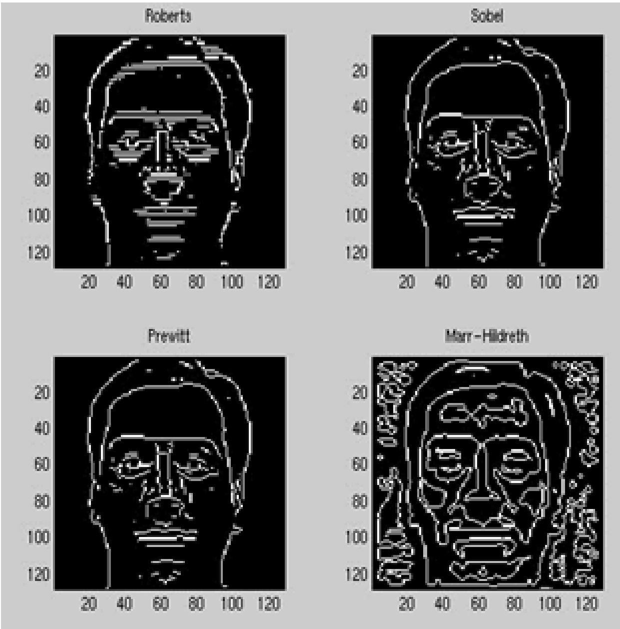
II. Edge Detection Methods

Edge widely exists between objects and backgrounds, objects and objects, primitives and primitives. The edge of an object is reflected in the discontinuity of the gray. Therefore the general method of edge detection is to study the changes of a single image pixel in a gray area, edge detection is mainly the measurement, detection and location of the changes in image gray. Suppose in an image if there were two pictures in an image which were attached or side by side, difference in these two will be identified by the edge, therefore edge extraction is the important technique.

There are many ways to perform edge detection. However, the most may be grouped into two categories, gradient and laplacian. The gradient method detects the edges by looking for the maximum and minimum in the first derivative of the image. The laplacian method searches for zero crossings in the second derivative of the image to find edges. This first figure shows the edges of an image detected using the gradient method (Roberts, Prewitt, Sobel) and the Laplacian .

III. Principal of Edge Detection

The basic idea of edge detection is as follows: First, use edge enhancement operator to highlight the local edge of the image. Then, define the pixel "edge strength" and set the threshold to extract the edge point set. However, because of the noise and the blurring image, the edge detected may not obtained edge point set into be continuous. So, edge detection includes two contents. First is using edge operator to extract the edge point set. Second is removing some of the edge points from the edge point set, filling it with some another and linking the obtained edge point set into lines. in this paper we use sobel operator.



IV. Sobel Operator

Compared to other edge operator, Sobel has two main advantages:

Since the introduction of the average factor, it has some smoothing effect to the random noise of the image. Because it is the differential of two rows or two columns, so the elements of the edge on both sides have been enhanced, so that the edge seems thick and bright. A way to avoid having the gradient calculated about an interpolated point between the pixels which is used 3 x 3neighborhoods for the gradient calculations

$$G_x = \begin{bmatrix} +1 & 0 & -1 \\ +2 & 0 & -2 \\ +1 & 0 & -1 \end{bmatrix} * A \quad \text{and} \quad G_y = \begin{bmatrix} +1 & +2 & +1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} * A$$

Since the Sobel kernels can be decomposed as the products of an averaging and a differentiation kernel, they compute the gradient with smoothing. For example,

$\mathbf{G_x}$ Can be written as

$$\begin{bmatrix} +1 & 0 & -1 \\ +2 & 0 & -2 \\ +1 & 0 & -1 \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix} \begin{bmatrix} +1 & 0 & -1 \end{bmatrix}$$

The x-coordinate is defined here as increasing in the "right"-direction, and the y-coordinate is defined as increasing in the "down"-direction. At each point in the image, the resulting gradient approximations can be combined to give the gradient magnitude, using:

$$\mathbf{G} = \sqrt{\mathbf{G}_x{}^2 + \mathbf{G}_y{}^2}$$

Using this information, we can also calculate the gradient' direction:

$$\mathbf{\Theta} = \operatorname{atan2}(\mathbf{G}_y, \mathbf{G}_x)$$

Where, for example, □ is 0 for a vertical edge which is darker on the right side. Sobel operator is a kind of orthogonal gradient operator. Gradient corresponds to first derivative, and gradient operator is a derivative operator. For a continuous function f(x, y), in the position (x, y), its gradient can be expressed as vector (the two components are two first derivatives which are along the X and Y direction respectively

$$\nabla f(x,y) = \begin{bmatrix} G_x & G_y \end{bmatrix}^T = \begin{bmatrix} \frac{\partial f}{\partial x} & \frac{\partial f}{\partial x} \end{bmatrix}$$

