Edge Detection Using Circular Sliding Window

A.A. D. Al-Zuky and H. J. M. Al-Taa'y

Department of Physics, College of Science, University of Al-Mustansiriya

Abstract

In this paper, we devoted to use circular shape sliding block, in image edge determination. The circular blocks have symmetrical properties in all directions for the mask points around the central mask point. Therefore, the introduced method is efficient to be use in detecting image edges, in all directions curved edges, and lines.

The results exhibit a very good performance in detecting image edges, comparing with other edge detectors results.

Key-words: (edge image, circle mask, filtering algorithms, edge detector, thinning edge, segmentation)

Introduction

The ascertaining of image edge is considered to be a heavy problem in image analysis and computer vision, where most of image information are conserve in image edges. Therefore, one can construct important features from image edges. In many image analysis, and applications boundaries of the image targets are of particular attention. For instance, the size and the shape of the outline of the target can be frequently used to recognize the target or detect the abnormalities. So, many edge detection methods have been suggested and developed previously (1-6). Most of these methods are based on the local image properties, and these methods are developed around the assumption that one wishes to identify step edges and they are optimally performed with respect to some criteria for this type of edge (1, 2, 5).

Theoretical Considerations

Usually, the recognition of image edges is performing by using local image properties. This is implemented by adopting small box (rectangular or square) sliding window (mask) to extract the local image feature for the central point in the sliding box. This feature is utilized to detect image edge at this point by using thresholding operation.

The simplest edge detection methods depend on the image gradient. If two targets with different gray mean values are adjacent to each other in the image (there will be a large change in gray levels means as we transit from one target to the next one). Hence, discontinuities in image gray values would represent the edges that separate the two targets. For one dimensional function I(x) the derivative given by dI/dx measures the rate of change in intensity with the distance (x). When dI/dx is greater than a given threshold, we can say that the function is discontinuous. This can be extended into two dimensional function I(x,y).(5)

$$\nabla I(x,y) = \frac{\partial I}{\partial x} + \frac{\partial I}{\partial y} \qquad \textit{gradient} \quad [1]$$

$$|\nabla I(x,y)| = \sqrt{\left(\frac{\partial I}{\partial x}\right)^2 + \left(\frac{\partial I}{\partial y}\right)^2} \qquad \textit{gradient magnitude} \quad [2]$$

If $|\nabla I(x,y)| \geq$ threshold then the function is discontinuous in point (x,y). The discontinuous point can be label as an edge point (5).

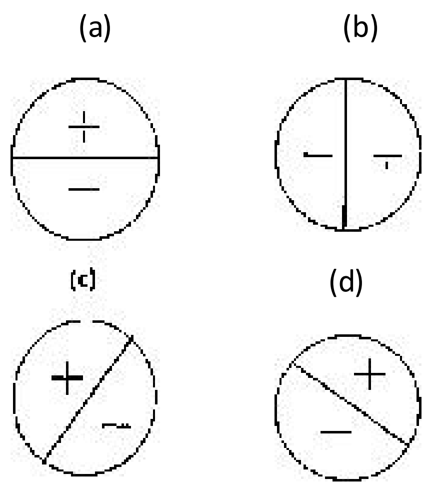
The most conventional edge detectors are (Robert gradient, Sobel, and Kirsch) see (1-3). There are other types of edge detection filters that determine the local inhomogeneous variability to precise the edges. These filters, are based on to determine the high order statistics and then to evaluate the edges. Example of these filters (edge detector is based on computing local variance, and that one is based on computing coefficient of variation (7).

All of the above mentioned filters used sliding box window to precise the edges. In this work we introduce a new type of circular sliding mask to keep symmetrical sorting of points around the central mask point. Therefore, it can efficiently evaluate image edges.

Optimal Edge Detector

The suggested adaptive edge detector algorithm, that is based on using circular sliding block. This is performs by applying the following procedure.

1) Determine radius of circular mask (R).
2) Put threshold (th.) (of the determined edges).
3) Generate four different circular masks, to evaluate the edges in four directions. The four circular windows are shown as below:



These masks are use to detect edges in four directions, a) horizontally, b) vertically, c) from top right to left down, and d) from top left to right down.

4) Applying the circular sliding mask to scan the image plane point by point. The edge detection operations are performing by using the following algorithm:

Edge Detection Algorithm Using Circular Mask

i. Put S=0 & SS=0
ii. For k = 1 to Tn do
iii. Put x = Cbk(k,l)
iv. Put y = Cbk(k,2)
v. Compute me weighting value (w) for the point(x,y). in the circular block, from:

$$w = \frac{1}{A + |x| + |y|}$$

(A: constant can be adjusted to get the best w in filtering operation).

vi. Put xp = x0 + x & yp = y0 + y.

(x0,y0): represent the central point in the mask and (xp,yp): the current point in the mask, presented by image plane coordinate.

vii. Put S = S + w*Sn(k)*Img(xp,yp)

[Sn(k): may be Snl(k) or Sn2(k) or Sn30<) or Sn4(k)]

Img Q: is the image matrix.

viii. Put SS=SS+w
ix. End For (ii)
x. $av = \left|\frac{S}{SS}\right|$
xi. If av. > th then Img (xp, yp) is an edge point.

