Edge Detection in an Image by Using the Elimination Rule

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Abstract:
Edges are significant local changes of intensity in an image. In this paper, an elimination rule which based on triangular inequality elimination (TIE) has been adopted to perform the edge detection procedures. A new method has been included the combining between an elimination rule which based on triangular inequality elimination (TIE) and the differentiation operator by using the filters mask in one dimension. The introduced algorithm has been produced a good image quality by comparison with that which may be obtained by using the differentiation operator of sharpening an image. The proposed algorithm has been proved it is good for finding the edge in an image data.

كشف حافةٍ في صورةٍ باستخدام قاعدةِ الإزالةَ

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الخلاصة
الحافات تغييراتَ محليّةَ هامّةَ للكثافةِ في صورةٍ. في هذا البحثِ، استخدمت قاعدة الإزالةِ المستندة علىِ (TIE) لكشفِ الحافةَ. أي بعبارة أخرى هذا البحثِ تضمّنْ طريقة جديدة تجَمْع بين قاعدةِ الإزالةِ المستندة علىِ (TIE) ومشغل التفاضلَ الذي يَستعملُ فيها المرشحاتَ في بُعدٍ واحد. الخوارزمية المقترحة أُنتجتْ صور جيدةِ مقارنة مع التي تم الحصول عليها باستعمال مشغل التفاضلَ لشَحْذ صورة. الخوارزمية المُقتَرَحة أثبتتْ بأنّها جيدة لإيجاد الحافةِ في بياناتِ صورة.

Introduction:

For the last years, a successful movement has been started towards the direction for processing the image by sharpening it [1]. Edge detection means the process of locating sharp discontinuities in an image data. In fact, the discontinuities are immediate changes in the intensity of pixel which describe boundaries of objects in an image. such as the differentiation operator on an edge which shows significant responses, this operator is used for edge detection such as using the first derivative in order to sharpening an image. The basic importance for distinguish edges in image processing is image edge detection by reducing the amount of data and filtering out ineffective information, while preserving the important structural properties in an image. So edge detection is very good in image processing [1,2].

This paper shows the sharpening for an image using an elimination rule which based on triangular inequality elimination (TIE) [3,4]. In other word, in this paper, a new method has been included combining between an elimination rule which based on triangular inequality elimination (TIE) and the differentiation operator using the filters mask in one dimension [1]. This method has been used for finding the edge in an image data. While the principal objective of sharpening is to highlight fine detail in an image, therefore, in this paper, the proposed technique which advanced have focused on detect an edge of gray-level images in the spatial domain.

In this paper, a new algorithm which has been presented is adopted to perform the edge detection procedures, the (TIE) rule will be very efficient in edge detection because one can detect an edge pixel which has high detail. This is because many pixels which have low detail can be eliminated. The introduced algorithm has been produced good image quality by comparison with that which may be obtained by using the differentiation operator of sharpening filter [1,3].

First Derivatives:

An image is a two-dimensional signal whose intensity at any point is a function of two spatial variables [1]. Let x and y are the row and column coordinates respectively, and $f(x,y)$ the image intensity values. While an edge is a jump in intensity [1], so an edge is defined as a local variation (difference) of the image intensity $f(x,y)$. In this case, an image sharpening has been applied by using a differentiation operator on the image, therefore the filters mask are used to implement H_x and H_y in one dimension these are called Pixel Difference and they can be designed as $H_x = [1\ -1]$ and $H_y = [1\ -1]^T$. The one directional derivatives $f_x(x,y)$ and $f_y(x,y)$ are calculated as follows;

$$\nabla f_x(x,y) = f(x,y).H_x = f(x-1,y) - f(x,y) \quad \text{….(1)}$$

$$\nabla f_y(x,y) = f(x,y).H_y = f(x,y-1) - f(x,y) \quad \text{….(2)}$$

These can then be combined together to find the absolute magnitude of the gradient at each point [3]. The gradient magnitude is given by:

$$\left|\nabla f(x,y)\right| = \sqrt{(\nabla f_x(x,y))^2 + (\nabla f_y(x,y))^2} \quad \text{…..(3)}$$

Because this idea is derivative operator, therefore the high details for gray-level values will be high values. This will tend to produce images that have grayish edge lines.

An Elimination Rule:

An elimination rule which based on triangular inequality elimination (TIE) is the most popular. One can describe this rule as follows [3]:

Let a1, a2, and a3 are the values and D(a1,a2) is the distortion between a1 and a2. The condition of this rule is "If D(a1,a2) >=2D(a1,a3), then eliminate the computation of D(a2,a3)" because it is always greater than D(a1,a3),see [3,4,5].

The form of an elimination rule used in this paper is; Let a1 and a2 are the intensity values of two pixels and a3 = D(a1,a2) is the distortion between a1 and a2. The condition of this rule will be "If a3>2a2, then eliminate the value of a2 because a1 is always greater than the value of a2.

