Low Magnitude Edge Detection Algorithm

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ABSTRACT
Edge detection are very important in the digital world to find the information about an object like range, boundaries, level,, hidden and missing fields or edges etc. There are very few approaches and algorithms to show the finer details of an object. The proposed edge detection technique explores the hidden edges in a very simpler manner.

Keywords: Edge, Enhancement, pixel, Gradient, Canny, Sobel, Prewitt.

1. INTRODUCTION

1.1. Edge Detection
Edge detection plays a vital and forefront role in image processing for object detection. The edge of an image describes the boundary between an object and its background. Edge can be identified as a sudden change in the value of the image intensity function. So an edge separates two regions of different intensities [1].

Edge detection is a fundamental tool used in most image processing applications to obtain information from images as a precursor step to feature extraction and object segmentation. This process detects boundaries between objects and the background in the image at which the image brightness changes sharply or more formally has discontinuities. The image containing these boundaries is known as edge map [2].

To determine the edge pixels, it is necessary to detect the position between two pixels. The traditional edge detection operators include Gradient operator, Sobel operator, Robert operator, Prewitt operator, Canny operator, Log operator, and so on [3].

1.2. Image Enhancement
Image enhancement technique has been commonly used in various applications where the subjective quality of image is very important. The objective of image enhancement is dependent on the application circumstances. Contrast is an important factor in any individual estimation of image quality, it can be controlling tool for documenting and presenting information collected during examination [4].

The basic purpose of Image enhancement is that the observed image have obvious trait which was not available for the original image. Various techniques such as intensity transformation histogram equalization, homomorphic filtering, and have been proposed to enhance images degraded by irregular illumination. These methods usually enhance an input image by reducing its dynamic range and or increasing its contrast [5].

2. APPROACHES FOR MASKING, EDGE DETECTION AND IMAGE ENHANCEMENT

2.1. Convolution based operation
Convolution is local operation because the outcome of convolution at each pixel is just the sum of multiplications between neighboring pixels of the point in the image and pixels in a kernel [6]. The output pixel value is the weighted sum of the input pixels within the window where the weights are the values of the filter assigned to every pixel of the window itself. The window with its weights is called the convolution kernel [7].

$$[m.n] = \sum_{j,k} a[j.k]h[m-j.n-k] \qquad (1)$$

2.2. Gradient operator
Gradient operators are based on the idea of using the first or second derivative of the gray level. The first derivative will mark edge points, with steeper gray level changes providing stronger edge points (large magnitudes). The second derivative returns two impulses, one on either side of the edge. An advantage of this is that if a line is drawn between the two impulses the position where this line crosses the zero axis is the center of the edge, which theoretically allows us to measure edge location to sub-pixel accuracy. Sub-pixel accuracy refers to the fact that zero-crossing may be at fractional pixel distance. In the traditional edge detector, the gradient of image is calculated using first order deviation [8]. When the gradient is above the threshold, there is an object in the image. As regarding to image f(x, y), the gradient of point (x, y) is defined as follows:

$$\nabla f(x,y) = \begin{bmatrix} G_x & G_y \end{bmatrix} = \begin{vmatrix} \frac{\partial f}{\partial x} & \frac{\partial f}{\partial y} \end{vmatrix} \qquad (2)$$

The weight of the vector is

$$\nabla f = mag(\nabla f) = \left[G_x^2 \quad G_y^2\right]^{1/2} \qquad (3)$$

And its direction as

$$\emptyset(x,y) = \arctan\left(G_y/G_x\right) \qquad (4)$$

Where G_x and G_y are the gradient in x and y direction. Gradient of every pixel of the image is calculated using the above three equations. In fact, small region pattern convolution is used to process the image. Gradient operators include Robert, Prewitt and Sobel operator.
Laplacian operator uses second derivative, the operator is defined as:

$$\nabla^2 f(x,y) = \frac{\partial^2 f(x,y)}{\partial x^2} + \frac{\partial^2 f(x,y)}{\partial y^2} \quad (5)$$

The Laplacian operator finding the correct places of edge, testing wider areas around the pixel but malfunctioning at corners, curves. Also and where the gray level intensity function varies, not finding the orientation of edge because of using the Laplacian filter.

