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Image Segmentation Using Edge Detection Technique

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ABSTRACT

Interpretation of picture substance is one of the targets in PC vision explicitly in image processing. In this era, it has received much awareness of researches. In image interpretation the partition of image into object and background is a severe step. Segmentation isolates an image into its segment areas or articles. Image Segmentation needs to segment the item from the foundation to peruse the picture appropriately and recognize the substance of the picture cautiously. In this context, edge detection is a fundamental tool for image segmentation. In this paper an endeavor is made to examine the performance of most ordinarily utilized edge detection methods for image segmentation and furthermore examination of these procedures of these strategies can be completed by utilizing MATLAB Software.

Keywords: *Image processing, MATLAB, edge detection, image segmentation,*

INTRODUCTION

Edge detection is a crucial apparatus utilized in most image processing applications to acquire data from the casings as an antecedent advance to highlight extraction and object segmentation. This interaction recognizes frameworks of an objects and limits among objects and the background in the image. An edge-detection filter can also be used to improve the appearance of blurred image. Soft computing techniques have found wide applications. Perhaps the main application is edge detection for image segmentation. The way toward dividing a digital image into numerous areas or sets of pixels is called image segmentation. Edge is a limit between two homogeneous districts. Edge detection alludes to the way toward recognizing and finding sharp discontinuities in an image. The Canny algorithm uses an optimal edge detector based on a set of criteria which include finding the most edges by minimizing the error rate, marking edges as closely as possible to the actual edges to maximize localization, and marking edges only once when a single edge exists for minimal response. edges as much as possible. The Roberts Cross administrator plays out a straightforward, quick to compute, 2-D spatial gradient estimation on an image. It thus highlights regions of high spatial frequency which often correspond to edges. The prewitt edge detector is a suitable method to assess the magnitude and orientation of an edge. The planned fuzzy standards are an attractive solution for improve the nature of edges however much as could reasonably be expected.[3,9,10]

IMAGE SEGMENTATION

The first phase in image analysis is segment the image. Segmentation partitions an image into its constituent parts or objects. The level to which this development is conveyed relies upon the issue being seen. At some point need to segment the object from the background to peruse the image accurately and recognize the substance of the image therefore there are two strategies of segmentation, discontinuity detection technique and

Similarity detection procedure. In the first technique, one approach is to partition an image based on abrupt changes in grey-level image. The second method depends on the threshold and locale developing. This paper examines the primary procedures utilizing Edge Detection technique.[11]

EDGE DETECTION

The edge representation of an image significantly reduces the quantity of data to be processed, yet it retains essential information regarding the shapes of objects in the scene. This clarification of a picture is not difficult to incorporate into a lot of object recognition algorithms utilized in computer vision alongside other image preparing applications.[1] The major property of the edge detection technique is its ability to extract the exact edge line with good orientation as well as more literature about edge detection has been available in the past three decades. On the other hand, there is not yet any common performance directory to judge the performance of the edge detection techniques. The performance of an edge detection procedures is constantly judged actually and independently ward to its application. Edge detection is more normal for identifying discontinuities in gray level than recognizing isolated points and slender lines on the grounds that isolated points and thin lines so not happen every now and again in most functional images.[2,4,6]

The edge is the boundary between two regions with relatively distinct gray level properties. It is likely here that the transition between two areas can be belongings. It is assumed here that the transition between two regions can be determined on the basis of gray level discontinuities alone. Edge detection includes a variety of mathematical methods that aim at identifying points in a digital image at which the image brightness changes sharply or, more formally, has discontinuities. The points at which image brightness sharply are characteristically ordered into a set of curved line sections called as edges.[7,8]

Edges

Edges portray boundaries and are consequently an issue of major significance in image processing. Edges in images are regions with strong intensity contrasts – a leap in intensity starting with one pixel then onto the next. Edge identifying an image fundamentally decreases the amount of data and channels out useless information, while saving the significant primary properties in an image. Edges are significant nearby changes of intensity in an image. Edges regularly happen on the boundary between two distinct regions in an image.

