International Journal of Computing Academic Research (IJCAR)
ISSN 2305-9184, Volume 5, Number 1 (February 2016), pp.39-45

http://www.meacse.org/ijcar

A Generic Permutational Edge Detection Approach for Corrupted Images

P.Shanmugavadivu and A.Shanthasheela

Department of Computer Science and Applications, Gandhigram Rural Institute - Deemed University, Gandhigram, India

Abstract

Edge detection, one of the most common approaches of image segmentation is an element of digital image processing. Edge detection focuses to detect meaningful discontinuities among the intensities of an image. The conventional edge detection methods such as Sobel, Prewitt and Canny are commonly used, due to their efficiency. However, edge detection is proved to be too challenging in the corrupted images. By principle, the presence of noise is also featured by the abrupt discontinuities in the intensity values. This research work proposes a generic edge detection technique namely Permutational Edge Detection (PED), for the corrupted images, using the principle of morphological operations. This approach detects the edges using an optimal structuring element (SE). The novelty of this edge detection is exhibited by the human visual perception of the obtained results.

Keywords: Edge Detection, Speckle Noise, Structuring Element, Dilation, Erosion, Opening, Closing, Top-hat, Bottom-hat.

Introduction

Edge detection identifies and locates the sharp discontinuities in an image, which may characterize the boundary of an object or image. The intensity discontinuities may represent the presence of edge, line, boundary or even noise [1-3]. The noises which commonly corrupt the images are impulse noise, Gaussian noise, Poison noise, thermal noise and speckle noise [4]. This paper focuses on the speckle noise that degrades the quality of images by reducing the ability of a human vision to discern the fine details

The literature gives an account on the principle and performance of a good number of edge detection methods including Canny, Prewitt and Sobel [5]. Though, the Canny edge detection algorithm shows better performance, it is computationally costlier, when compared to other conventional methods such as Sobel, Prewitt and Robert's operator. The other methodologies of edge detection reported in the literature are Gradient and Laplacian transformation [6]. But for the mismapping of a few lines or edges, the Laplacian is proved to perform well than its peers.

The edge detection algorithm should provide an optimal solution to the image with different noise levels, by identifying the original image contents, even in the presence of noise contents[7, 13]. A structuring element is used as a moving window in the image plane to analyze the geometric shape and texture of the images [8,13].

The basics of morphological operators namely, dilation and erosion used in this research work are described by Eqn. (1) - (8).

Dilation is used for expanding an element A by using structuring element B. Dilation of A by B with A and B sets in Z^2 is defined as:

$$A \oplus B = \{z \mid (\hat{B})_z \cap A \neq \phi\} \tag{1}$$

This equation is based on obtaining the reflection of B about its origin and shifting this reflection by z. The dilation of A by B is the set of all displacements z, such that B and A overlap by at least one element [9, 11] and is described as:

$$A \oplus B = \{z \mid [(\hat{B})_z \cap A] \subseteq A\} \quad (2)$$

Erosion is used for shrinking of element A by using element B. Erosion for sets A and B in Z^2, is defined by the following equation:

$$A \ominus B = \{z \mid (B)_z \subseteq A\} \quad (3)$$

This equation shows that the erosion of A by B is the set of all points z such that B, translated by z, is combined in A [10, 11]. If set B is assumed to be a structuring element then B has to be contained in A is equivalent to B not sharing any common elements with the background and this can be shown by the following equation.

$$A \ominus B = \{z \mid (B)_z \cap A^c = \phi\} \quad (4)$$

Where A^c is the complement of A and ϕ is the empty set.

The opening of A by B is the erosion of A by B followed by dilation of the result by B. So, the opening of set A by the structuring element B $A \circ B$ defined by the following equation:

$$A \circ B = (A \ominus B) \oplus B \quad (5)$$

The morphological close operation of A by B is the dilation of A by B, followed by the erosion of the result by B. That is the closing of set A by structuring element B, A●B is shown by the following equation:

$$A \bullet B = (A \oplus B) \ominus B \quad (6)$$

Morphological Top-hat and bottom-hat transformations are performed by combining image subtraction with opening and closing results. The mathematical representation of Top-hat and bottom-hat is as follows:

$$T_{hat}(A) = A - (A \circ B) \quad (7)$$

$$B_{hat}(A) = (A \bullet B) - A \quad (8)$$

The remaining part of this research article is organized as the computational methodology of the proposed technique, the results and discussions of the proposed technique and the conclusion.

