Integrated Intelligent Research (IIR) International Journal of Data Mining Techniques and Applications
Volume: 04 Issue: 01 June 2015 Page No.10-14
ISSN: 2278-2419

Segmentation of Tiles Image Using Various Edge Detection Techniques

C.Umamaheswari [1], R.Bhavani[2],K.Thirunadana Sikamani [3]
[1]Research Scholar, [2]Professor, [3]Professor,
[1, 2] Dept. of computer science, Annamalai University, Chidambaram
[3]Dept. of Computer Science, Anna University, Chennai
Email:[1]umavijay99@gmail.com[2]Shahana_1992@yahoo.co.in[3]ktsikamani@yahoo.com

Abstract—Segmentation is a major step in image processing. Segmentation subdivides an image into its constituent regions or objects. Image segmentation segments the object from the background to understand the quality of the image properly and to identify the content of the image carefully. Segmentation can be done as Edge-based segmentation or Region based segmentation. Edge based segmentation considerably reduces the amount of data and filters out useless information, while preserving the important structural properties in an image. Since it is very much needed to have a good understanding of Edge based segmentation. In this paper an attempt is made to study the performance of most commonly used edge detection techniques for edge based image segmentation. The comparisons of these techniques are carried out with a tiles image as an experiment by using MATLAB software.

Keywords— Image Segmentation, Edge detection, Gradient, Laplacian

I. INTRODUCTION

The image segmentation is used to reduce the information for easy analysis.The component parts or objects of an image is separated by image segmentation[1]. Usually, the process of image segmentation is done using edge detection techniques, which detects the edges depending upon the level of intensity difference of pixels and the level of discontinuity [2-3]. The choice of image segmentation technique depends on the quality of the edge detecting operators. For the last few decades there has been a lot of research work is carried out in this field. The edge detection performance measure is how well edge detector markings match with the visual perception of object boundaries [4]. Points, lines, and edges are the three types of image features.The edge pixels are pixels at which the intensity of an image function changes abruptly, and the sets of connected edge pixels are called edges. Edge detectors are local image processing methods designed to detect edge pixels. The detection process is carried out by the examination of local intensity changes at each pixel element of an image. Traditional methods of edge detection involves that the image through an operator/filter, which is constructed to be perceptive to large gradients in the image, although returning values of zero in uniform regions [5-6]. A large number of edge detection techniques are available, with mainly each technique designed to be perceptive to certain types of edges. Variables related to the selection of an edge detection operator consist of edge orientation, edge structure and noise environment. Edge detection is a difficult task in noisy images, as both the edges and noise hold high-frequency content. Efforts to reduce the noise result in unclear and distorted edges. This results in less perfect localization of the detected edges; and results in problems of fake edge detection, edge localization, and missing true edges [7-9]. In this paper gradient based classical operators like Robert, Prewitt, Sobel, Laplacian based operator LoG and Canny operators were used for edge based segmentation.

II. EDGEMODELS

Edge models are classified according to their intensity profiles.

A. Step-edge model

A step edge involves a transition between two intensity levels occurring ideally over the distance of one pixel. Digital step-edges are used frequently as edge models in algorithm development. Canny edge detection algorithm was derived using a step-edge model.

B. Ramp-edge model

In practice, digital images have edges that are blurred and noise. In such situation, edges are more closely modelled has having an intensity ramp profile. The slope of the ramp is inversely proportional to the degree of blurring in the edge. Instead, an edge point is any point contained in the ramp, and edge segment would then be a set of such points that are connected.

C. Roof Model

Roof edges are models of lines through a region, with the base of a roof edge being determined by the thickness and sharpness of the line. In the limit, when its base is one pixel wide a roof edge is really nothing more than one- pixel-thick line running through a region in an image.

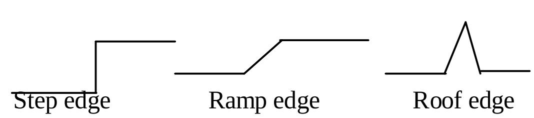


Figure 1. Edge Models

III. PROPOSED METHOD

International Journal of Data Mining Techniques and Applications
Volume: 04 Issue: 01 June 2015 Page No.10-14
ISSN: 2278-2419

Due to the presence of noise, the problems of false edge detection, missing of true edges, producing thick or thin lines etc. are caused.In the proposed method the color image is converted into Gray scale image and it is taken as input to the most commonly used edge detection operators (robert, sobel, prewitt, LoG, and canny). Segmentation is performed after Binary and Dilated Gradient mask with threshold using edge detection operatorsand we did the visual comparison of images for the problem of in-accurate edge detection, omitting of true edges, generating thin or thick lines and problems due to noise etc. The comparison of these techniques is carried out with a defected tile image as an experiment. The software is developed using MATLAB R2009a.

