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A Resourceful Comparison of First Order Edge Detections Using Grayscale Intensities

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Abstract: *Images are replications of real world objects. Processing those copies to get betterment of an image is called as image processing. Image processing can also be said as processing an image to enhance the quality and clarity of it. Image can be represented in the area of digital processing, which can be told as another reproduction of an object. In this proposed research work various first order edge detections are applied on an original image and also on fuzzy edge detected image. Then several measures are evaluated. Sobel, Prewitt and Roberts operators detects only the gray part with high intensity. Canny operator alone detects the entire gray part in the image. This shows that different edge detection technique detects the edges in gray part depending on the intensity values and the obtained result shows that Canny is the best edge detector because it detects edges of images with high as well as low intensity values.*

Keyword: *Edge detection, Fuzzy Edge Segmentation, Gray-Scale Intensity.*

I.INTRODUCTION

A grayscale image is one which has only the intensity value ranging from 0 to 1. Zero represents black and 1 represents white. Edge detection is one of the feature detection. It is also a fundamental step in image pattern recognition, image analysis and computer vision techniques. There are many types of operators such as Sobel, Roberts, Prewitt and Canny for performing edge detection operation. Edge detection is a set of mathematical method which targets at identifying points in a digital image at which the image brightness changes formally or, more sharply, has discontinuities. The dots at which image changes sharply are classically organized into a set of bended line segments called edges. The pixels at which the intensity of an image function changes hurriedly are called as edge pixels. The main steps in edge detection are smoothing, thresholding, differentiation and localization.

The fuzzy relative pixel value algorithm method helps us to detect edges in an image in all cases due to subjection of pixel values to an algorithm involving host of fuzzy conditions for edges associated with an image. The purpose of this paper is to present a new comparison methodology for image edge detection.

II. METHODOLOGY

The system architecture of our proposed work is shown in the following Fig.1

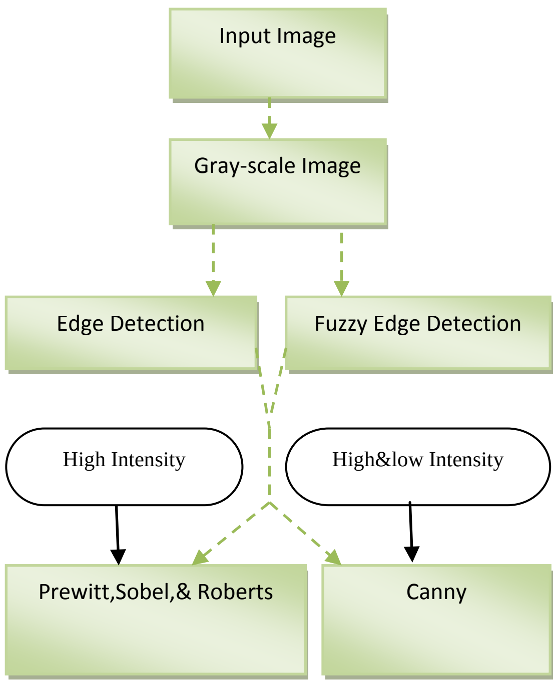

Fig.1 System Architecture

III. The Fuzzy Relative Pixel Value algorithm

The Algorithm starts with reading an MxN image. The primary set of nine pixels of a 3x3 window are selected with central pixel having values (2,2). After the initialization, the pixel values are subjected to the fuzzy circumstance for edge existence shown in Fig.2.(a-i). After the subjection of the pixel values to the fuzzy conditions the algorithm generates a transitional image[12]. It is checked whether all pixels have been checked or not, if not then foremost the horizontal coordinate pixels are checked. If all horizontal pixels have been checked then the vertical pixels are checked else the horizontal pixel is incremented to regain the next set of pixels of a window[13]. In this manner the window reallocates and checks all the pixels in one horizontal line then increments to ensure the next vertical location.

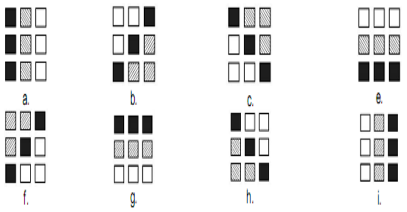

Fig 1(a-i). Fuzzy conditions have been displayed

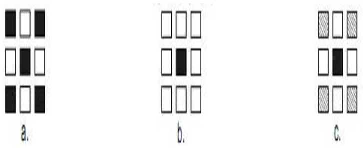

Fig 2. (a,b) Type of unwanted edge pixels (c) Fuzzy condition for removal of unwanted edge pixels.

