Edge Searching and Object Enhancing Algorithm

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Ranbeer Tyagi[1], Sanjay Singh Kushwah[2], Ashish Bagwari[3]

Abstract

Image improvement and edge discovery are very important in the digital globe to discover the knowledge relating to an entity similar to strength, level, contrast, range, limitations, missing and hidden areas or boundaries etc. There are very a small amount of methods and algorithms to show the finer facts of an aim. The primary we planned edge detection method explores the hidden boundaries in a extremely easy approach. Our other future technique of enhancement finds its path to depiction and enhances the darkest observation of an aim

Keywords

Edge Detection, Image Enhancement, Pixel, Gradient Operator, Canny Operator, Sobel Operator, Zero-crossing.

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[1]Department of EC, UTU, Dehradun, Uttarakhand, India.
[2]Department of EC, GEC, Gwalior, Madhya Pradesh, India.

Corresponding author:
Email: ranbeertyagi85@gmail.com

Introduction

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.[2,19,20].

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].

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[5,16–18].

Currently used approaches for masking and edge detection

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].

$$[m, n] = \sum_{j,k} a[j, k]\, h[m - j, n - k] \tag{1}$$

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:

$$\nabla f(x,y) = [G_x \;\; G_y] = \left| \frac{\partial f}{\partial x} \quad \frac{\partial f}{\partial y} \right| \tag{2}$$

The weight of the vector is

$$\nabla f = mag(\nabla f) = \left[G_x^2 \;\; G_y^2\right]^{\frac{1}{2}} \tag{3}$$

And its direction as

$$\varnothing(x,y) = \arctan\left(\frac{G_y}{G_x}\right) \tag{4}$$

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:

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

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.

LOG Filter

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

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

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

$$\nabla^2 \left[G_\delta(x,y) * f(x,y)\right] = \left[\nabla^2 G_\partial(x,y) * f(x,y)\right] \tag{7}$$

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].

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[8,21,22]:

a) The first criterion is to minimize the situations of detecting false edges and missing actual edges.
b) The second criterion is to minimize the distance between the detected edges and actual edges.

c) 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.

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.

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

Sobel operator

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

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

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

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].

Commonly used enhancement method

There are common methods for contrast enhancement. They fall into two categories special domain and frequency domain method.

In special domain approach the pixels o an image are manipulated directly and modifies pixels values based on values of neighboring pixels. Frequency domain methods are based on modifying the Fourier Transform of an image [4,10].

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].

Power law transformation

The output image of a power law transformation is related to its input image.

$$G(m, n) = b\,[E(m, n)]^{\gamma} \tag{8}$$

c and γ are constant .The value of γ determines the degree to which the intensity range expands. In a power law transformation, each pixel of the original image is raised to specific exponent value. By selecting exponent value appropriately one may boost either high or low luminance value[11,15].

Sigmoid function

Sigmoid function is a non linear function. The name sigmoid derives from the fact that the function is "G" shaped statisticians call this function the logistic function using e(m) for the input and with *l* as a gain[4].

The sigmoid function is

$$e(m) = \frac{1}{1 + e^{-glm)}} \tag{9}$$

Gamma correction

Gamma correction, gamma nonlinearity, gamma encoding, or often simply gamma, is the name of a nonlinear operation used to code and decode luminance or tristimulus values in video or still image systems.

In image processing symbol γ representing the numerical parameter which describes the nonlinearity of intensity reproduction. The process of pre-computing for the nonlinearity by computing signal from an intensity value is called gamma correction[12]. Let J_o is the output image and J_i is input image

$$J_o(m, n) = [J(m, n)]^{\frac{1}{\gamma}} \tag{10}$$

Proposed approaches for edge detection and image enhancement

We use modified operator based on the approximation, the following matrix can be obtained.

$$\text{Operator A} \quad \begin{bmatrix} 0 & 0.111111 & 0 \\ 0.111111 & -0.444444 & 0.111111 \\ 0 & 0.111111 & 0 \end{bmatrix}$$