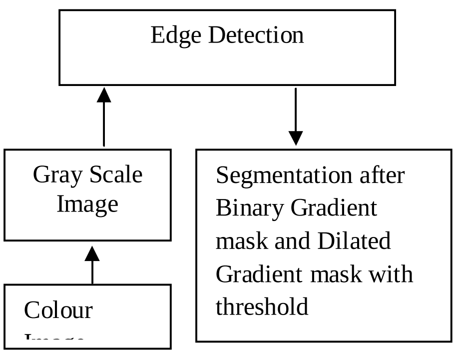


Figure 2. Proposed Method

IV. METHODOLOGIES

Edge detection is performed in many different ways. The majority of the methods are grouped into three categories:[11]
Gradient Based Edge Detection*:* In this type derivative of image is taken by edge detectors and edges are detected by looking for maximum and minimum in that derivative.Taking its gradient with respect to t of figure 1 is shown in figure2.

Laplacian Based Edge Detection*:* To find edges, the Laplacian method searches for zero crossings in the second derivative of the image. Furthermore, when the first derivative is at a maximum, the second derivative is zero. As a result, another alternative to finding the location of an edge is to locate the zeros in the second derivative. The Laplacian and the second derivative of the signal with respect to t of figure1 is shown in figure3.

Non-derivative Based Edge Detection*:*This category of edge detectors do not require image derivatives at all.

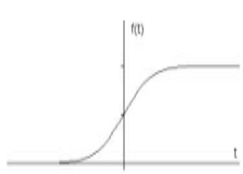


Figure3.(Example)

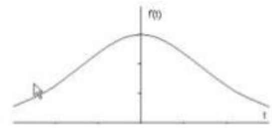


Figure4.Gradient

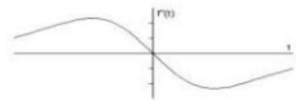


Figure5. Laplacian

V. THE FOUR STEPS OF EDGE DETECTION

- Smoothing: suppress as much noise as possible, without destroying the true edges.
- Enhancement: apply a filter to enhance the quality of the edges in the image (sharpening).
- Detection: determine which edge pixels should be discarded as noise and which should be retained (usually, thresholding provides the criterion used for detection).
- Localization: determine the exact location of an edge (sub-pixel resolution might be required for some applications, that is, estimate the location of an edge to better than the spacing between pixels). Edge thinning and linking are usually required in this step.

VI. PROPERTIES OF THE GRADIENT

- The magnitude of gradient provides information about the strength of the edge.[10]
- The direction of gradient is always perpendicular to the direction of the edge (the edge direction is rotated with respect to the gradient direction by -90 degrees).[10]

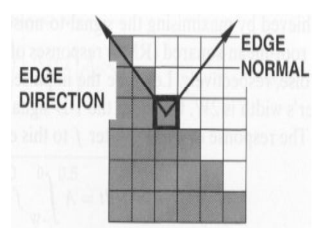


Figure 6. Edge is perpendicular to direction of gradient

Here edge detection method takes the assumption edges are the pixels with a highgradient. For finding edge strength and direction at location (x, y) of the image f is the gradient, denoted by ∇f, and defined as the vector

$$\nabla f = grad(f) = \begin{bmatrix} G_x \\ G_y \end{bmatrix} \quad (1)$$

The magnitude of vector ∇f denoted as M(x,y), where

$$M(x, y)=mag(\nabla f)=\sqrt{G_x^2+G_y^2} \quad (2)$$

The direction of the gradient vector is given by the angle

$$\alpha(x,y)=\tan^{-1}\left(\frac{G_y}{G_x}\right) \quad (3)$$

Where,

Volume: 04 Issue: 01 June 2015 Page No.10-14
ISSN: 2278-2419

$$Gx=f(x+1,y)-f(x,y) \quad (4)$$
$$Gy=f(x,y+1)-f(x,y) \quad (5)$$

These two equations are used to implement all values of f(x,y) with the masks:

TABLE 1- 1-D MASKTOIMPLEMENTEQS. 4 AND 5.

