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# Comparative Analysis of Edge Detection between Gray Scale and Color Image

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## ABSTRACT
One of the essential tasks in Digital image processing is edge detection. Edge detection generally makes the process of image segmentation and pattern recognition a bit more comfort. Edge detection significantly reduces the amount of data and filters out useless information, while preserving the relevant structural properties in an image. The paper applied the edge detection techniques on color images as well as on grey scale images. It has been shown that the Canny's edge detection algorithm performs better than all other methods under almost all scenarios. It has been observed that canny edge detection method gives better result in gray scale images as well as in color. Moreover just to add Edge detection in color images has not received the same attention as gray scale images. The difference between color images and gray-level images is that, in a color image, a color vector (which generally consists of three components (RGB) is assigned to a pixel. Thus, in color image processing, vector-valued image functions are used instead of scalar image functions. The paper is implemented using MATLAB 12.0.

## Keywords
Edge Detection, Gradient based edge detection, Laplacian based edge detection.

## 1. INTRODUCTION
Edge detection is an essential field of work in image processing. Edge detection is the process of locating sharp discontinuities in an image. These discontinuities comes from different scene features such as discontinuities in depth, discontinuities in surface orientation, and changes in material properties and variations in scene illumination. [5] Many operators have been introduced for example Roberts, Sobel and Prewitt [1, 2, 4, 6, 7, 8]. Edges can be detected by two operators. When edges detected using either the first derivatives called gradient, or the second derivatives, called Laplacien. Laplacien is more sensitive to noise since it uses more information because of the nature of the second derivatives. Most of the classical methods for edge detection based on the derivative of the pixels of the original image that are Gradient operators, Laplacian and Laplacian of Gaussian (LOG operators [9]. Edge detection based on Gradient based methods, such as Roberts, Sobel and Prewitt, use two 2-D linear filters to process vertical edges and horizontal edges separately to approximate first-order derivative of pixel values of the image.

There are number of ways to perform edge detection however different methods may be grouped into two categories:

a. Gradient based Edge Detection

The gradient method detects the edges in terms of the maximum and minimum in the first derivative of the image.

b. Laplacian based Edge Detection:
The Laplacian method based on the second derivative of the image to find edges and search for Zero crossing. Derivative calculation of the image can give its location.

## 2. EDGE DETECTION METHODS
There are different types of edge detectors:-

### 2.1 Sobel Edge Detectors
The Sobel edge detector uses the first derivative and it is based on the gradient based edge detector, it is used to find the maximum and minimum of the image of first derivative such as Gx and Gy are the gradient of first derivative and sobel edge detector uses the mask as shown in Figure 1.

Gx

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

Gy

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

**Figure 1. Masks use for gradient operation on sobel operations**

The general syntax for the Sobel detector is

[g, t] = edge (f, 'sobel', T, dir)

Where f is the input image, T is a specified threshold, and dir specifies the direction of the edges detected. 'horizontal', 'vertical' or 'both' (the default)

Test Image : Fish Name :Puffer

Family Name: Cichidal

It is dangerous kind of fish and the image is 360 X360 size of image as shown in Figure 2.The sobel edge detector applied on Puffer.

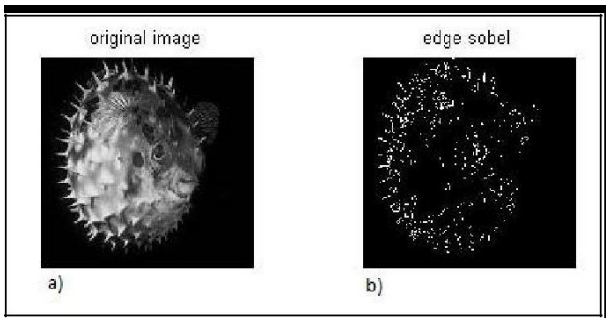


**Figure 2. a) Original Image in Gray Scale b) Edge Detection in Sobel Method**

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## 2.2 Robert Edge Detectors

The Roberts edge detector also based on the first derivative and it is more sensitive to noise Gx and Gy are the gradient derivative in the form of vertical and horizontal as shown in Figure 3.