Intensity Changes are Due to

- Several physical actions cause intensity changes.
- Non-geometric events
- specularity (direct reflection of light, such as a mirror)
- shadows (from different objects or from the similar object)
- inter-reflections
- Geometric events
- object boundary (discontinuity in depth and/or surface colour and texture)
- surface boundary (discontinuity in surface orientation and/or surface colour and texture

Properties of Edges

The edges extracted from a 2-D image of 3-D scene can be classified as either view point dependent or viewpoint independent. A viewpoint independent edge typically reflects inherent properties of the 3-D objects, such as surface makings and surface shapes. A viewpoint dependent edge might alteration as the viewpoint changes, and characteristically reflects the geometry of the act, such as objects together with one another.

A typically edge might for instance be the border between the block of red colour and a block of yellow.

Types of Edges

Step edge

The image intensity suddenly changes from one value to one side of the discontinuity to an alternate value on each side.

Ramp edge

A step edge where the intensity change isn't prompt however happening over a finite distance.

Ridge edge

The image intensity unexpectedly changes value but then re-visitations of the beginning value within some brief distance (generated ordinarily by lines).

Roof edge

A ridge edge where the intensity change isn't immediate however happen over a finite distance (produced ordinarily by the intersection of surfaces).

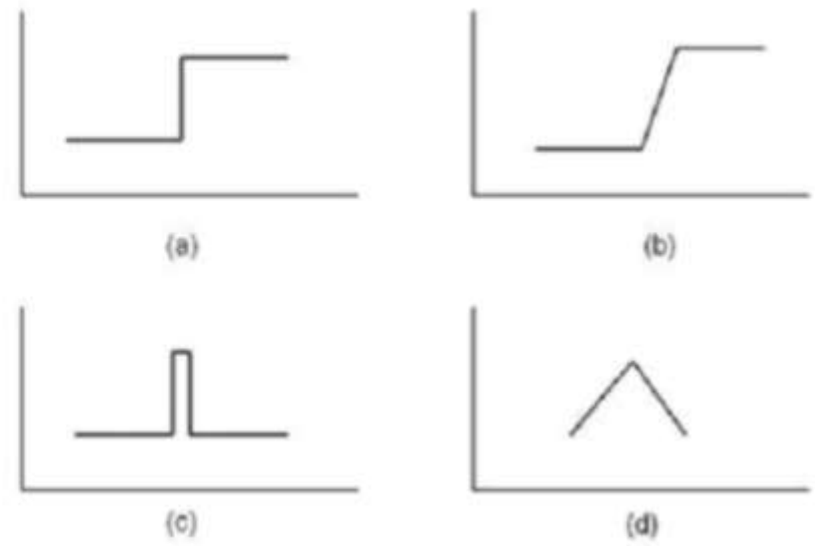

Fig. 1: *Types of Edges a) Step Edge, b) Ramp Edge c) Line Edge d) Roof Edge.*

Steps in Edge Detection

1. **Smoothing:** suppress however much noise as could be expected, without destroying the true edges.
2. **Enhancement:** apply a filter to improve the quality of the edges in the image (sharpening).
3. **Detection:** determine which edge pixels ought to be disposed as noise and which ought to be held (usually, thresholding gives the criterion used for recognition).
4. **Localization:** decide the specific area of an edge (sub-pixel resolution may be needed for certain applications, that is, estimate the location of an edge to better compared to the spacing between pixels). Edge thinning and linking are generally needed in this step.

Edge Descriptors

Edge normal: unit vector in the direction of most extreme intensity change.

Edge direction: unit vector to perpendicular to the edge normal.

Edge position or centre: the image position at which the edge is found.

Edge strength: identified to the local image contrast along the normal.

METHODS IN EDGE DETECTION

Robert Edge Detection

The Roberts edge detection is presented by Lawrence Roberts (1965). Robert's operator is a sort of the easiest operator utilizes partial difference operator to search for edge. Its effect is good for image with steep low noise. But the border line of the extracted image is quite thick, so the edge location is not very accurate.