2.3. LOG Filter

Laplacian of Gaussian combined Gaussian filtering with the Laplacian and defined as:

$$G_\delta(x,y) = \frac{1}{2\pi\delta^2}\exp\left(-\frac{x^2+y^2}{2\delta^2}\right) \quad (6)$$

Using Convolution of Gaussian operator with image f(x,y), the image is smoothed, then the edge is detected using the following equation:

$$\nabla^2[G_\delta(x,y) * f(x,y)] = [\nabla^2 G_\partial(x,y) * f(x,y)] \quad (7)$$

Gaussian edge detectors are symmetric along the edge, and reduce the noise by smoothing the image.

The significant operator is Canny which convolve the image with the derivative of Gaussian for Canny [7].

2.4. Canny operator

The Canny edge-detector is the first-order derivative of Gaussian function. The Canny edge detector was devised to be an optimal edge detector, which satisfies all of the three performance criteria [8]:

- *(i).* The first criterion is to minimize the situations of detecting false edges and missing actual edges.
- *(ii).* The second criterion is to minimize the distance between the detected edges and actual edges.
- *(iii).* The third criterion is to minimize multiple responses to an actual edge, i.e. to ensure there is only one response for an actual edge point.

2.5. Prewitt operator

The Prewitt edge detector is an appropriate way to estimate the magnitude and orientation of an edge. The Prewitt edge detection obtains the orientation directly from the kernel with the maximum response.

The Prewitt edge detector calculates an edge gradient vector at each point of the source image. An edge enhanced image is produced from the magnitude of the gradient vector.

$$\begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{bmatrix}$$

2.6. Sobel operator

The Sobel method finds edges using the Sobel approximation to the derivative. It returns edges at those points where the gradient is maximum.

Sobel operator was the most popular edge detection operator until the development of edge detection techniques with a theoretical basis.

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

2.7. Zerocrossing detector

One approach for finding zero crossing at any pixel p of the filtered image g(x, y) is based on using 3X3 neighborhood centered at p. A zero crossing at p implies that the signs of at least two of it's opposing neighboring pixel must differ. There are four case of test: left/right, up/down and then two diagonal. If the value of g(x, y) is being compared against a threshold, then not only must the sign of opposing neighbors be different, but the absolute value of their numerical difference must also exceed the threshold before we can call p a zero crossing pixel [9].

2.8. Histogram equalization

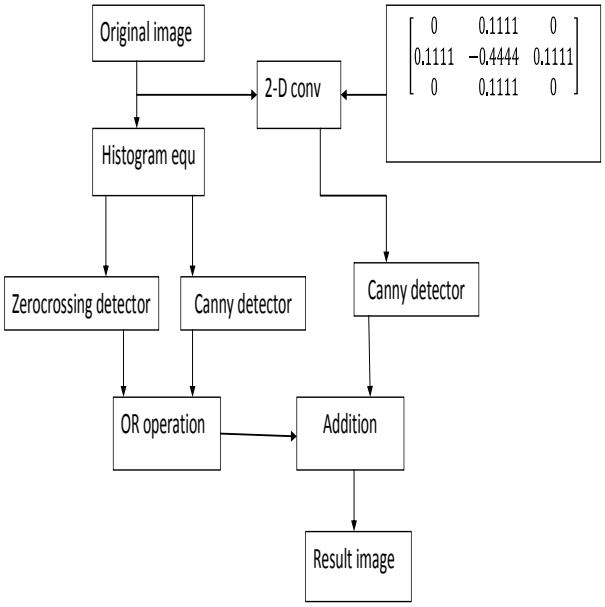
A histogram is a graph that shows how much of the image has certain intensity. Histogram equalization is a technique that generates a gray map which changes the histogram of an image and redistributing all pixels values to be as close as possible to a user-specified desire histogram. This technique is useful for processing images that have little contrast with equal number of pixels to each of the output gray level [4].