Gx

| | |
|---|---|
| -1 | 0 |
| 0 | 1 |

Gy

| | |
|---|---|
| 0 | -1 |
| 1 | 0 |

**Figure 3: Masks use for gradient operation on Roberts Operations**

Its general syntax is

[g, t] = edge (f, 'Roberts', T, dir)

The parameters of this function are same as the Sobel parameters.

The Robert edge detector applied on fish name Puffer, the size of image is 360 X 360.

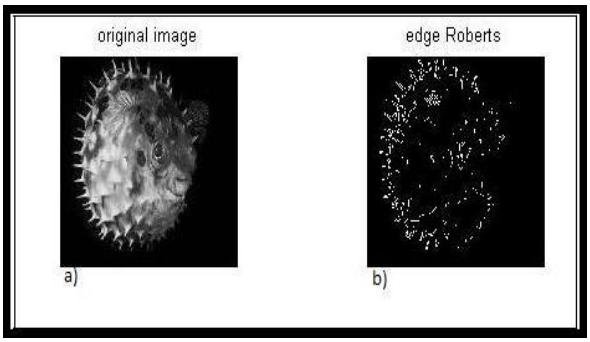


**Figure 4.a) Original Image in Gray Scale b) Edge Detection in Roberts Method**

## 2.3 Prewitt Edge Detectors

The Prewitt edge detector is a gradient based edge detector but it gives somewhat nosier image or result. The mask used in prewitt as shown in Figure 5.

Gx

| | | |
|---|---|---|
| -1 | -1 | -1 |
| 0 | 0 | 0 |
| 1 | 1 | 1 |

Gy

| | | |
|---|---|---|
| -1 | 0 | 1 |
| -1 | 0 | 1 |
| -1 | 0 | 1 |

**Figure 5. Masks use for gradient operation on prewitt operations**

Its general syntax is:

[g, t] = edge (f, 'Prewitt', T, dir)

The parameters of this function are identical to the Sobel parameters.

The Prewitt edge detection applied on fish name Puffer as the size of image is 360 X 360 as shown in Figure 6.

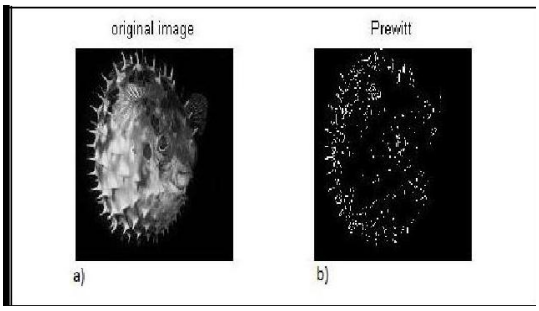


**Figure 6 a) Original Image in Gray Scale b) Edge Detection in Prewitt Method**

## 2.4 Laplacian of Gaussian (LoG)

The Laplacian is often applied to an image that has been smoothed using a Gaussian smoothing filter to reduce noise sensitive .Single gray level image serve as an input to the operator and produce a gray level image as an output.

The general syntax of the LoG detector is

[g, t] = edge (f, 'log', T, sigma)

Where sigma is the standard deviation (SD).

The LoG edge detector Method applied on fish name Puffer, the size of image is 360 X 360 as shown in Figure 7.

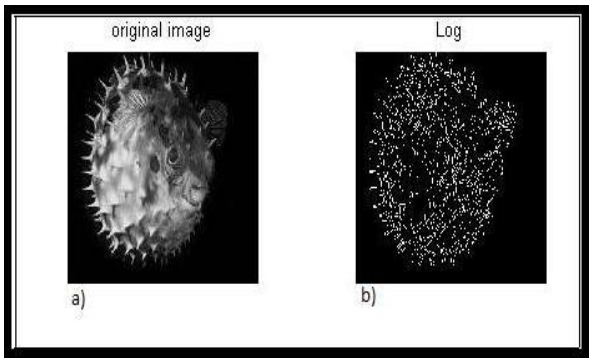


**Figure 7 a) Original Image in Gray Scale b) Edge Detection in Log Method**

## 2.5 Zero Crossing

This method uses second derivative and zero crossing of the second derivative of image and it is based on Laplacian edge detection.

The general syntax of the zero crossing detector is

[g, t] = edge (f, 'zero cross', T, H)

Where H is the filter function (FD).

