

## WAVELETS FOR EDGE DETECTION IN NOISY IMAGES

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**Abstract:**-In this paper, we present a wavelet based edge detection technique. Edge detection is an important step in pattern recognition, image segmentation, and scene analysis. The conventional approaches to edge detection fail in presence of noise in images and may cause problems in many applications. But noise is very effectively reduced by wavelet filters without any significant loss in the image resolution. Unlike canny edge detection in which the first step is image smoothing by a Gaussian filter to reduce the effect of noise and next step is edge detection. In wavelet these two steps are combined into a single step and thus wavelet based techniques are computationally more efficient. It is experimentally proved that the wavelet based edge detector gives better result than traditional techniques for noisy images.

**Keywords** – Edge detection, digital image processing and wavelet transform

### 1. INTRODUCTION

An edge in an image can generally be defined as a boundary or contour that separates adjacent image regions having relatively distinct characteristics according to some feature of interest. Edges have vital information contributing towards the analysis and interpretation of image information. The steps of edge detection are smoothing/enhancement, detection localization. There are many methods for edge detection, but most of them can be grouped into two categories. The first one is search based and the second one is zero crossing based. The search-based methods detect edges by looking for maxima and minima in the first derivative of the image, usually local directional maxima of the gradient magnitude. The zero-crossing based methods search for zero crossings in the second derivative of the image in order to find edges, usually the zero-crossings of the Laplacian or the zero-crossings of a non-linear differential expression [1].

### 2. BRIEF REVIEW OF WAVELET ANALYSIS

In 1873, Karl Weierstrass mathematically described how a family of functions can be constructed by superimposing scaled versions of a given basis functions. Wavelets are functions generated from one basis function called mother wavelet by scaling and translating in frequency domain. If the mother wavelet is denoted by  $\psi(t)$ , the other wavelets  $\psi_{a,b}(t)$  can be represented as

$$\psi_{a,b}(t) = \frac{1}{\sqrt{|a|}} \psi\left(\frac{t-b}{a}\right) \quad (1)$$

Where  $a$  and  $b$  are two arbitrary real numbers. The discrete wavelets can be represented by

$$\psi_{m,n}(t) = a_0^{-m/2} \psi(a_0^{-m} t - n_0 b_0) \quad (2)$$

There are many choices to select the values of  $a_0$  and  $b_0$ , generally used values of  $a_0 = 2$  and  $b_0 = 1$  thus the above equation becomes

$$\psi_{m,n}(t) = 2^{-m/2} \psi(2^{-m} t - n) \quad (3)$$

In 2D wavelets we have a scaling function and three wavelets.

The scaling function

$$\varphi^{2D} = \varphi(x)\varphi(y) \quad (4)$$

The three wavelets

$$\psi_1^{2D}(x, y) = \varphi(x)\psi(y) \quad (5)$$

$$\psi_2^{2D}(x, y) = \psi(x)\varphi(y) \quad (6)$$

$$\psi_3^{2D}(x, y) = \psi(x)\psi(y) \quad (7)$$

Where  $\varphi$  and  $\psi$  indicate the scaling function and 1-D wavelet respectively. The discrete wavelet transforms of image  $f(x, y)$  of size  $M$  and  $N$  is

$$W_\varphi(j_0, m, n) = \frac{1}{\sqrt{MN}} \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x, y) \varphi_{j_0, m, n}(x, y) \quad (8)$$

$$W_\varphi^i(j, m, n) = \frac{1}{\sqrt{MN}} \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x, y) \psi^i_{j, m, n}(x, y) \quad (9)$$

The discrete values of  $\varphi$  and  $\psi$  are sampled versions of basis functions respectively. The coefficients  $W_\varphi(j_0, m, n)$  and  $W_\varphi^i(j, m, n)$  are called the approximation and detailed coefficients. The image is broken up into a sum of orthogonal signals

corresponding to different resolution scales. From the detailed coefficients we get the horizontal, vertical and diagonal detailed of the image [1, 3].

### 3. EDGE DETECTION USING WAVELETS

Mallet et. Al[2] studied the properties of multiscale edges through the wavelet theory. The Wavelets have the capacity to locally analyze the fluctuations of image grayscale levels. Without processing, the analysis of images by wavelets makes it possible to extract a new image from which we can isolate the edges [1, 3]. The general idea of edge detection using wavelet transform is as follows:

- Choose a suitable wavelet function
- Use the function to transform images into decomposition levels.
- The wavelet detailed coefficients containing significant energy at noise scales are filtered out.
- Finally edges are detected from the filtered detailed coefficients.

### 4. RESULTS AND CONCLUSIONS

To prove the validity of the proposed edge detection it was implemented in MatLab and executed on Intel(R) CPU T2050@1.60GHz. Various gray scale test images of different sizes were used for comparing the results of the proposed algorithm and canny edge detector (two test images are shown in Fig.1 (a) & (b)). The visual performance of the proposed method is clearly perceptible from Fig 2. (a) & (b). In all the test images, the original shape is retained with a good balance of detail and the edge localization accuracy is also high. The edge results for canny are shown in Fig 2(c) & (d). The behavior of the proposed algorithm in presence of noise in images is evaluated by taking a test image shown in Fig. 3. (a). The result of the proposed method is shown in Fig 3. (b) and that of canny edge detector is shown in Fig 3. (c).

It is evident that the results of the proposed method are better than that of canny.



Figure 1: (a) test image one



Figure 1: (b) test image two

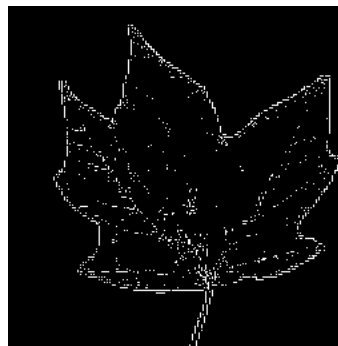


Figure 2. (a) and (b) shows the results of the proposed edge detector .



Figure 2. (b)



Figure 2 (c) and (d) the results of canny edge detector.



Figure 2 (d)

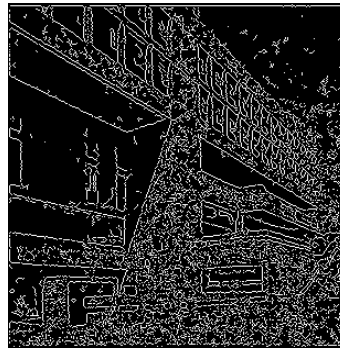


Figure 3 (c)

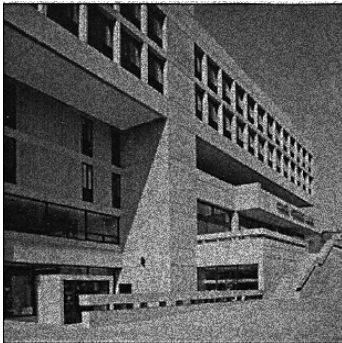


Figure 3 (a) shows the noisy test image, (b) shows the edge results of the proposed algorithm and (c) shows the results of canny edge detector for the noisy test image.



Figure 3 (b)

The experimental analysis conducted in this paper proves that the proposed wavelet based edge detector gives comparable results to canny edge detector in (edge location and edge thinness) case of noise free images and better edge results than canny edge detector in case of noisy images. The dominant edge features are picked by the wavelet high pass filter and the undesired image clutter as seen in canny edge results Fig 2. (c) and (d) are filtered out as is evident from Fig 2. (a) and (b).

## 5. REFERENCES

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