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

Algorithm: For edge detection

1. *Take original image J*
2. *I =apply histogram equalization on original image I*
3. K =*apply zerocrossing edge detector on I*
4. *L =apply canny edge detector on J*
5. *R1 = OR (K, L)*
6. *Operator A = [3x3] matrix; % is a filter mask*
7. *% now convolve image I with operator A, we get*
D(m, n) =convolution (A, J)
8. *S=apply canny edge detector on Image D*
9. *R2=add(S, R1)*

End

Algorithm: For image enhancement

1. Take original image J

2. G=CJ^{γ} % power law transform*

% Apply sigmoid function on image S

3. P1=min (min(G))

4. P2=G-p1

5. P3=p2/max (max (p2)

6. Sig=1/1+ (1+exp (gain*(cutoff-P3))

% apply gamma correction on Image Sig

7. P4=min (min (Sig))

8. P5=Sig-p4

9. P6=P5/max (max (p5))

10. Finim=$(P6)^{\frac{1}{\gamma}}$

End

Simulation results and comparison

Let us consider the following image for verification of our proposed approaches:-

Figure 1. Original image

We can see the effect of canny edge detector on the original image (Fig.2)

Figure 2. Canny edged of original image

In our old approach when original image is convolved with the operator A and then use canny edge detector with convolved image of operator A [13,14]. We find the image shown in the fig.3.

Figure 3. Convolved image obtained with operator A and passing through Canny filter

We let us find the edge detection using our proposed approach. This algorithm is helpful to find the all hidden edged as well as boundary of objects is highlighted.

Now consider the proposed approach for the image enhancement as shown in algorithm 2.

For the verification of our results we have considered the following image as shown in fig.5.

Please see the following enhancement images for the various values of gamma, gain, cutoff and gamma2.

Figure no.6 shows the image when it is passed through the proposed algorithm 2 when parameter gamma is set to value 2, gain is set to value 3, cutoff is set to value 0.8 and 2nd gamma is set to value 0.6. This shows the far end object clearly which is not observable in original image due to high brightness.

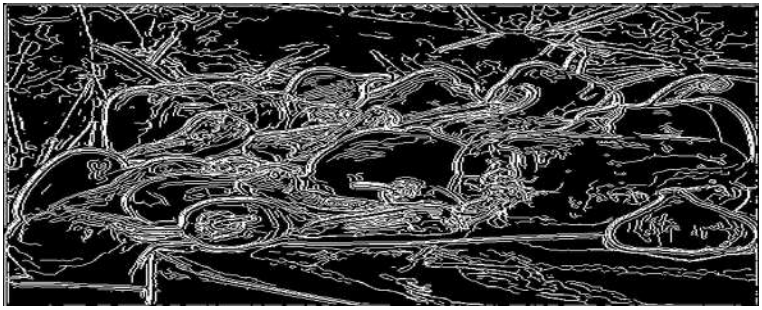

Figure 4. Edged image of proposed algorithm

Figure 5. Original image

Figure 6. Contrast image on gamma=2, gain=3, cutoff, 0.8, 2nd gamma=0.6

Figure no.7 shows the image when it is passed through the proposed algorithm 2 when parameter gamma is set to value 2, gain is set to value 5, cutoff is set to value 0.8 and 2nd gamma is set to value 5. In this image the dark side of the original image is clear but not sufficient.

Figure 7. Enhanced image on gamma=2, gain=5, cutoff= 0.8, 2nd gamma=5

Fig. 8 shows the image when it is passed through the proposed algorithm 2 when parameter gamma is set to value 2, gain is set to value 5, cutoff is set to value 0.4 and 2nd gamma is set to value 9. In this image the dark side of the original image is clearly observable.

This means the result image is depends on the different value of parameters. Here gain controls the actual contrast. Cutoff is set to the value in a manner that the grey value about which contrast is increased or decreased.