Proposed method:

A new algorithm can be obtained by using the elimination rule, based on triangular inequality elimination (TIE) method in order to detecting edges in an image data [3,4,5]. The procedure which is used it as follows:

Step1. Initialization; Input the threshold value *(TH)* then start from the pixel of value $f(2,2)$, which has the location $x=2$ and $y=2$ in an original image, and for each pixel perform these steps;

Step2. Calculate the different between two pixels $f(x,y)$ and $f(x-1,y)$ in x direction, and let the value of differentiation "D_x" represents a distortion of matching of two pixels value in x direction.

Step3. If $D_x > TH.\ f(x,y)$, then eliminate the pixel's value $f(x,y)$ and put it equal to zero $g_x(x,y)=0$, because it is no edge or it has low detail value. Other wise it can be considered as edge value $g_x(x,y)= D_x$, and then continue.

Step4. Repeat the process of step 2 and 3 again on the next pixel in an original image i.e. $(f(x+1,y))$.

Step5. Repeat the process of step 2,3and 4 again on the same image but in y direction to find $g_y(x,y)$.

Step6. Calculate the gradient magnitude from equation (3) to find the edge gray level image.

The (TIE) rule will be very efficient because one can detect an edge pixel which has high detail, this is because many pixels which have low details can be eliminated.

Experimental:

The purpose of this paper is to study and understand an elimination rule which bases on triangular inequality elimination (TIE) and it is compared with the differentiation operator of sharpening filter in edge detection such as illustrated in the conclusions of this paper. The proposed algorithm for sharpening of gray-scale images is based on a very simple rule i.e.; elimination rule, it can be detected an edge in the image by depending on this rule, where this rule will be very efficient in edge detection because one can detect an edge pixel which has high detail, this is because many pixels which have low detail can therefore be eliminated. In other word, this technique is simple conceptually to get edged image close to that is produced from the differentiation operator using Pixel Difference filters in two directional *x* and y. Important information to be noted in this paper is that all the filtering was done in spatial domain.

Conclusion And Discussion:

For image quality measurement it can be used objective measure (PSNR), but the subjective quality evaluation of human is the most important measurement. The introduced algorithm was produced good image quality by comparison with that which was obtained by using the differentiation operator of sharpening filter. The tested image was 64x64 pixels.

Table.1; The PSNRs obtain by applying only the differentiation operator and our proposed method. In this paper, the detecting of an edge was done according to our proposed method, on "EARTH" images, for different threshold values. As expected, our proposed method lead to a good PSNR for image, by comparison with that which was obtained by using the differentiation operator which was filtered in two directional x and y.

Using different threshold values (TH) in our presented method, one can notice that many edges are preserved in fig.3c better than in fig.3a and b. From these results, in fact, the (TIE) rule will be very efficient because one can detect an edge pixel which has high detail by depending on the threshold values. This is because all pixels which have low details can be eliminated

TABLE 1- The Mses And Psnrs Obtain By Applying Only The Differentiation Operator And Our Proposed Method On "EARTH" Images, For Different Threshold Values.

Threshold values(TH)	MSE	PSNR(dB)
1	**13.067**	**25.807**
2	**8.099**	**29.961**
3	**7.321**	**30.835**
4	**7.175**	**31.014**
5	**7.155**	**31.038**

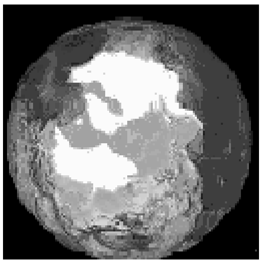


Figure 1- Original "EARTH" Image

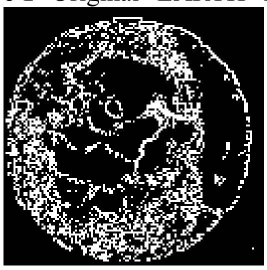
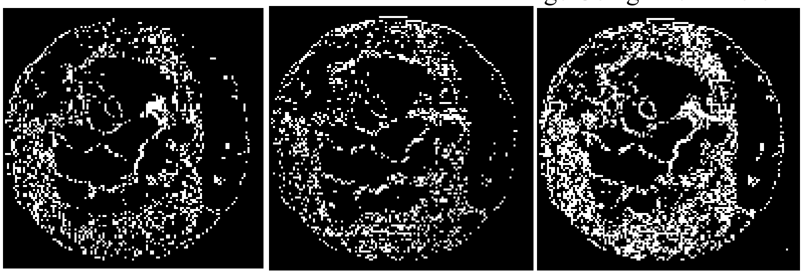


Figure 2- Shows The Edge Detected For "EARTH" Image Using The Differentiation Operator.



a. TH=1 **b. TH=3** **c. TH=5**

Figure 3- Shows The Edge Detected For "EARTH" Image Using The New Proposed Method For different Threshold Values.

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