Computational Methodology

The framework of the devised PED technique is shown in Fig.1

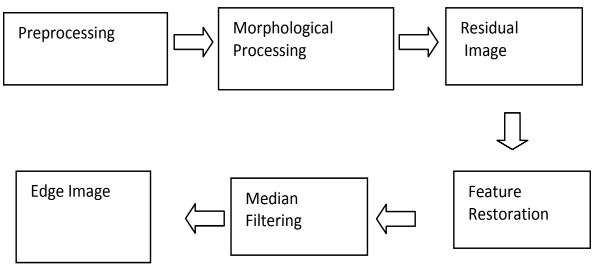


Fig1. Framework of Permutational Edge Detection Model

As shown in the figure, the input image is preprocessed by using the morphological operators to produce the residual image, $I_{residue}$. The features of the given input image are extracted from the morphologically processed input image, as $I_{feature}$. It is further manipulated using median filter, giving I_{med}. The edge detected input image I_{edges} is produced as final output.

Algorithmic Description

1. Read an *input image I*

2. Perform Preprocessing:
   a. If Input I is color image then convert into grayscale image I_{GS} otherwise assign I into I_{GS}
   b. Add Speckle noise to I_{GS}.

3. Perform the Morphological Operations
   a. For varying structuring element from 1 to 3
   b. $I_{close} \leftarrow$ *morphological_close* (I_{GS})
   c. $I_{dilate} \leftarrow$ *morphological_dilate* (I_{GS})

4. Residual Image Creation
   a. $I_{residue} \leftarrow I_{dilate} - I_{close}$
   b. Enhance I_R using T_{Hat} and B_{Hat} Transformation

5. Feature Extraction
   a. For varying structuring element from 1 to 3
   b. $I_{temp} \leftarrow I_{open} + I_{close}$
   c. $I_{feature} \leftarrow I - I_{temp}$

6. $I_{med} \leftarrow$ *Median(I)* Find med_image suppressing the noise using median filtering

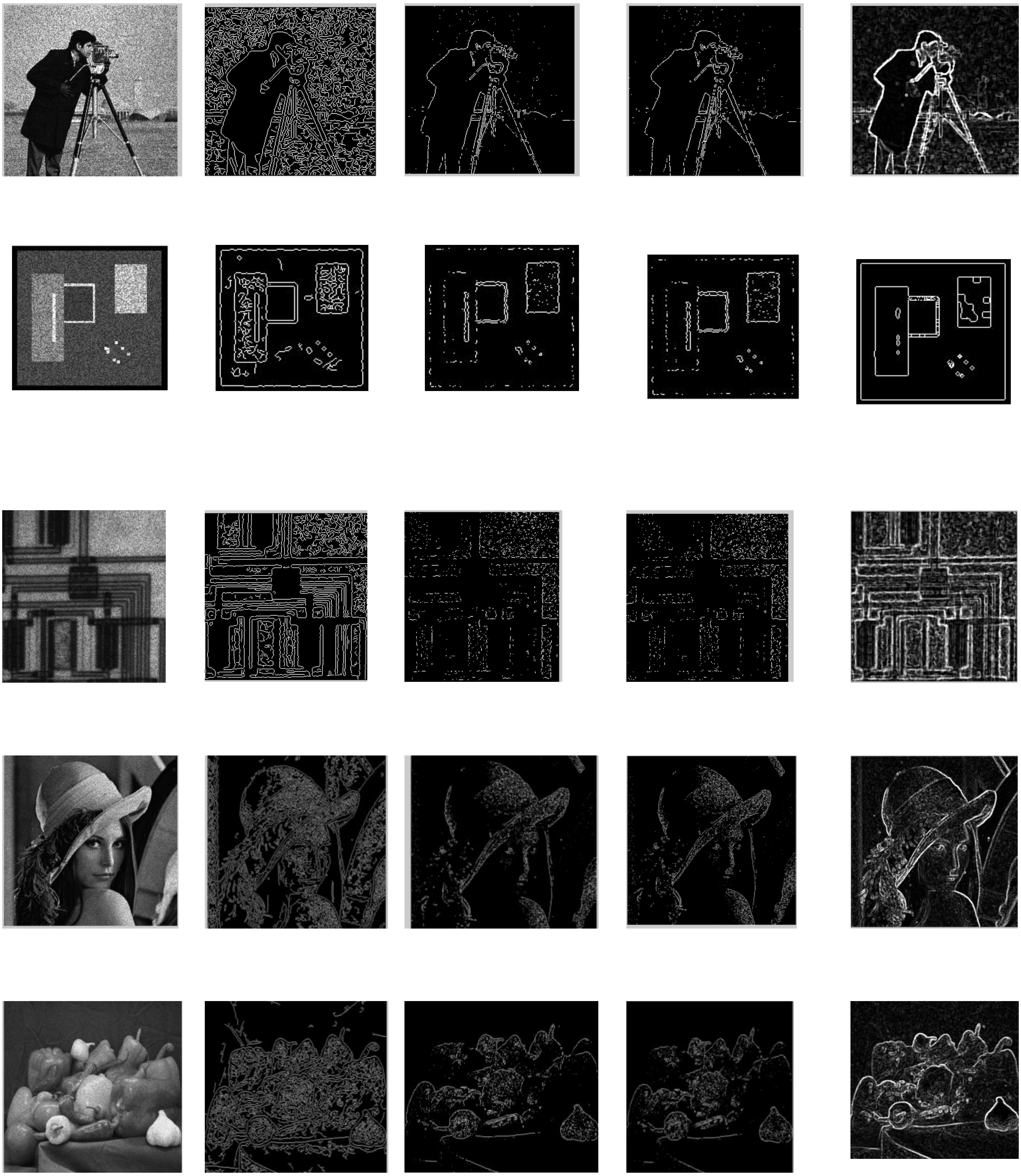
7. $I_{edges} \leftarrow I_{med} \cup I_{temp}$