End Algorithm

Result and Discussion

In this study, we have tested an adopted edge detecting algorithm by using two images (Laylal, and House) Fig. (1:a & e), these images of size (256 x 256) pixels with 256 gray levels.

The symmetrical shape of the circular mask is exploiting to determine the curved edges and lines. The results are show in Fig. (1: b, c, d, f, g, and h), where the results of the introduced filter are compared with that of Sobel and Prewit edge detectors. From the results, we can show that the suggested edge detector give low false edges and low isolated points comparing with the other detectors. In addition, we can note that it highly response to faint edges. Therefore, we can conclude that the introduced edge detector algorithm, can be considered as robust algorithm in detecting faint edges, and removing isolated points. This is deducing from the symmetry of the filter points around the central filtered point.

The algorithm of generation these masks established as follow:

Circular Mask Generation Algorithm

i. Determine array for circular mask (block). **Cbk (1000,2)** where (1000,2) represent the dimensions of the circular block that present by matrix **Cbk ( )**. the 1000 denote the maximum number of pixels in the block, and 2 is the number of axis in the plane (x and y).hence (x,y) is central point in the circular block.

ii. Determine four sign arrays,one for each edge direction these are:
Sn1 (1000). will be used to detect horizontal edges.
Sn2 (1000), will be used to detect vertical edges.
Sn3 (1000), will be used to detect top right to left down edges.
Sn4 (1000), will be used to detect top left to right down edges.

iii. Put L= 1, initial value of for number of points in the circular block **Cbk ().**

iv. Put Cbk (L, 1)=0 & Cbk (L,2)=0.

v. Put Sn1 (L)=0, Sn2 (L)=0, Sn3 (L)=0,& Sn4 (L)=0.

vi. Put Pi=0.0001 (precision value)

vii. For R1=1 to R do (R: is the Radius of a circular block).

viii. *Compute* $d\theta = 45/R1$

ix. *Compute* $N_t = 360/d\theta$

Nt: number of partitions of circular blocks at radius R1)

x. N1= Nt -1

xi. For T=0 to N1 do

xii. Compute $\theta = T * d\theta$ (angle of partition T).

xiii. Compute $S = \mathrm{Sin}(\theta)$ and $C = \mathrm{Cos}(\theta)$.

xiv. If $|C|$ < pr then put x=0 Else x=Round_Integer(R1*C).

xv. If $|S|$ < pr then put y=0 Else y=Round_Integer(R1*S).

xvi. Compute L=L+1

xvii. Put Cbk(L,1)=x, & Cbk(L,2)=y

xviii. If $C \geq 0$ then Sn1 (L)=1 Else Sn1(L) = -1

xix. If $S \geq 0$ then Sn2 (L) = 1 Else Sn2(L) = -1

xx. If (θ>45) and(θ < 225) then Sn3(L) = 1 Else Sn3(L) = -1

xxi. If(θ >135) and(θ < 315) then Sn4(L) = 1 Else Sn-l(L) = -1

xxii. End for (xi).

xxiii. End for (vii).

xxiv. Put $T_n = L$ (total number of points in the circular mask)

End Algorithm

References

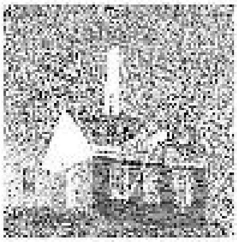
1. Pratt W.K., (1978),"Digital Image Processing", Wily; New York.
2. Gonzalez R.C. and Wintz P., (1987) "Digital Image Processing", Addison Wesley.
3. John A. Richards and Xinping Jia, (1999) "Remote Sensing Digital Image Analysis", Springer.

4. Sangwine S.J. and Home R.E.N., (1998) "The color image processing Handbook", First addition, Chapman and Hall London.

5. Petrou M., (1994)"The differentiating filter approach to edge detection", Advances in Electronics and Electron physics, V(88), PP. (297-345).

6. Thomas H. Short, (1993)"An Algorithm for the detection and measurement of Rail surface defects ", J. of the American statistical association, V(88), n(422), PP. (436-440).

7. Touzi R., Lopes A. and Bousquet P., (1988) "A Statistical and geometrical edge detector for SAR images", IEEE Trans. GE-26, n. (6), PP. (764-773).



House
(a)

Sobel
(b)

Circle
(c)

Prewitt
(d)

Lalylal
(e)

Sobel
(f)

Circle
(g)

Prewitt
(h)

كشف الحافات باستخدام النافذة الدائرية المنزلقة

علي عبد داود الزكي، حيدر جواد محمد الطائي
قسم الفيزياء ، كلية العلوم ، الجامعة المستنصرية

الخلاصة

في هذا البحث توجهنا الى استخدام الشكل الدائري للنافذة المنزلقة لغرض تحديد الحافات في الصور. حيث إن النافذة الدائرية لها خواص تناظرية في جميع الاتجاهات لكل النقاط حول نقطة مركز النافذة، لذا فان عملية كشف الحافات باستخام هذه النافذه سوف تكون كفؤة ولجميع الاتجاهات الموجودة فيها الحافات ولاسيما الحافات والخطوط المقوسة.

النتائج أظهرت إنجاز جيد جدا في كشف الحافات للصور باستخدام هذه الطريقة مقارنة مع الطرائق الأخرى.