-1
1

-1	1

To find diagonal edge direction 2-D mask is used. Consider 3×3 region in the following figure for 2-D mask,

TABLE 2. 2-D Mask

z1	z2	z3
z4	z5	z6
z7	z8	z9

VII. EDGE DETECTION TECHNIQUES

A. Robertscross-gradientoperator

Robert cross-gradient operators are one of the earliest attempts to use 2-D mask with squares of the difference between diagonally adjacent pixels through discrete differentiation and then calculate approximate gradient of the image. The input image is convolved with the default kernels of operator and gradient magnitude and directions are computed. It uses following 2 x2 two kernels.

TABLE 3 -.2-D MASKTOIMPLEMENTEQS.6AND 7.

-1	0		0	-1
0	1		1	0

GxGy

$$\text{Here, } Gx=(z9-z5) \quad (6)$$
$$Gy=(z8-z6) \quad (7)$$

The plus factor of this operator is its simplicity but having small kernel it is highly sensitive to noise and not much compatible with today's technology.

B. Prewittoperator :

The difference between the third and first rows of the 3×3 region approximates the derivative in the x-direction and the difference between the third and first columns approximate the derivate in the y-direction. This is more accurate than Roberts's operators. The equations

$$Gx=(z7+z8+z9)-(z1+z2+z3) \quad (8)$$
$$Gy=(z3+z6+z9)-(z1+z4+z7) \quad (9)$$

Can be implemented over entire image by filtering f with the two masks in

TABLE 4 .2-D MASKTOIMPLEMENTEQS.8AND9.

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

GxGy

These masks are called the Prewitt operators.

C. Sobeloperator

Sobel operator is a discrete differentiation operator used to compute an approximation of the gradient of image intensity function for edge detection. At each pixel of an image, sobel operator gives either the corresponding gradient vector or normal to the vector. It convolves the input image with kernel and computes the gradient magnitude and direction. It uses following 3x3 two kernels:

TABLE 5 .2-D MASKTOIMPLEMENTEQS.10AND 11.

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

GxGy

It uses a weight of 2 in the center coefficient. Using 2 in the center location provides image smoothing.

$$Gx=(z7+2z8+z9)-(z1+2z2+z3) \quad (10)$$
$$Gy=(z3+2z6+z9)-(z1+2z4+z7) \quad (11)$$

These masks are called the sobel operators.As compared to Robert operator have slow computation ability but as it has large kernel so it is less sensitive to noise as compared to Robert operator. As having larger mask, errors due to effects of noise are reduced by local averaging within the neighborhood of the mask.It is possible to modify 3×3 masks, so that they have strongest responses along the diagonal directions. The two additional Prewitt and Sobel masks needed for detecting edges in the diagonal directions are

TABLE 6 PREWITT MASKS FOR DETECTING DIAGONAL EDGES

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

TABLE 7 .SOBELMASKSFORDETECTINGDIAGONALEDGES

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

D. LoG(Laplacian of a Gaussian) operator[11]:

This operator belongs to Laplacian based edge detectors class. This operator highlights the regions of rapid intensity changes in an image. As the Laplacian of an image detects the noise along with the edges in an image, the image is smoothened first by convolving by a 2-D Gaussian kernel of standard deviation C

$$G(x,y)=e^{-(x^2+y^2)/2\sigma^2} \quad (12)$$

The expression for LOG is given as

$$\nabla^2 G(x,y)=\left(\frac{x^2+y^2-2\sigma^2}{\sigma^4}\right) e^{-(x^2+y^2)/2\sigma^2} \quad (13)$$

Volume: 04 Issue: 01 June 2015 Page No.10-14
ISSN: 2278-2419

LoG is then convolved with input image f(x,y) giving resultant edge map.

$$g(x,y) = f(x,y) * \nabla^2 G(x,y) \quad (14)$$

TABLE 8. 5*5 MASKUSEDFORLOGOPERATOR

0	0	1	0	0
0	1	2	1	0
1	2	-16	2	1
0	1	2	1	0
0	0	1	0	0

LoG

The kernels of any size can be approximated by using the above expression for LoG.

LoG operator can thus be obtained by the following steps:

1. Apply Log to the input image.
2. Detect the zero-crossings of the image.
3. Apply threshold to minimize the weak zero-crossings caused due to noise.