The mask for Robert operator is given by the equation

Gx=(Z9-Z5)
Gy=(Z8-Z6)

Here Gx and Gy are the gradient component of x and y component respectively. The ideal 3×3 mask is as follows

Table 1: *Ideal 3×3 Convolution Mask.*

Z1	Z2	Z3
Z4	Z5	Z6
Z7	Z8	Z9

Table 2: *Masks used by Robert Operator.*

0	0	0
0	-1	0
0	0	1

0	0	0
0	0	-1
0	1	0

Fig. 2: *Robert Detection.*

Sobel Edge Detection

The Sobel edge detection strategy is presented Sobel in 1970 (Rafael C. Gonzalez (2004)). The Sobel method of edge detection for image segmentation discovers edges utilizing the Sobel approximation to the subsidiary. It precedes the edges at those focuses where the gradient is most noteworthy. The Sobel method performs a 2-D spatial gradient amount on an image and so features regions of high spatial frequency that compare to edges. Overall, it is utilized to discover absolute gradient magnitude at each point in n input grayscale image. In conjecture at least the operator comprises of a pair of 3×3 complexity kernels as given away in under table. One kernel is essentially the other turned by 90 degree. This is actual similar to the Roberts Cross operator.

Convolution mask of size 3x3 matrix is obtained by following equation
Gx=(Z3+2 Z6+Z9)-(Z1+2 Z4+Z7)
Gy=(Z1+2 Z2+Z3)-(Z7+2 Z8+Z9)`

Table 3: *Mask used by Sobel Operator.*

-1	0	1
-2	0	2
-1	0	1

Fig. 3: *Sobel Detection.*

Prewitt Edge Detection

The Prewitt edge recognition is proposed by Prewitt in 1970 (Rafael C. Gonzalez). To estimate the magnitude and orientation of an edge Prewitt is a right way. Despite the fact that distinctive gradient edge detection needs a very tedious computation to appraise the direction from the magnitudes in the x and y-directions, the compass edge detection gets the course straightforwardly from the piece with the most noteworthy reaction. It is restricted to 8 possible directions; anyway, information shows that most direct direction evaluations are not much more perfect. This gradient based edge identifier is assessed in the 3×3 neighbourhood for eight directions. All the eight convolution masks are determined. One complication mask is then chosen, specifically with the reason for the biggest module. Prewitt detection is marginally easier to carry out computationally than the Sobel detection, however it will in general create to some degree noisier outcomes. The convolution mask of 3×3 matrix is given by

Table 4: *Mask by Prewitt Operator.*

-1	-1	-1
0	0	0
1	1	1

Fig. 4: *Canny Detection.*

Krisch Edge Detection

Kirsch edge detection is introduced by Kirsch (1971). The masks of this Kirsch technique are well-defined by in view of a single mask and rotating it to eight foremost compass directions: North, Northwest, West, Southwest, South, Southeast, East and Northeast. The edge magnitude is well-defined as the maximum value originate by convolution of each mask with the image. The direction is well-defined by mask that creates the maximum magnitude. Example: mask k0 corresponds to vertical edge, while mask k5 corresponds to a diagonal edge. Notice that the last four masks are actually the same as the first four, but flipped as the central axis.

Fig. 5: *Kirch Detection.*

Robinson Edge Detection

Table 6: *Masks of Robinson Operator.*

-1		0	1
-2		0	2
-1		0	1

0	1	2
-1	0	1
-2	-1	0

The Robinson method (Robinson 1977) is similar to Kirsch masks but is easier to implement because they rely only on coefficients of 0, 1 and 2. The masks are proportioned about their directional axis, the axis with the zeros. One need only to compute the result on four masks and the result from other four can be obtained by negating the result from the first four. The masks are as follows:

Marr-Hildreth Edge Detection

The Marr-Hildreth (1980) technique is a method of detecting edges in digital images that is continuous curves wherever there are well-built and fast variations in image brightness.[5] It is a easy and it operates by convolving the image with the LoG function, or, as a quick approximation by DoGs. Subsequently the zero-crossings are discovered in the filtered result to find the edges. The LoG method is sometimes as well referred to as the Mexican hat wavelet due to its image shape while turned up-side-down. Algorithm for the Marr-Hildreth edge detector is:

- Smooth the image using a Gaussian
- Apply a two-dimensional Laplacian to the smoothed image (often the first two steps are combined into a single operation)
- Loop through the result and look for sign changes. If there is a sign change plus the slope across the sign change is greater than some threshold, mark as an edge.
- To get better results it is possible to run the result of the Laplacian through a hysteresis alike to Canny's edge detection although this is not how the edge detector was firstly implemented.

