Comparison of Traditional Edge Detection Techniques with Novel Fuzzy Approach in Noisy Medium

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***ABSTRACT*-Edge detection is an important element in image processing, since edge detection is to identify the boundaries of homogeneous regions in an image based on properties such as intensity and texture. Many edge detection algorithms have been developed based on computation of the intensity gradient vector, which, in general, is sensitive to noise in the image. In order to suppress the noise, the operator based on fuzzy technique is introduced. This paper uses a fuzzy logic based algorithm to detect the edges of noisy input images by scanning it throughout using 3x3 window. Fuzzy Inference systems has been designed, that has eight inputs, which corresponds to eight pixel of scanning window, one output that tells whether the pixel under consideration(target pixel) is "black", "white" or "edge" pixel. FIS rule base comprises of forty six rules that classify the target pixel. Algorithm for the noise removal has also been implemented. The results of the implemented algorithm have been compared with the standard edge detection algorithm such as Sobel, Prewitt and Roberts operators as well as fuzzy based one another method(2x2 window).**

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***Keywords*-Fuzzy logic, Edge detection, digital image processing, feature extraction, computer vision.**

I. INTRODUCTION

Edges in a digital image provide important information about the objects contained within the image since they constitute the boundaries between the objects in the image. Edge detection is a frequently performed operation in many image processing applications because it is usually the first operation that is performed before other image processing tasks such as image segmentation, boundary detection, object recognition and classification, image registration, and so on. Consequently, the success of these subsequent image processing tasks is strictly dependent on the performance of the edge detection operation. Today the images can come from different modalities beyond normal gray-scale and colour photographs, such as infrared, X-ray, as well as the new generation of hyper-spectral satellite data sets. Usage of specific Linear time-invariant (LTI) filter is the most common procedure applied to the edge detection problem, and the one which results in the least computational effort. In the case of first-order filters, an edge is interpreted as an abrupt variation in gray level between two neighbour pixels. The goal in this case is to determine in which points in the image the first derivative of the gray level as a function of position is of high magnitude. By applying the threshold to the new output image, edges in arbitrary directions are detected.The classic operators work well in circumstances where the area of the image under study is of high contrast. In fact, classic operators work very well in an image that can be simply converted into a binary image by simple thresholding.

Zhengquan He et. al. in 1998 proposed a paper in which the edge patterns in binary images are classified into 18 categories. After training on the pre-defined edge pattern, the neural network is applied to classify any type of edges into one of the 18 categories. For different edge patterns, corresponding algorithms are employed to process the image to extract edges [1]. **Mohsen Sharifi et. al.** in 2002 proposed a paper in which they classified the most commonly used algorithms into five category, then seven algorithms have been applied to 30 images and lastly two sets were presented. Subjective evaluation of images showed that

under noisy conditions ISEF, Canny, Marr- Hildreth, Kirsch, Sobel, Lapla2 and Lapla1 exhibit better performances, respectively [2].

Mohd Ashri Abu Hassan et. al. in 2008 proposed a paper in which they introduces a sample line histogram method (SLHM) in evaluating the accuracy in detecting bone edges. CR images of bone joints namely the knee and the elbow joints are used in this experiment.The performance of three edge detection method: Sobel, Canny and Shen & Castan are compared [3]. **Hamed Mehrara et. al.** in 2009 proposed a a new edge detection technique that is based on the BP neural network. Here, it is classified the edge patterns of binary images into 16 possible types of visual patterns. In the following, After training the pre-defined edge patterns, the BP neural network is applied to correspond any type of edges with its related visual pattern [4].

Wafa barkhoda et. al. in 2009 proposed a new fuzzy edge detection method. Based on the primary edge detection methods, gradient and standard deviation computed at each pixel, and are used as fuzzy system input. The fuzzy system includes appropriate defined membership function and fuzzy rules, decide about pixel classification as edge or non-edge [5]. **Er Kiranpreet Kaur et.al.** in 2010 proposed a paper based on fuzzy logic to detect the edges of an input image by scanning it throughout using a 2*2 pixel window. Rule base comprises of sixteen rules, which classify the target pixel. Algorithm for the noise removal has been implemented at different levels of processing [6].