Legend: Pixel Checked Edge pixel Unchecked Pixel

After edge prominence image is subjected to another set of condition with the help of which the unnecessary parts of the output image of type shown in Fig.2.(a-b) are removed to generate an image which has only the edges associated with the input image. Let us now think about the case of the fuzzy order displayed in Fig.1. (g). for an input image A and an output image B of size MxN pixels respectively we have the following set of conditions that are implemented to spot the edges pixel values.

IV. EDGE DETECTION

The first order derivative of a function represents the difference between subsequent values and measures the rate of change of value.

$$\frac{\partial f}{\partial x} = f(x+1) - f(x)$$

The first derivative of an image can be computed using gradient:

$$grad(f) = \begin{pmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial y} \end{pmatrix}$$

A gradient is a vector which has a magnitude and direction

$$magnitude(grad(f)) = \sqrt{\frac{\partial f}{\partial x}^2 + \frac{\partial f}{\partial y}^2}$$

$$direction(grad(f)) = tan^{-1}(\frac{\partial f}{\partial y} / \frac{\partial f}{\partial x})$$

Magnitude indicates edge strength and direction indicates edge direction. Consider the arrangement of pixel about the pixel(i,j):

3 x 3 neighborhood :

$$\begin{matrix} a_0 & a_1 & a_2 \\ a_7 & [i,j] & a_3 \\ a_6 & a_5 & a_4 \end{matrix}$$

The partial derivatives $\frac{\partial f}{\partial x}$ and $\frac{\partial f}{\partial y}$ can be computed as

$$M_x = (a_2 + ca_3 + a_4) - (a_0 + ca_7 + a_6)$$

$$M_y = (a_6 + ca_5 + a_4) - (a_0 + ca_1 + a_2)$$

The constant *c* implies the emphasis given to pixels closer to the center of the mask.

A Prewitt Operator

Setting *c* = 1, we get the Prewitt operator:

$$M_x = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix} \quad M_y = \begin{bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{bmatrix}$$

M_x and M_y are approximations at(I, j)

B.Sobel Operator

Setting c=2 we get Sobel operator

$$M_x = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \quad M_y = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$$

M_x and M_y are approximations at (i,j)

To filter an image it is filtered using both operators M_X and M_Y the results of which are added together

C Roberts operator

Robert kernels are derivative with respect to diagonal elements. They are based on cross diagonal differences. They are also called cross gradient operators.

$$\frac{\partial f}{\partial x}(x,y) = f(x,y) - f(x+1,y+1)$$

$$\frac{\partial f}{\partial x}(x,y) = f(x+1,y) - f(x,y+1)$$

Where $\frac{\partial f}{\partial x}$ and $\frac{\partial f}{\partial y}$ can be implemented by using the following mask

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

D. Canny Edge Detector

Canny computes the Gradient magnitude using approximations of partial derivative and computes thin edges by applying non-maxima suppression to the gradient magnitude. It Detect edges by double thresholding

1. Compute f_x and f_y

   $$f_x = \frac{\partial}{\partial x}(f * G) = f * \frac{\partial}{\partial x}G = f * G_x$$

   $$f_y = \frac{\partial}{\partial y}(f * G) = f * \frac{\partial}{\partial y}G = f * G_y$$

   G(x,y) is the Gaussian function

   $G_x(x,y)$ is the derivate of G(x,y) with respect to x: $G_x(x,y) = \frac{-x}{\sigma^2}G(x,y)$

   $G_y(x,y)$ is the derivate of G(x,y) with respect to y: $G_y(x,y) = \frac{-y}{\sigma^2}G(x,y)$

2. Compute the gradient magnitude(and direction)

   $magn(x,y) = |\hat{f}_x| + |\hat{f}_y| \; dir(x,y) = tan^{-}$

3. Apply non-maxima suppression.

4. Apply hysteresis thresholding / edge linking.

1st order derivatives generally produce thicker edges. It has stronger response to gray level and sensitive to abrupt change.

V. Evaluation Measures

The statistical measurement, such as Root Mean Square Error (RMSE), Signal-to-Noise Ratio (SNR), Peak Signal-to-Noise Ratio (PSNR) and Average Signal-to-Noise Ratio(ASNR) are used to evaluate the enhancement performance.

SNR: Signal-to-noise ratio is defined as the ratio of the power of a signal (meaningful information) and the power of background noise (unwanted signal).

RMSE: The root-mean-square deviation (RMSD) or root-mean-square error (RMSE) is a commonly used measure of the differences between values (sample and population values) predicted by a model or an estimator and the values actually observed.

PSNR: It is the evaluation standard of the reconstructed image quality, and is important feature.

ASNR: Signal averaging is a signal processing method applied in the time domain, intended to increase the strength of a signal relative to noise that is obscuring it. By averaging a set of replicate measurements, the signal-to-noise ratio, S/N, will be increased, ideally in percentage to the square root of the number of measurements.