E. CannyEdgeDetector

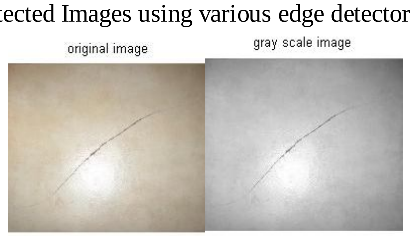
The Canny edge detector is regarded as one of the best edge detectors currently in use, Canny's edge detector ensures good noise immunity and at the same time detects true edge points with minimum error.Canny’s approach is based on three basic objectives [12]

1. Low error rate: Canny edge is as close as to the tree edge.
2. Edge points should be well localized: Distance between canny edge and the true edge is minimum.
3. Single edge point response: It will not find multiple edge points when single edge point exit[13].

VIII. EXPERIMENTAL RESULTS

This section presents the relative performance of various edge detection techniques such asRoberts’s edge detector, Sobel Edge Detector, Prewitt edge detector, LoG edge detector and Canny Edge Detector. A simulation study is done to compare the various methods for segmentation and to detect the edges accurately. The edge detection techniques were implemented using MATLAB R2009a, and tested with an experiment using tiles images.The objective is to produce a clean edge map by extracting the principal edge features of the image. The original image, the image obtained by using different edge detection techniques and the segmented image using various edge detection operators are given in the following figures.

(a).Edge detected Images using various edge detector operators



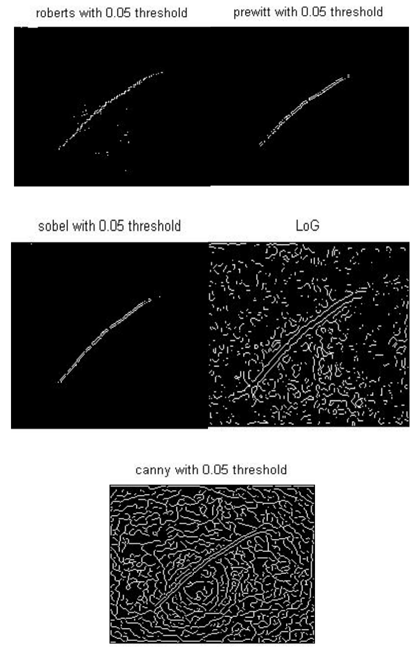


Figure 7

(b).Segmented images using various Edge Detection operators:

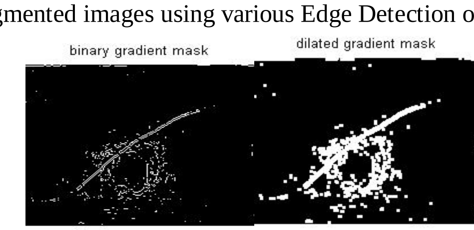
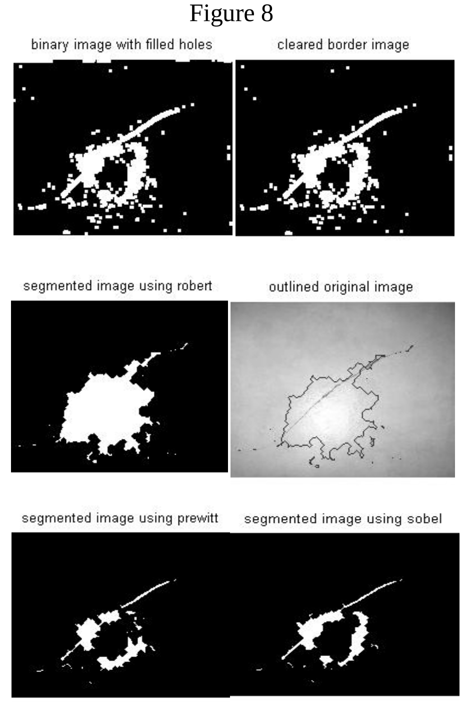


Figure 8



International Journal of Data Mining Techniques and Applications
Volume: 04 Issue: 01 June 2015 Page No.10-14
ISSN: 2278-2419