Sabina Priyadarshini et al. in 2010 proposed a new technique of edge detection that is based on additions and divisions. It makes use of a threshold value that is automatically computed by the program that implements this technique [7]. **H. Farahanirad et. al.** in 2011 proposed a hybrid edge detection algorithm in situations where the image is corrupted by Saltand- Pepper noise.The proposed edge detector is combination of neural networks, neuro-fuzzy network and adaptive median filter. The internal parameters of these networks are adaptively optimized by training using very simple artificial images that can be generated by computer. The proposed method is tested under noisy conditions on several images and also compared with conventional edge detectors such as Sobel and Canny and a neuro-fuzzy edge detector [8].

A. Jayachandran et. al. proposed 3×3 window technique for scanning the image. In their technique they used only 8 rules for detecting the edge [9].**Pinaki Pratim Acharjya1 et. al.** in 2012 proposed a paper in which the study and comparative analysis of various gradient based image edge detection techniques is presented [10]. **Mrs.R.Shenbagavalli et al.** in 2013 proposed a paper in which Edge detector is developed for satellite image using fuzzy logic concept. Fuzzy logic helps to find and highlight all the edges associated with an image by checking the relative pixel values. Scanning of an image using the 3x3 windowing technique takes place which is subjected to a set of fuzzy conditions for the comparison of pixel values with adjacent pixels to check the pixel magnitude gradient in the window. After the testing of fuzzy conditions the appropriate values are allocated to the pixels in the window under testing to provide an image highlighted with all the associated edge [11].

The most important factor decreasing the performance of edge detection is the noise. Unfortunately, digital images are certainly degraded by noise during image acquisition and/or transmission due to a number of imperfections encountered in imaging processes and/or communication channels. Most edge detection operators are based on the assumption that images contain large homogeneous regions separated by clear boundaries. However, this assumption loses its validity if the image is corrupted by noise. Therefore, majority of the edge detection operators require a pre- filtering of the noisy image by using an appropriate noise filter before edge detection is performed. In this case, how- ever, the performance of the edge detection operation be- comes strictly dependent on the performance of the noise filter. Moreover, the complexity of the system and the processing time are considerably increased.

A. Fuzzy Image Processing

Fuzzy image processing has three main stages: image fuzzification, fuzzy technique, and finally image defuzzification. The fuzzification and defuzzification steps are due to the fact that we do not possess fuzzy hardware. Therefore, the coding of image data (fuzzification) and decoding of the results (defuzzification) are steps that make possible to process images with fuzzy techniques. The main power of fuzzy image processing is in the middle step in which firing strength is calculated, fuzzy rules are applied for each crisp

inputs and finally aggregate resultant output is achieved. The basic block diagram of fuzzy image processing is shown in Figure 1.

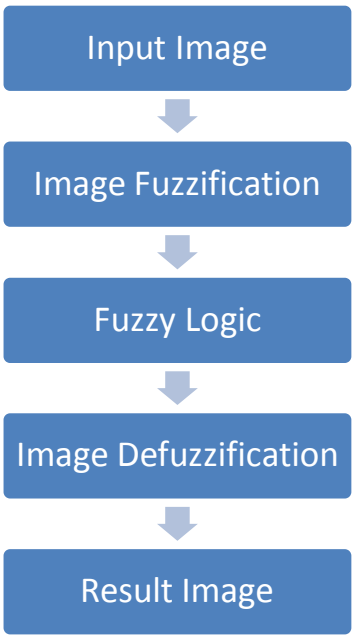

Figure 1. Basic Block Diagram of Fuzzy Image Processing

B. Advantages of Fuzzy Image Processing

Fuzzy image processing is important to represent uncertainty in data. Some of the main benefits of fuzzy image processing are listed as below:

• Fuzzy techniques are powerful tools for knowledge representation and processing
• Fuzzy techniques can manage the vagueness and ambiguity efficiently.
• Fuzzy logic is tolerant of imprecise data.
• Fuzzy logic is conceptually easy to understand.

The mathematical concepts behind fuzzy reasoning are very simple. What makes fuzzy nice is the "naturalness" of its approach and not its far-reaching complexity. In many image processing applications, expert knowledge is used to overcome the difficulties (e.g. object recognition, scene analysis). Fuzzy set theory and fuzzy logic offer powerful tools to represent and process human knowledge in form of fuzzy if-then rules. On the other side, many difficulties in image processing arise because the data/tasks/results are uncertain. This uncertainty, however, is not always due to the randomness but to the ambiguity and vagueness. Beside randomness which can be managed by probability theory. Imperfection in the image processing can be distinguished into three types as follows:

• Grayness ambiguity
• Geometrical fuzziness
• Vague knowledge
These problems are fuzzy in the nature.