The Zerocross edge detector Method applied on fish name Puffer, the size of image is 360 X 360 as shown in Figure 8

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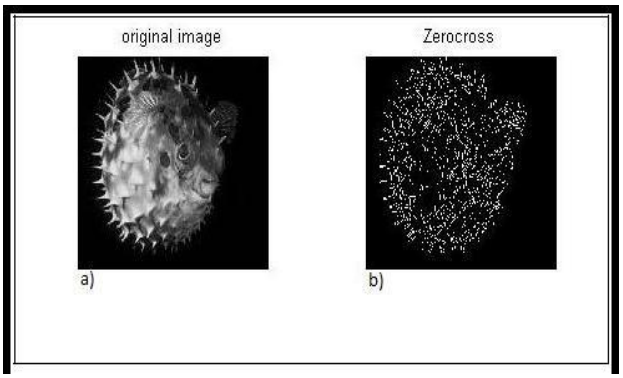


**Figure 8. a)Original Image in Gray Scale b)Edge Detection in Zerocross Method**

## 2.6 Canny Edge Detector

In Canny Edge detector [2] Gaussian filter is use to smooth edges and derivative function is used to calculate maxima and minima, it also uses the second derivative zero crossing point for the strong and weak edges and two thresholds are used to detect strong edges and weak edges.

The following steps are used in a canny edge detector algorithm:

1. Smoothing: To remove noise from the image when the image get Blurry.
2. Finding gradients: The gradients of the image have defined magnitudes and edges should be marked there.
3. Direction calculation: In which direction of edges are to be calculated.
4. Non maximum suppression: In which only local maxima is marked in terms of edges.
5. Double thresholding: By thresholding edges are determined and it is used for weak and strong edges.
6. Edge tracking by hysteresis: Final edges are defined by suppressing all edges that are not connected to strong edge.

The Canny edge detector Method applied on fish name Puffer, the size of image is 360 X 360 as shown in Figure 9

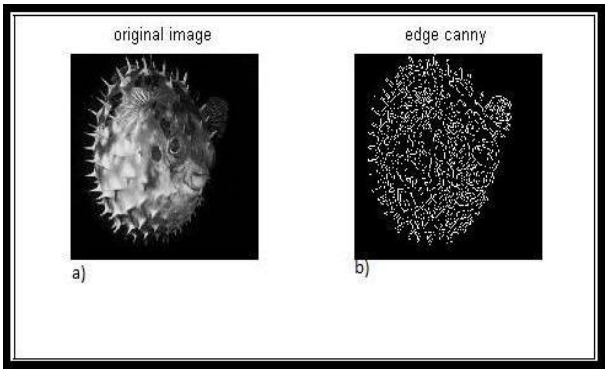


**Figure.9 a)Original Image in Gray Scale b)Edge Detection in Canny Method**

# 3. COLOR EDGE METHOD

The color images give more information about objects in a scene than gray-scale images. One of the important tasks in image processing is edge detection as edges contain essential image information .The color images uses a function that is color vector (which generally consists of three components RGB) is assigned to a pixel but gray scale images uses scalar image functions. The techniques used for this can be subdivided into two classes on the basis of their principle procedures.

- Monochromatic-based techniques- In which the information from the individual color channels first separately (RGB) and then combine together the individual and find the result.
- Vector-valued techniques- In which the color information as color vectors in a vector space provided with a vector norm, most of the color edge detection methods are monochromatic-based techniques, which give better result than when traditional gray-value techniques are used or applied.

The vector-valued technique is applied on the color images and separate individual component RGB and ea while in gray-scale images a discontinuity in the gray-scale function is term as an edge, the term "color edge" has not been clearly defined for color images. Many different definitions have been proposed for color edges. In the paper of G.S Robison [15] the intensity image contains an edge only when the edge exists precisely in the color image. In the Figure 11 shows a fish image consisting of three different color components (RGB) and a color version of the canny operator is able to detect the all borders in the fish image [see Figure 11 ], the grayscale version is not able to detect more edges [see Figure 10]. As in the second definition of G.S Robison[15] of color edge detection ,If at least one of the color components contains an edge only then edge exist in color image However ,when edges are merged in edge detection then the color components may cause some problems due to localization inaccuracies of edges in the individual color channels.[15] As in the third definition of G.S Robison To detect the color edges it is based on the sum of absolute values of the gradients for the three color components(RGB).color edge exists only when the absolute values of the gradients exceeds or greater than the threshold value. The results of the color edge detection by the two previously named definitions depend heavily on the used color spaces. [15]. A color image represents in the terms of vector-valued function; a discontinuity of chromatic information can also be defined in a vector-valued way.