8. Display image I_{edges}

9. Stop

Results and Discussion

The algorithm was implemented using Matlab 7.8. The results of PED are compared with those of Sobel, Prewitt and Canny detectors. From the visual perception of all the obtained results, it is evident that PED has extracted the edge details, far better t Images obtained by applying the proposed algorithm on its competitive techniques. The speckle noise was simulated using a predefined function. The performance of PED was tested on the standard images with speckle noise of 10% to 90%. The results are proved to be consistently promising, despite the nature of the images. For illustrative purpose, the results of Cameraman, shapes, Circuits, Lena and peppers are shown. It is apparent from the results the proposed PED is able to highlight the edges of those images better than its competitive techniques.



(a) (b) (c) (d) (e)

Fig. 2 Edge Detection Potential of PED for images with 10% of Speckle Noise (a) Images with Speckle Noise(10%); Edges detected by (b) Canny (c) Prewitt (d) Sobel & (e) PED (Proposed)

Additionally the performance was analyzed by varying the probability of speckle noise between 50% and 90%. The results are depicted in Fig. 3. The results of PED are recorded to be effective in the speckle noise corrupted images, despite the level of noise.

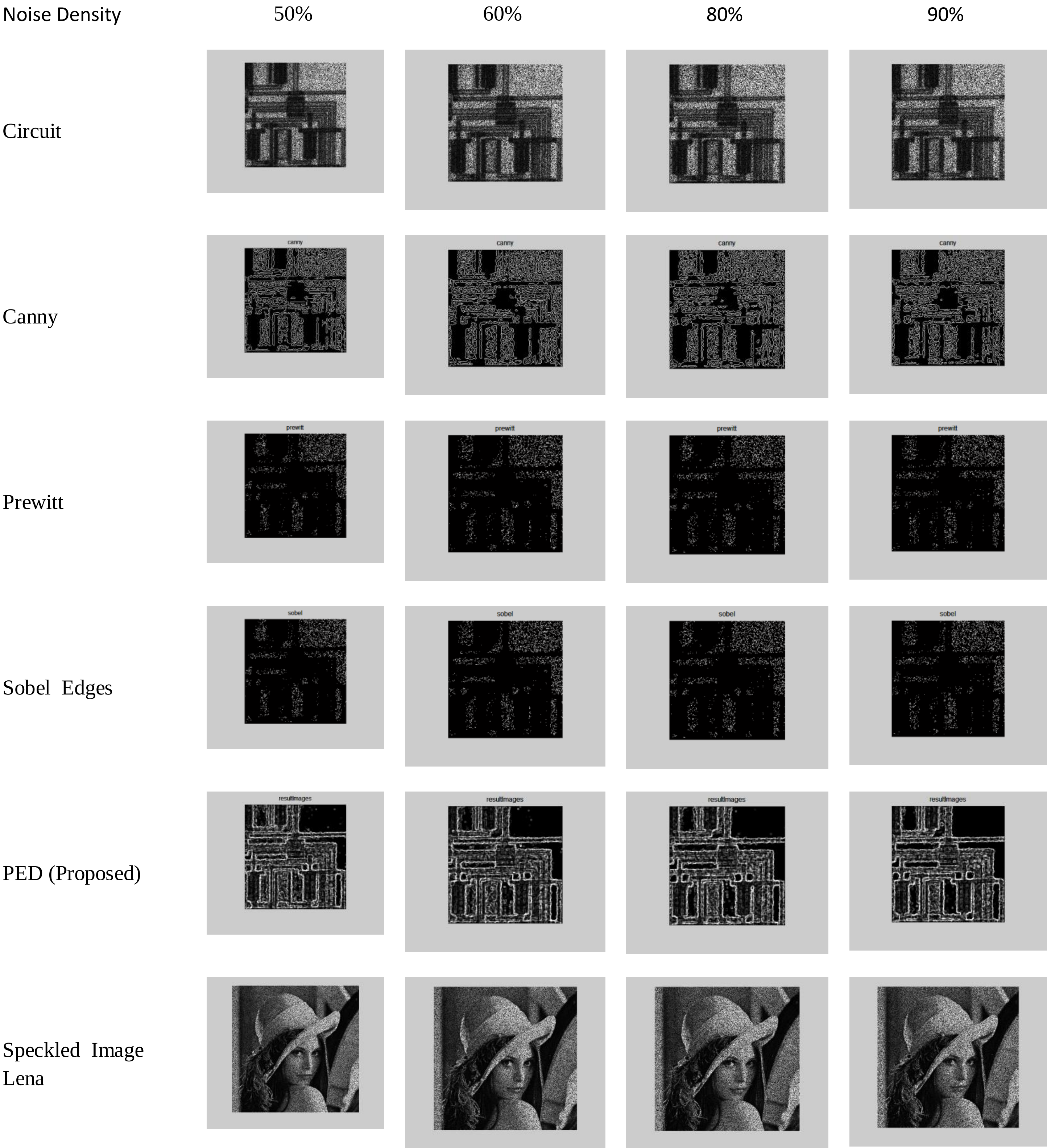


Fig. 3 Edge Detection Potential of PED for images with 50%-90% of Speckle Noise (a) Images with Speckle Noise(50%-90%); Edges detected by (b) Canny (c) Prewitt (d) Sobel & (e) PED (Proposed)

Conclusion

The proposed edge detection method, PED locates the edges in the presence of the speckle noise effectively. This technique is proved to be robust on the images corrupted with different probabilities of Speckle noise. The edge detection ability of the PED promises its applications in the subsequent image processing, for instance image segmentation.

References

[1] Mitra Basu, Gaussian-based edge-detection methods - a survey. IEEE Transactions on Systems, Man, and Cybernetics, Part C (TSMC) VOL 32(3), pp 252-260, 2002