Fig. 6: *Marr Hildreth Detection.*

Canny Edge Detection

In industry, the canny edge detection technique is one of the standard edge detection techniques. It was first created by John Canny for his Master's thesis at MIT in 1983, and still outperforms many of the newer algorithms that have been developed. To find edges by separating noise from the image before find edges of image the Canny is a very important method. Canny method is a better method without disturbing the features of the edges in the image afterwards it applying the tendency to find the edges and the serious value for threshold. The algorithmic steps are as follows:

- Convolve image f (r, c) with a Gaussian function to get smooth image
  - **f^ (r, c). f^ (r, c)=f (r,c)*G(r,c,6)**
- Apply first contrast gradient operator to compute edge strength at that point edge magnitude and direction are get as in the past.
- Apply non-maximal or critical suppression to the gradient magnitude.
- Apply threshold to the non-maximal suppression image.

In contrast to Roberts and Sobel, the canny operation isn't entirely susceptible to noise. On the off chance that the Canny detector functioned admirably it would be prevalent.

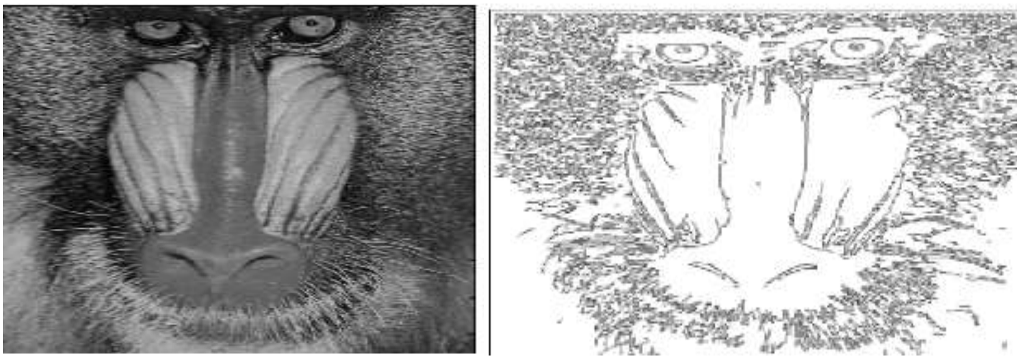

Fig. 7: *Canny Detection.*

PROGRAM

```
%vertical images
I=double((imread('image1.jpg')));
%read image
In=I;
%copy image
mask=[1, 0, -1;1, 0, -1;1, 0, -1];
%Rotate image by 180 degree first flip up to down then left to right
mask=flipud(mask);
mask=fliplr(mask);
for i=2:size(I, 1)-1
for j=2:size(I, 2)-1
%multiplying mask value with the corresponding image pixel value
neighbour_matrix=mask.*In(i-1:i+1, j-1:j+1);
avg_value=sum(neighbour_matrix(:));
I(i, j)=avg_value;
end
end
figure,
imshow(uint8(I));
%horizontal images
I=double((imread('ima ge1.jpg')));
In=I;
mask=[1, 1, 1;0, 0, 0;-1, -1, -1];
 mask=flipud(mask);
mask=fliplr(mask);
for i=2:size(I, 1)-1
for j=2:size(I, 2)-1
neighbour_matrix=mask.*In(i-1:i+1, j-1:j+1);
avg_value=sum(neighbour_matrix(:));
I(i, j)=avg_value;
end
```

```
end
figure,
imshow(uint8(I));
%diagnol edges
I=double((imread('image1.jpg')));
In=I;
mask=[0, -1, -1;1, 0, -1;1, 1, 0];
mask=flipud(mask);
mask=fliplr(mask);
for i=2:size(I, 1)-1
for j=2:size(I, 2)-1
neighbour_matrix=mask.*In(i-1:i+1, j-1:j+1);
avg_value=sum(neighbour_matrix(:));
I(i, j)=avg_value;
end
end
figure,
imshow(uint8(I));
%sec diagnol images
I=double((imread('image1.jpg')));
In=I;
mask=[1, 1, 1;0, 0, 0;-1, -1, -1];
mask=flipud(mask);
mask=fliplr(mask);
for i=2:size(I, 1)-1
for j=2:size(I, 2)-1
neighbour_matrix=mask.*In(i-1:i+1, j-1:j+1);
avg_value=sum(neighbour_matrix(:));
I(i, j)=avg_value;
end
end
figure,
imshow(uint8(I));
%edge detection
I=double(imread('image1.jpg'));
In=I; mask1=[1, 0, -1;1, 0, -1;1, 0, -1];
mask2=[1, 1, 1;0, 0, 0;-1, -1, -1];
mask3=[0, -1, -1;1, 0, -1;1, 1, 0];
mask4=[1, 1, 0;1, 0, -1;0, -1, -1];
mask1=flipud(mask1);
mask1=fliplr(mask1);
mask2=flipud(mask2);
mask2=fliplr(mask2);
mask3=flipud(mask3);
mask3=fliplr(mask3);
mask4=flipud(mask4);