Statistical Measurement	Formula
RMSE	$\sqrt{\frac{\sum(f(i,j)-F(i,j))^2}{MN}}$
SNR	$10\log_{10}\frac{\sigma^2}{\sigma_e^2}$
PSNR	$20\log_{10}\frac{255}{RMSE}$

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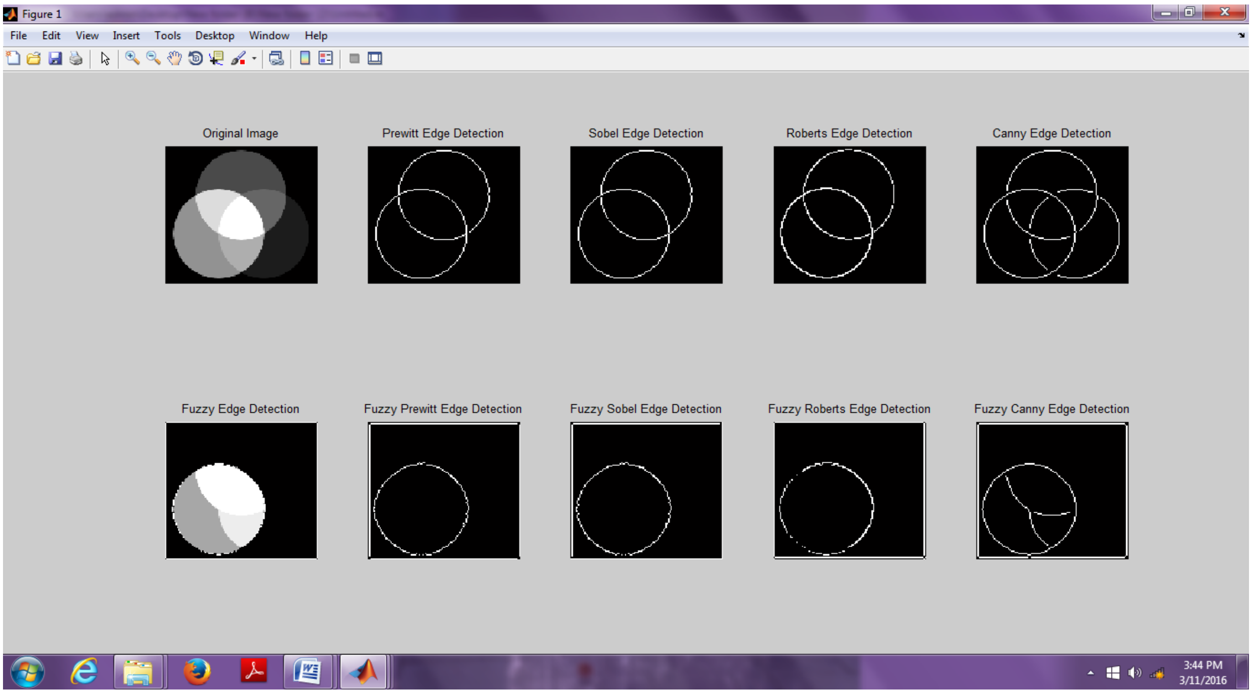
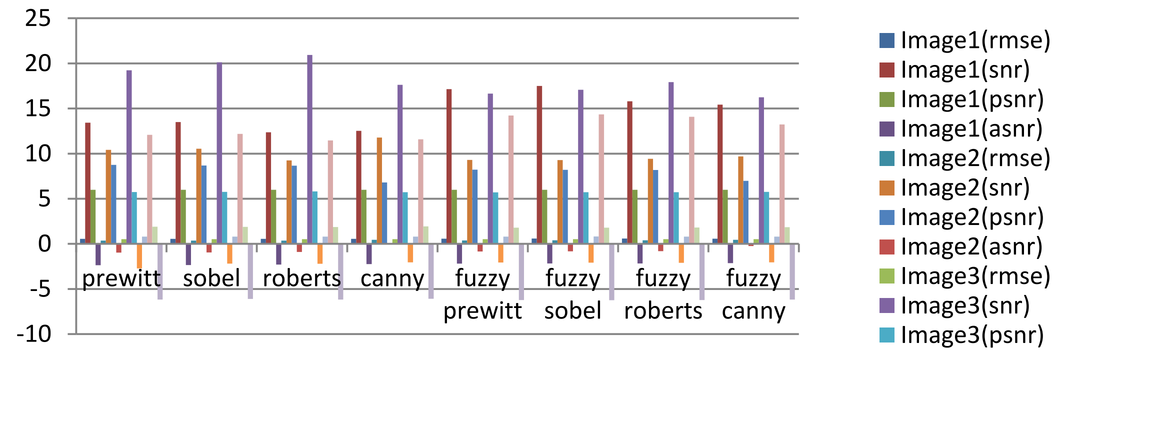
VI.RESULT