[2] Patricia Melin, Claudia I. González, Juan R. Castro, Olivia Mendoza, Oscar Castillo: Edge-Detection Method for Image Processing Based on Generalized Type-2 Fuzzy Logic. IEEE T. Fuzzy Systems (TFS) VOL 22(6) pp 1515-1525 (2014)

[3] Marivi Tello Alonso, Carlos López-Martínez, Jordi J. Mallorquí, Philippe Salembier: Edge Enhancement Algorithm Based on the Wavelet Transform for Automatic Edge Detection in SAR Images. IEEE T. Geoscience and Remote Sensing (TGRS)VOL 49(1-1) pp 222-235, 2011

[4] Shanmugavadivu P, Shanthasheela A, Feature Variance based Filter for speckle noise removal, IOSR-JCE, Vol 16,issue 5(I), pp 15-19

[5] John Canny: A Computational Approach to Edge Detection. IEEE Trans. Pattern Anal. Mach. Intell. (PAMI) VOL 8(6) pp 679-698, 1986

[6] Wolfgang H. Gerstacker, Robert Schober: Equalization concepts for EDGE. IEEE Transactions on Wireless Communications (TWC) VOL 1(1) pp190-199, 2002

[7] Sonya A. Coleman, Bryan W. Scotney, Shanmugalingam Suganthan: Edge Detecting for Range Data Using Laplacian Operators. IEEE Transactions on Image Processing (TIP) VOL 19(11), pp 2814-2824 , 2010

[8] Erik R. Urbach, Michael H. F. Wilkinson: Efficient 2-D Grayscale Morphological Tr
ansformations With Arbitrary Flat Structuring Elements. IEEE Transactions on Image Processing (TIP) VOL 17(1), pp 1-8, 2008

[9] Shanmugavadivu P, Shanthasheela A, Morphological Gradient based Transformation Controlled Multilevel Edge detector for digital images Journal of Computer Applications, Morphological Gradient Based Transformation Controlled Multilevel Edge Detector for Digital Images, Volume IV, 2011.

[10] Paul T. Jackway, Mohamed Deriche: Scale-Space Properties of the Multiscale Morphological Dilation-Erosion. IEEE Trans. Pattern Anal. Mach. Intell. (PAMI) VOL 18(1), pp 38-51 , 1996.

[11] Shanmugavadivu P, Shanthasheela A, Journal of Computer Applications, Morphological Gradient Based Transformation Controlled Multilevel Edge Detector for Digital Images, Volume IV, Issue-I, pp 81-84,2011.

[12] Rafael C. Gonzalez, Richard E.Woods, “Digital Image Processing”, Third edition, Tata McGraw Hill, 2011.

[13] Joseph Gil, Ron Kimmel: Efficient Dilation, Erosion, Opening, and Closing Algorithms. IEEE Trans. Pattern Anal. Mach. Intell. (PAMI) VOL 24(12) , pp 1606-1617 , 2002