## 3.1 COLOR VARIANTS OF THE CANNY OPERATOR

Canny operator[11] operator consists of a Gaussian filter for smoothing of image and uses first derivatives function for finding the magnitude and direction of best edged in terms of x and y with the three components. In a color vector space where RGB are three component and pixel value of vector C = (R,G, B) where C as a function of (x, y) in the image and when it describe in the terms of the equation then C = J_(x, y) where J is Jacobian .Canny edge detection give better performance among all other methods while applying on color image and gives more edges and information rather than other operators.

# 4. EXPERIMENTATION

Experiments were carried out over 360X360 sizes of standard test images. Edge Detection methods like Sobel operator, Roberts's operators, Prewitt operators, Canny operators have

been implemented on standard test image.

Test Image –I

Fish Name: Puffer, Fish Family: Cichidal

The visual results of Fish Image are shown in Figure 10(a)-(e)

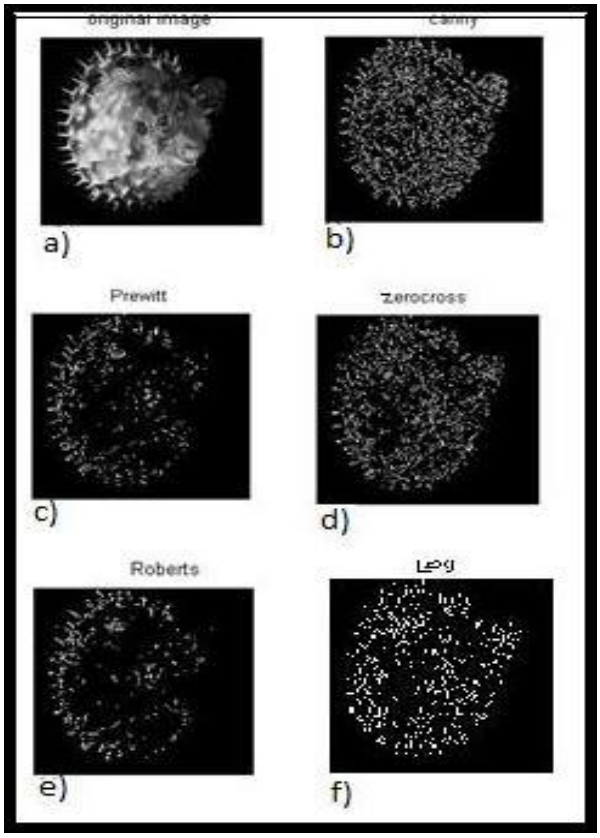


**Figure 10.Edge detection result a)original image in Gray Scale b)Canny Method c)Prewitt Method d) Zerocross Method e)Roberts Method**

The result has been shown that the Canny method gave better results than other methods like prewitt, zero cross, Roberts on Gray Scale image .Canny method gave good detection effect on the outline and also in the middle of the fish image and other methods gave weak and discontinuous edge. It also includes false edges.