mask4=fliplr(mask4);
for i=2:size(I, 1)-1
for j=2:size(I, 2)-1
neighbour_matrix1=mask1.*In(i-1:i+1, j-1:j+1);
avg_value1=sum(neighbour_matrix1(:));
neighbour_matrix2=mask2.*In(i-1:i+1, j-1:j+1);
avg_value2=sum(neighbour_matrix2(:));
neighbour_matrix3=mask3.*In(i-1:i+1, j-1:j+1);
avg_value3=sum(neighbour_matrix3(:));
neighbour_matrix4=mask4.*In(i-1:i+1, j-1:j+1);
avg_value4=sum(neighbour_matrix4(:));
%using max function for detection of final edges
I(i, j)=max([avg_value1, avg_value2, avg_value3, avg_value4]);
end
end
figure,
imshow(uint8(I));
```

RESULT

Fig. 7: *Input Image.*

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Fig. 8: *Output Image.*

CONCLUSION

In the control of computer vision, image processing is a rapidly moving field. Its development has been fuelled by mechanical advances in digital imaging, computer processors and mass stockpiling gadgets. In this paper an endeavour is made to audit the edge detection strategies which depend on intermittence intensity levels. The relative performance of various edge detection techniques is carried out with an image by using MATLAB software. It is seen from the outcomes Marr-Hildreth, LoG and Canny edge detectors produce practically same edge map. Canny result is superior one when compared to all for a selected image since different edge detections work better under different conditions. Despite the fact that, so many edge detection procedures are accessible in the literature, since it is a challenging task to the examination networks to identify the exact image without noise from the original image.

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Biographical note

Prof. K. Thamizhmaran received his B.E, M.E, degree from Faculty of Engineering Annamalai University, Tamilnadu in the year 2008 and 2012 respectively. Post Graduate diploma in yoga, M.sc in yoga degree from Faculty of Education, Annamalai University, Tamilnadu in the year 2018 and 2019 respectively and Post Graduate in Guidance & Counselling degree from Faculty of Psychology, Annamalai University, and Tamilnadu in the year 2020 respectively. He is currently pursing Doctor of Philosophy in Mobile Ad-hoc Network (Network Security) from 2013 to till date. He is currently working as an Assistant Professor (senior scale) in the Department of Electronics & Communication Engg, Government College of Engineering, Bodinayakkanur, Theni, and Tamilnadu, India. Teaching Experience 12 years 2 months and Industrial Experience 3 months (team leader in honey drops-Chennai). His research interest includes Wireless Communication, Ad-Hoc Networks, Networks security, Mobile Communications, and Digital Signal Processing. He has published more than 150 technical papers at various National / International reputed Conferences and in journals including IEEE Explore, Interscience, and Serial Publication also Scopus with UGC approved publications. He is a member life 22 professional bodies. He is editor, advisory board member and reviewer of 22 international journals.