A.Image-1



B. Table-1 and Chart-1

Edge Detection Operators	Image 1				Image 2				Image 3				Image 4			
	Rmse	Snr	Psnr	Asnr	Rmse	Snr	Psnr	Asnr	Rmse	Snr	Psnr	Asnr	Rmse	Snr	Psnr	Asnr
Prewitt	0.553	13.432	5.997	-2.36	0.364	10.41	8.76	-0.96	0.516	19.23	5.74	-2.72	0.803	12.08	1.90	-6.17
Sobel	0.554	13.495	5.997	-2.35	0.368	10.54	8.69	-0.95	0.514	20.13	5.77	-2.19	0.803	12.19	1.89	-6.11
Roberts	0.555	12.374	5.997	-2.29	0.367	9.25	8.67	-0.90	0.512	20.94	5.81	-2.21	0.806	11.46	1.87	-6.17
Canny	0.560	12.529	5.996	-2.24	0.457	11.79	6.80	-0.06	0.517	17.63	5.72	-2.05	0.801	11.58	1.93	-6.08
Fuzzy Prewitt	0.580	17.139	5.997	-2.19	0.387	9.31	8.23	-0.84	0.518	16.65	5.71	-2.07	0.812	14.23	1.80	-6.23
Fuzzy Sobel	0.587	17.498	5.997	-2.18	0.388	9.29	8.21	-0.83	0.517	17.07	5.72	-2.08	0.813	14.35	1.79	-6.24
Fuzzy Roberts	0.587	15.806	5.997	-2.18	0.389	9.42	8.18	-0.81	0.517	17.93	5.73	-2.10	0.811	14.08	1.81	-6.22
Fuzzy Canny	0.581	15.428	5.996	-2.14	0.447	9.70	6.98	-0.24	0.515	16.25	5.77	-2.04	0.808	13.24	1.85	-6.17



VII. CONCLUSION

In this proposed research work a resourceful comparison of first order edge detection operators has been done. Various measures are evaluated. Sobel, Prewitt and Robert's operators detects only the gray part which has low intensity. Canny operator alone detects the entire gray part in an image. It shows that different edge detection detects the edges in gray part depending on the intensity values. Thus it is concluded that Canny edge detector is the best first order edge detection operator because it detects the edges of images with high as well as low intensity values.

REFERENCE

[1] Canny, J., A Computational Approach to Edge Detection, IEEE Trans. Pattern Analysis and Machine Intelligence, 8(6):679–698, 1986.

[2] Lindeberg, Tony "Edge detection and ridge detection with automatic scale selection", International Journal of Computer Vision, 30, 2, pp 117-154, 1998.

[3] Lindeberg, Tony (2001), "Edge detection", in Hazewinkel, Michiel, Encyclopedia of Mathematics, Springer, ISBN 978-1-55608-010-4

[4] T. Lindeberg (1998) "Edge detection and ridge detection with automatic scale selection", International Journal of Computer Vision, 30, 2, pages 117--154.

[5] W. Zhang and F. Bergholm (1997) "Multi-scale blur estimation and edge type classification for scene analysis", International Journal of Computer Vision, vol 24, issue 3, Pages: 219 - 250.

[6] D. Ziou and S. Tabbone (1998) "Edge detection techniques: An overview", International Journal of Pattern Recognition and Image Analysis, 8(4):537–559, 1998

[7] J. Canny (1986) "A computational approach to edge detection", IEEE Trans. Pattern Analysis and Machine Intelligence, vol 8, pages 679-714.

[8] R. Haralick, (1984) "Digital step edges from zero crossing of second directional derivatives", IEEE Trans. on Pattern Analysis and Machine Intelligence, 6(1):58–68.

[9] R. Kimmel and A.M. Bruckstein (2003) "On regularized Laplacian zero crossings and other optimal edge integrators", International Journal of Computer Vision, 53(3) pages 225-243.

[10] T. Pajdla and V. Hlavac (1993) "Surface discontinuities in range images," in Proc IEEE 4th Int. Conf. Comput. Vision, pp. 524-528.

[11] Jump up ^ BARGHOUT, Lauren. "System and method for Edge Detection in Image Processing and Recognition." Wipo Patent No. 2007044828. 20 Apr. 2007.

[12] Stefano B. D., Fuks' H. and Lawniczak A. T. 2000. Application of fuzzy logic in CA/LGCA models as a way of dealing with imprecise and vague data, IEEE 2000

[13] Chen Y., 2002.A region-based fuzzy feature matching approach to content based image retrieval. In proceedings of IEEE Transactions on pattern analysis and machine intelligence, VOL 24, NO. 9.

[14] E. Argyle. "Techniques for edge detection," Proc. IEEE, vol. 59, pp. 285-286, 1971.