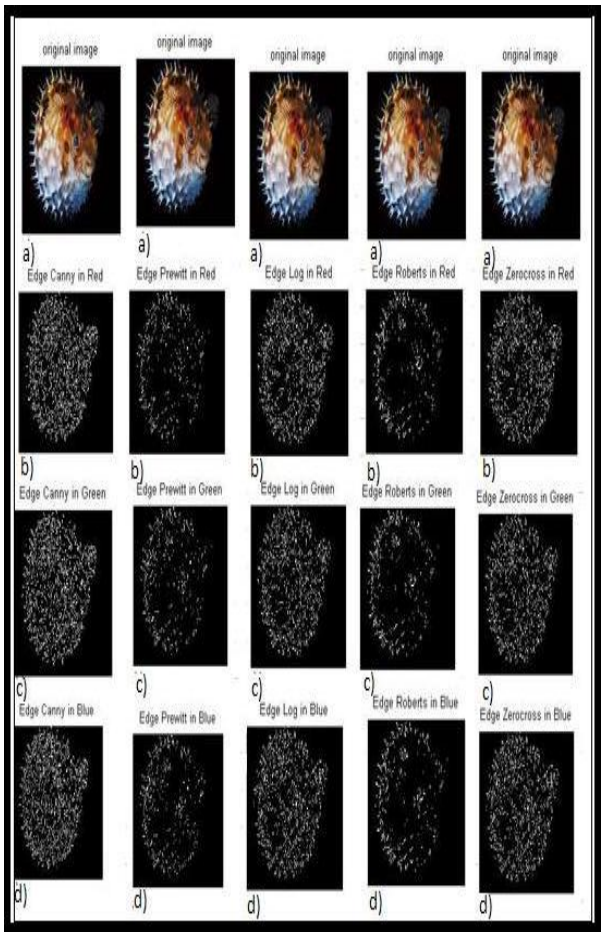


**Figure11.Edge Detection Results: a) Original Image) Edge Detection Method On Color Image (Red Component)c)Method On Green Component d)Method On Blue Component**

The result has been shown that the Canny method gave better results than other methods like prewitt, zero cross ,Roberts on Gray Scale image as well as on color image(RGB) .Canny method gave good detection effect on the outline and also in the middle of the fish image and other methods gave weak and discontinuous edge. It also includes false edges. Color image gave better results on indivisiual component as compare with gray scale image .In color image edge detection apply on indivisiual Component R,G and B.

As shown in the Figure 11 canny edge detection apply on color image on indivisiual component R,G and B gave better results and Zerocross and Log method also gave good results as compared with Sobel, Prewitt and Roberts in color image and also in gray scale image. Color edge operators are able to detect more edges than gray-scale edge operators and additional features can be obtained in color images that may not be detected in gray-scale images.

## 4.1 Comparison between Gray Scale and Color Image

**Table 1. Comparison between Gray scale and color image in different methods (Refer Figure 11)**

| Method /Technique | Gray-Scale Image | Color Image (R G B) |
|---|---|---|
| Prewitt | Edge Detection not good and it is most sensitive to noise. | Edge Detection not good but detect more edges than Gray Scale. |
| Roberts | Edge Detection not good as compare to other operators | Edge Detection not good but detect more feature than Gray Scale |
| Canny | Edge Detection better than other methods and it also detect weak edges. | Detecting of edges is better than Gray Scale However, each component give better result than gray scale. |
| LoG | Edge Detection good than Prewitt and Roberts. It is two dimensional second order derivative .This is useful in locating centre of thick edges. | Edge Detection good and detect more edges than Prewitt and Roberts and also better than Gray Scale |
| Zerocross | Edge Detection good than Prewitt and Roberts and it is based on laplasian edge detection | Edge Detection good than Prewitt and Roberts and better than Gray Scale. |

## 5. CONCLUSION

In the paper vector-valued techniques used for the detection of edges in color images. Color edge operators are able to detect more edges than gray-level edge operators. In color image edge detection additional features can be obtained that may not be detected in Gray-level images. However, the most commonly used edge detection techniques are Gradient-based and Laplacian based Edge Detection. Gradient-based algorithms such as the Prewitt, Sobel, Roberts and prewitt filter have a major drawback of being very sensitive to noise. Canny's edge detection algorithm is computationally more expensive as compared to Sobel, Prewitt and Robert's operator. The Canny's Edge detection method give better results in color images as well as in gray level images .Canny edge detection algorithm performs better than all these operators under almost all scenarios. While comparing the gray scale image with color image, color image gave better result or detect more edges.

## 6. REFERENCES

[1] Aurich, and J. Weule, "Nonlinear Gaussian filters performing edge preserving diffusion. ", Proceeding of the 17th Deutsche Arbeitsgemeinschaft für Mustererkennung (DAGM) Symposium, Sept. 13-15, Bielefeld, Germany, Springer-Verlag, 1995, pp. 538-545.

[2] M. Basu, "A Gaussian derivative model for edge enhancement.", Patt. Recog., 27:1451-1461, 1994.

[3] J. Canny, "A computational approach to edge detection.", IEEE Trans. Patt. Anal. Mach. Intell., 8, 1986, pp. 679-698.