3. PROPOSED APPROACH FOR EDGE DETECTION AND IMAGE ENHANCEMENT

Operator has been modified based on the approximation; the following matrix can be obtained.

$$\begin{bmatrix} 0 & 0.1111 & 0 \\ 0.1111 & -0.4444 & 0.1111 \\ 0 & 0.1111 & 0 \end{bmatrix}$$

Based on the above approximated operators we have synthesized the following algorithms to perform task:



4. EXPERIMENT RESULTS AND COMPARISON

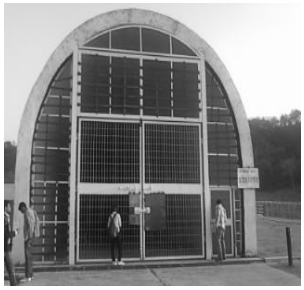


Figure no. 1: Original images

For the comparison of the proposed algorithm with the Sobel and Canny filter for edge detection, the effect of Sobel and Canny edge detector on the original image can be seen in Figure no.2 and Figure no.3.

Figure no.2: Sobel edged image of original images

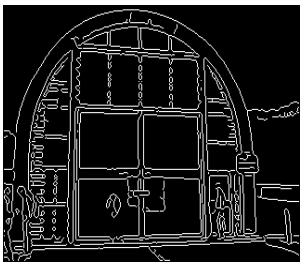


Figure no.3: Canny edged image of original images

Figure no.4 shows the result of edge detection using proposed algorithm. This algorithm is helpful to find the all hidden edges in background and surface of the objects as well as boundary of objects is highlighted.

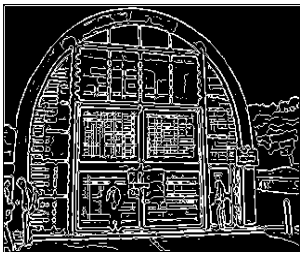


Figure no.4: Edged image of proposed algorithm

5. CONCLUSION

Based on the previously adapted algorithms in edge detection we have first seen the old results and then applied proposed algorithms to find the better results in the field of image processing.

In this paper, an important challenge is to detect the low magnitude edges through image processing. This paper describes new method for edge detection using histogram equalization at first stage of processing which is useful for

processing images that have little contrast with equal number of pixels to each of the output gray level and Canny edge detector, which is useful to minimize the situations of detecting false edges and missing actual edges.

6. REFERENCES

[1] Chandra Sekhar Panda, Prof. (Dr.) Srikanta Patnaik. "Filtering corrupted image and edge detection in restored grayscale image using derivative filters", International journal of image processing (IJIP), volume 3, issue 3, 2008.

[2] Febriliyan Samopa, Akira Asano, "Hybrid image thresholding method using edge detection", (IJCSNS) International Journal of Computer Science and Network Security, VOL.9 No.4, April 2009.

[3] Yuqin Yao, Hui Ju, "A sub- pixel edge detection method based on canny operator", Sixth International Conference on Fuzzy Systems and Knowledge Discovery 2009.

[4] Naglaa Hassan, Norio Akamatsu, "A new approach for contrast enhancement using sigmoid function", Inernational arab journal of information technology, vol 1, no. 2, july 2004

[5] Doo Hyun Choi, Ick Hoon Jang, Mi Hye Kim, Nam Chul Kim "Color image enhancement using single-scale retinex based on an improved image formation model", , 16th European Signal Processing Conference (EUSIPCO 2008), Lausanne, Switzerland, August , 2008.

[6] A. K. Manjunathachari, K. Satya Prasad "Implementation of image processing operations using simultaneous multithreading and buffer processing". GVIP Journal, Volume 6, Issue 3, December, 2006

[7] Ian T, Young Jan, J. Gerbrands, Lucas J.van Vliet, "Fundamental of Image Processing", 1995.

[8**]** Mohamed Roushdy, **"**Comparative Study of Edge Detection Algorithms Applying on the Grayscale Noisy Image Using Morphological Filter", GVIP Journal, Volume 6, Issue 4, December, 2006.

[9] Rafel C. Gonzalez, Richard E. Woods, "Digital image processing", third edition, 2008.