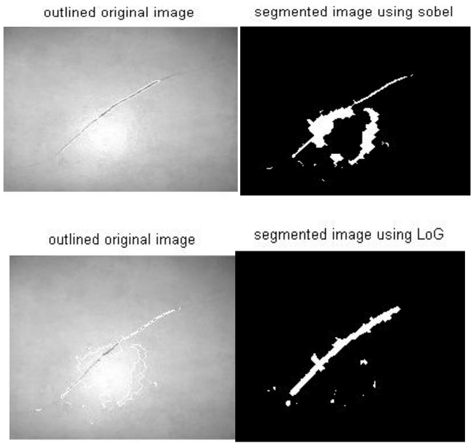


Figure 9

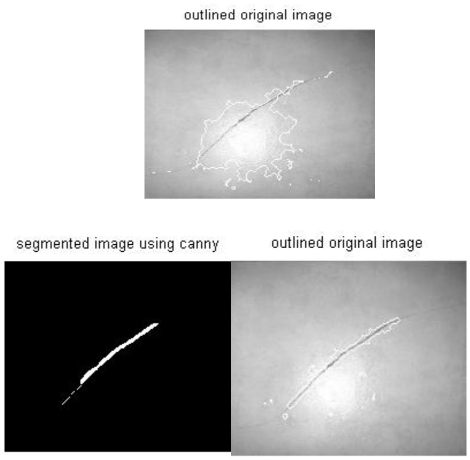


Figure 10

IX. CONCLUSION

By visual inspection it is clear that gradient based classical operators like Robert, Prewitt, and Sobel were used for edge detection did not give sharp edges and they were highly sensitive to noise image. Laplacian based LoG operators also suffers from two limitations, the probability of detecting false edges is high and at the curved edges, the localization error may be severe but Canny operator proposed by John F. Canny in 1986 is the ideal for segmentation of images that are corrupted with noise. Even though, the Canny's edge detection algorithm has a better performance. Canny's edge detection algorithm is more costly in comparing to Sobel, Prewitt and Robert's operator. Depending on the application technique it varies.

REFERENCES

[1] Amit Chaudhary,Tarun Gulati "Segmenting Digital Images using Edge Detection",International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 2, Issue 5, May 2013 Page 319
[2] S. Lakshmi & V.Sankaranarayanan (2010) "A Study of edge detection techniques for segmentation computing approaches", Computer Aided Soft Computing Techniques for Imaging and Biomedical Applications, 35-41.
[3] P. Thakare (2011) "A Study of Image Segmentation and Edge Detection Techniques", International Journal on Computer Science and Engineering, Vol 3, No.2, 899-904.
[4] Werner Frei and Chung-Ching Chen. Fast boundary detection: A generalization and a new algorithm. Computers, IEEETransactions on, 100(10):988–998, 1977.
[5] K. J. Pithadiya, C. K. Modi & J. D. Chauhan (2011), "Selecting the Most Favourable Edge Detection Technique for Liquid Level Inspection in Bottles" International Journal of Computer Information Systems and Industrial Management Applications (IJCISIM) ISSN: 2150-7988 Vol.3, pp.034-044, 2011.
[6] S. Jeong You & N. I. Choet (2011), "A New Image Denoising Method Based On The Wavelet Domain Nonlocal Means Filtering", International Conference on Acoustics, Speech and Signal Processing (ICASSP), pp. 1141-1144.
[7] Z. Zhang & G. Zhao (2011), "Butterworth filter and Sobel edge detection to image", International Conference on Multimedia Technology (ICMT), pp. 254-256.
[8] Deng, W. Ma & Y. Yin (2011), "An Edge Detection Approach of Image Fusion Based on Improved Sobel Operator" 4th International Congress on Image and Signal Processing, pp. 1189-1193.
[9] Zhang Jin-Yu, Chen Yan, Huang Xian-Xiang (2009), "Edge Detection of Images Based on Improved Sobel Operator and Genetic Algorithms", International Conference on Image Analysis and Signal Processing (ICASP),pp. 31-35.
[10] R. C. Gonzalez and R. E. Woods. Digital Image Processing, Second Edition, Prentice Hall, 2002. [5] J. A. Madhuri. Digital Image processing.
[11] Ayaz Akram, Asad Ismail, Comparison of Edge Detectors International Journal of Computer Science and Information Technology Research (IJCSITR) Vol. 1, Issue 1, pp: (16-24), Month: October-December 2013,
[12] Canny, J. F. (1986). A computation approach to edge detectors. IEEETransactions on Pattern Analysis and Machine Intelligence.
[13] T. Acharya and A. K. Ray. Image Processing Principles and Applications, John Wiley & Sons, Inc.,2005.