Figure 8. Intensity image on gamma=2, gain=5, cutoff= 0.4,gamma=9

Conclusion

Based on the previously adapted algorithms in image processing field we have first seen the old results and then applied our algorithms to find the better results in the field of image processing. Now it becomes easier for the researcher to use our approach and find the desired and calculative results. Our algorithms will really open the path for the researchers to find the good algorithms for the betterment of the world.

References

[1] Chandra Sekhar Panda and 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, year 2008.

[2] Febriliyan Samopa and 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 and 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 and 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 and Nam Chul Kim, “Color image enhancement using single-scale retinex based on an improved image formation model”, 16th European Signal Processing Conference (EUSIPCO 2008), August-2008.

[6] A.K.Manjunathachari, K.SatyaPrasad, “Implementation of image processing operations using simultaneous multithreading and buffer processing”, GVIP Journal, Volume 6, Issue 3, Dec.-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, Vol.-6, Issue 4, Dec.-2006.

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

[10] S. Annadurai, R. Shanmugalakshmi, “Fundamental of digital image processing”, 2007.

[11] David M. Scott and Hugh Mccann “Process imaging for automatic control”, 2005.

[12] Kon Plataniotis, A.N. Venetsanopoulos “color image processing and application”, 2000.

[13] L. D. Malviya, Rohit Yadav and Jaya Dipti Lal, “New Image processing techniques to disclose hidden boundaries”, to be published in 1st international conference on intelligent information system and management (IISM’10), Coimbatore, june 2010.

[14] Abbas Cheraghi, “Searching for an Unknown Edge in the Graph and its Tight Complexity Bounds”, Indian Journal of Science and Technology, Vol 9(13), April-2016.

[15] Chaohui Zhan, Xiaohui Duan, Shuoyu Xu, Zheng Song and Min Luo, "An Improved Moving Object Detection Algorithm Based on Frame Difference and Edge Detection", Proceeding ICIG '07 Proceedings of the Fourth International Conference on Image and Graphics, pp. 519-523, 2007.

[16] Kanwal, S. and Yousaf, M. H., "Optimization of real time edge enhanced object tracking algorithm on video processor", Technical Journal (Taxila), v. 19(4); p. 79-91, 2016.

[17] Naveen Singh Dagar and Pawan Kumar Dahiya, "Soft Computing Techniques for Edge Detection Problem:A state-of-the-art Review", International Journal of Computer Applications, Vol.-136,–No.12, February 2016.

[18] Gabriela Ghimpeţeanu, Thomas Batard, Marcelo Bertalmío and Stacey Levine, "A Decomposition Framework for Image Denoising Algorithms", IEEE Transactions on Image Processing, Vol.: 25, Issue: 1, pp. 388 – 399, Jan. 2016.

[19] Qingsong Zhu, Jiaming Mai and Ling Shao, "A Fast Single Image Haze Removal Algorithm Using Color Attenuation Prior", IEEE Transactions on Image Processing, Vol.: 24, Issue: 11, pp.: 3522 – 3533, Nov. 2015.

[20] JeongHee Cha and GyeYoung Kim, "Enhanced Snake Algorithm Using the Proximal Edge Search Method", Computational Science and Its Applications – (ICCSA 2007) Volume 4705 of the series Lecture Notes in Computer Science pp 1083-1095,-2007.

[21] Shiv Ram Dubey, Satish Kumar Singh and Rajat Kumar Singh, "Multichannel Decoded Local Binary Patterns for Content-Based Image Retrieval", IEEE Transactions on Image Processing, Vol.: 25, Issue: 9, pp.4018-4032, Sept. 2016.

[22] Jianchao Yang, John Wright, Thomas S. Huang and Yi Ma, "Image Super-Resolution Via Sparse Representation", IEEE Transactions on Image Processing, Vol.: 19, Issue: 11, pp.2861-2873, Nov. 2010.