The magnitude and direction angle of the vector are:

$$mag(\nabla f) = \left|\nabla f_{(2)}\right| = \begin{bmatrix} G_x^2 & G_y^2 \end{bmatrix}^{1/2}$$

$$\phi(x,y) = \arctan\left(G_x / G_y \right)$$

Every point in the image should use these two kernels to do convolution. One of the two kernels has a maximum response to the vertical edge and the other has a maximum response to the level edge. The maximum value of the two convolutions is used as the output bit of the point, and the result is an image of edge amplitude.

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

(a) Convolution template S1

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

(b) Convolution template S2

Their convolution is as follows:

$$g_1(x,y) = \sum_{k=-1}^{1}\sum_{l=-1}^{1} S_1(k,l) f(x+k, y+l) \qquad (4)$$

$$g_2(x,y) = \sum_{k=-1}^{1}\sum_{l=-1}^{1} S_2(k,l) f(x+k, y+l) \qquad (5)$$

$$g(x,y) = g_1^2(x,y) + g_2^2(x,y) \qquad (6)$$

If gl (X, y) > g2 (X, y) , it means that there is an edge with a vertical direction passing through the point (x ,y).otherwise, an edge with a level direction will pass through the point. If the pixel value of the point (x,y) is f(x,y), and this point is judged as an edge point if f(x,y) Satisfy one of the following two conditions

1) (1) $g(x,y) > 4 \times \sum_{i=1}^{row}\sum_{j=1}^{list} g^2(i,j) / row \times list$

(2) $g_1(x,y) > g_2(x,y)$

(3) $g(x,y-1) \le g(x,y)$

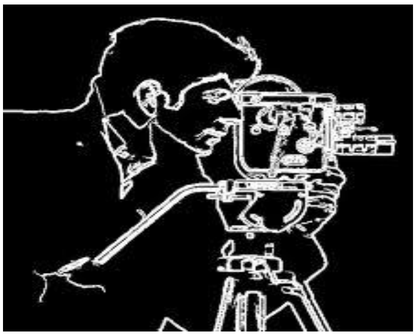
(4) $g(x,y) \ge g(x,y+1)$

$$2)\ (1)\ g(x,y) > 4\times\sum_{i=1}^{row}\sum_{j=1}^{list} g^2(i,j) \Big/ row\times list$$

$$(2)\ g_1(x,y) > g_2(x,y)$$

$$(3)\ g(x-1,y) \le g(x,y)$$

$$(4)\ g(x,y) \le g(x+1,y)$$



V. Image Denoising

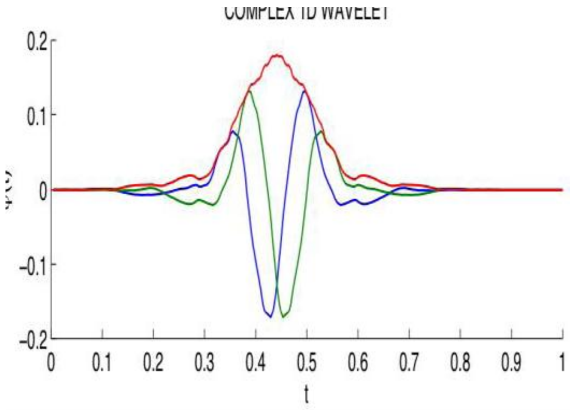
Information is important while processing an image that means it should not be lost. Due to noise we couldn't get the required information. . It is important to reduce noise before trying to extract features from a noisy image. so before we give a short introduction to wavelets.. Many filters have been developed to improve image quality .Recently there has been considerable interest in using wavelet transform as a powerful tool for recovering data from noisy data. But wavelet transform we have some problems to achieve this problems we use complex wavelets'.

VI. Complex wavelets

The complex wavelets have difficulty in designing complex filters which satisfy perfect reconstruction. To overcome this, Kingsbury proposed a dual tree implementation of the complex wavelet transform (DT CWT) which uses 2 trees of real filters to generate the real and imaginary parts of the wavelet coefficients separately. In our method we used dual tree complex wavelet transform