[4] G. Deng, and L.W. Cahill, "An adaptive Gaussian filter for noise reduction and edge detection.", Proceeding of the IEEE Nuclear Science Symposium and Medical Imaging Conference, Oct. 31-Nov. 6, IEEE Xplore Press, San Francisco, CA., USA, 1993, pp. 1615-1619.

[5] A. El-Zaart, "A Novel Method for Edge Detection Using 2 Dimensional Gamma Distribution", Journal of Computer Science 6 (2), 2010 , pp. 199-204,.

[6] C. Kang, and W. Wang, "A novel edge detection method based on the maximizing objective function.", Pattern. Recog., 40, 2007, pp. 609-618.

[7] J. Siuzdak, "A single filter for edge detection.", Pattern Recog., 31, 1998 , pp.1681-1686. [13] C. Tsallis, "Possible generalization of Boltzmann-Gibbs statistics," J. Stat. Phys., 52,1988, pp. 479–487.

[8] Q. Zhu, "Efficient evaluations of edge connectivity and width uniformity.", Image Vis. Comput., 14. 1996, pp.21-34.

[9] M. Wang and Y. Shuyuan, "A Hybrid Genetic Algorithm Based Edge Detection Method for SAR Image", In: IEEE Proceedings of the Radar Conference'05 May 9-12, 2005, pp. 1503-506.

[10] R.C. Gonzalez, and R.E. Woods, "Digital Image Processing.", 3rd Edn., Prentice Hall, New Jersey, USA. ISBN: 9780131687288, 2008, pp. 954.

[11] J. Canny, "A computational approach to edge detection," IEEE Trans. Pattern Anal. Machine Intell., vol. 8, no. 6, pp. 679–698, 1986

[12] T.L. Huntsberger and M.F. Descalzi, "Color edge detection," Pattern Recognition. Lett., vol. 3, no. 3, pp. 205–209, 1985.

[13] T. Kanade, "Image understanding research at CMU," in Proc. Image Understanding Workshop, vol. II, 1987, pp. 32–40

[14] M. Pietikäinen and D. Harwood, "Edge information in color images based on histograms of differences," in Proc. Int. Conf. Pattern Recognition., Paris, France,

1986, pp. 594–596.

[15] G.S. Robinson, "Color edge detection," in Proc. SPIE Symp. Advances Image Transmission Techniques, vol. 87, 1976, pp. 126–133.

[16] J.C. Solinsky, "The use of color in machine edge detection," in Proc. VISION'85, pp. 4-34–4-52, 1985.

[17] H. Tao and T. Huang, "Color image edge detection using cluster analysis," in Proc Int'l Conf. Image Processing, Washington, D.C., 1997, vol. I, pp. 834–837.

[18] C.K. Yang and W.H. Tsai, "Reduction of color space dimensionality by moment-preserving thresholding and its application for edge-detection in color images," Pattern Recognit. Lett., vol. 17, no. 5, pp. 481–490, 1996

[19] Raman Maini and Dr. Himanshu Aggarwal"Study & Comparison of various Image Edge Detection Techniques(IJIP),Volume(3):issue(1)

[20] Tapas Kumar and G.Sahoo,"A Novel Method of Edge Detection using Cellular Automata (IJCA 0975-8887),Volume 9-No.4,November 2010

[21] Ms. Suman and Mr. Pawan, "A Survey on various Methods of Edge Detection," International Journal Of Advanced Research in Computer and Software Engineering, vol. 4,issue 5, pp. 888-895, May, 2014.

[22] Shubhashree, "A Review Edge Detection Techniques for Image Segmentation," International Journal of Computer Science and Information Technologies, vol. 5(4),, issue 5, 2014,5898-5900

[23] Rashmi and Mukesh Kumar and Rohini Sexena, "Algorithm and Technique on Various Edge Detection :A Survey International Journal (SIPIJ), vol. 4, No.3,June 2013

[24] Kumar, Tapas., Sahoo, G., Lamba, I.M.S., Bhatia, C.M, 2008.Celllar automata based thresolding for edge detection in binary images. , Journal of Computer Science & its Application, vol.15. No.2. pp. 148-155.

[25] Simranjit Singh Walia and Gagandeep Singh .Color based Edge Detection Techniques-A Review, International Journal of Engineering and Innovative Technology (IJEIT), vol.3, Issue 9, March 2014.