VII. Dual Tree Complex Wavelet Transform

The dual-tree complex DWT of a signal x is implemented using two critically-sampled DWTs in parallel on the same data, as shown in the figure. The transform is 2-times expansive because for an N-point signal it gives 2N DWT coefficients [2][4]. If the filters in the upper and lower DWTs are the same, then no advantage is gained. However, If the filters are designed is a specific way, then the sub band signals of the upper DWT can be interpreted as the real part of a complex wavelet transform, and sub band signals of the lower DWT can be interpreted as the imaginary part. One of the advantages of the dual-tree complex wavelet transform is that it can be used to implement 2D wavelet transforms that are more selective with respect to orientation than is the separable 2D DWT. 2-D dual-tree DWT of an image x is implemented using two critically-sampled separable 2-D DWTs in parallel. Then for each pair of sub bands we take the sum and difference. The wavelet coefficients w are stored as a cell array. For j = 1...J, k = 1..2, d = 1..3, w{j}{k}{d} are the wavelet coefficients produced at scale j and orientation (k,d)The six wavelets associated with



Complex wavelet

VIII. Denoising

In an image like bacteria the information (micro cells)are very important ,if it is corrupted with noise it will be difficult to segment the number of cells. Hence denoising may be useful for improving the SNR. By improving the SNR the segmentation is related to SNR. Thus the probability of detecting the number of cells may be improved. One technique for denoising is wavelet thresholding (or "shrinkage").[8] When we decompose the data using the wavelet transform, some of the resulting wavelet coefficients correspond to details in the data set (high frequency sub-bands). If the details are small, they might be omitted without substantially affecting the main features of the data set. The idea of thresholding is to set all high frequency sub-band coefficients that are less than a particular threshold to zero. These coefficients are used in an inverse wavelet transformation to reconstruct the data set.

IX. Algorithm

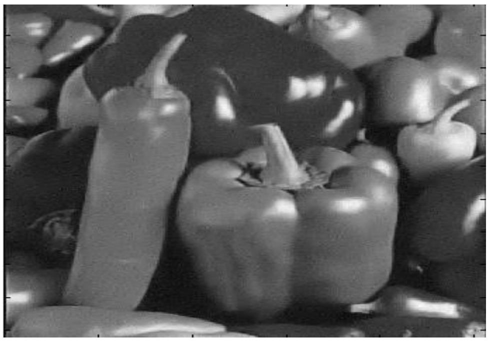
The advantage of Sobel edge operand is its smoothing effect to the random noises in the image. And because it is the differential separated by two rows or two columns, so the edge elements on both sides have been enhanced and make the edge seems thick and bright. Sobel operator is a gradient operator. The first derivative of a digital image is based on variety of two-dimensional gradient approximation, and generates a peak on the first derivative of the image, or generates a zero-crossing point on the second derivative. Calculate the magnitude and the argument value of the image horizontal and vertical first-order or second-order gradients, at last calculate modulus maxima along the angular direction and obtain the edge of the image. But when the image has lots of white Gaussian noises, it is very difficult to get the peak value of the first derivative; the reason is because that the noise points and the useful signals mix up. Therefore this paper combine soft-threshold wavelet de-noising and sobel operator. The core idea of the algorithm of de noising and sobel operator:

1. The standard test images like bacteria, Lena are considered and are corrupted by additive White Gaussian Noise. It is given as x = s + .g where s is original image, x is noisy image corrupted by additive white Gaussian noise g of standard deviation . Both s and x are of same sizes
2. The dual tree complex wavelet transform uses 10 tap filters for analysis at different stages. The reconstruction filters are obtained by simply reversing the alternate coefficients of analysis filters.
3. Perform the 2D Dual tree DWT to level J = 4. During each level the filter bank is applied to the rows and columns of an image.
4. A different threshold value with soft Thresholding is applied for each sub band coefficients.
5.The inverse DT DWT is performed to get the Denoised image
6. The quantitative measures, Mean Square Error and Peak Signal to Noise Ratio are determined for different thresholds.
7. Do wavelet decomposition to the image matrix and get the wavelet coefficients with noises.
8. Process the wavelet coefficients HL, LH and HH obtained by the decomposition, and keep the low frequency coefficients unchanging.
9. Select an appropriate threshold to remove Gaussian white noise signals.
10. Do inverse wavelet transformation to the image matrix and get the image matrix after de-noising.
11. Custom template edge coefficient according to the Sobel operator template showed in Figure 1.
12. After given Sobel edge detection operator template, convolute on every pixel of the image using this template, get the gradient of this point, and the gradient amplitude is the output of this point. At last we get the edge detection image.

X. Results

The original image

complex wavelet denoising



Sobel operator image

XI. Conclusion

As edges carry most important part of the information, here we used sobel operator and dual transform wavelet on white Gaussian noise images. By using the denoising wavelet, image is noise free after that sobel operator is applied to detect edges. By using this method we will obtain the edges thick and dark which we can identify accurately.

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