C. Fuzzy Sets and Fuzzy Membership Functions

The system implementation was carried out considering that the input image and the output image obtained after defuzzification are both 8-bit quantized; this way, their gray levels are always between 0 and 255. The fuzzy sets were created to represent each variable's intensities; these sets were associated to the linguistic variables "Black", Edge and "white".

II. FIS SYSTEM DESIGN

In order to detect the edge in the image, a fuzzy inference system has been designed which take different pixel value as inputs, fuzzified these input i.e. convert it into fuzzy plane and then using some predefined rule mark the considered pixel as edge, Black, White. Mandani method is chosen as the defuzzification method and the output of the system is calculated as the centroid of the resulting membership functions.

A. Window mask

The fuzzy inference systems is used in this paper takes 8 inputs from 3×3 windows. The mask used for scanning image is shown in Figure 2.

P1(I,J)	P2(I,J+1)	P3(I,J+2)
P4(I+1,J)	Test Pixel P5(I+1,J+1)	P6(I+1,J+2)
P7(I+2,J)	P8(I+2,J+1)	P9(I+2,J+2)

Figure 2. 3×3 mask used for scanning

III. ALGORITHM

The algorithm is based on the subjection of a set of eight pixels, part of a 3x3 window of an image to a set of fuzzy conditions which help to highlight all the edges that are associated with an image. The fuzzy conditions help to test the relative values of pixels which can be present in case of presence on an edge. So the relative pixel values are instrumental in extracting all the edges associated to an image. The image is said to have an edge if the intensity variation in between the adjacent pixels is large. This task is accomplished with the help of fourty six rules. Block diagram of proposed method is shown in Figure 3.

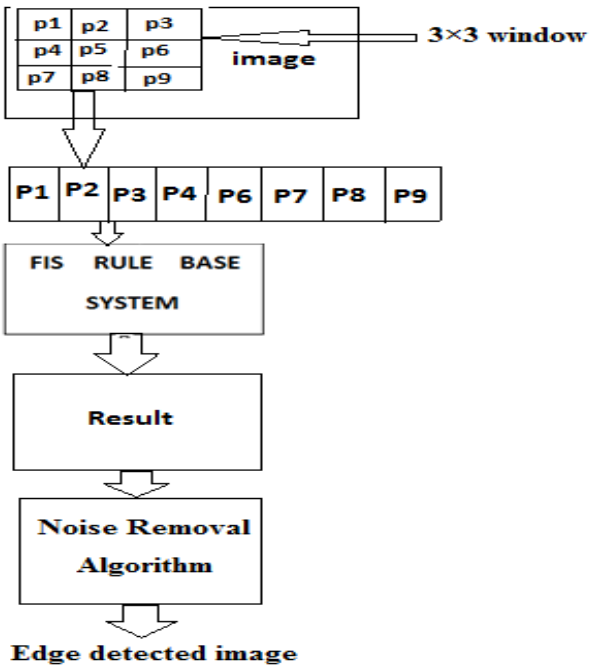

Figure 3. Block diagram of fuzzy system

The mask is slid over an area of the input image, changes that P5 pixel's value (target pixel) and then shifts one pixel to the right and continues to the right until it reaches the end of a row. It then starts at the beginning of the next row & process continues till the whole image is scanned. When this mask is made to slid over the image, the output is generated by the fuzzy inference system based upon the rules and the value of the pixels P1, P2, P3 P4, P6, P7, P8and P9

The following steps are performed step by step.

a) Crisp inputs P1,P2,P3,,P4,P6,P7,P8 & P9 are fuzzified into various Fuzzy sets, having membership functions i.e. Black & White.

b) Firing strength is calculated using fuzzy t-norms operators (MIN or PRODUCT) on Membership Functions.

c) Fuzzy rules are fired for each crisp input.

d) Aggregate resultant output Fuzzy Set for all fired rules are achieved by using MAX operator (s-norm).

e) De-fuzzification is performed using the Centroid method.

f) Crisp Output P5 is the pixel value of the output image i.e. one containing the Edges, Black and White regions.

g) Finally noise removal algorithm is applied.

A. Noise Removal

The idea of noise removal is to remove the pixels which have been falsely recognized as edge by the processing. Size of the scanning mask for this task is 3*3 pixels window. The 3*3 pixels mask is slid over the whole image pixel by pixel row wise and the process continues till the time whole image is scanned for unwanted edge pixels. Figure 4 Shows P5 as falsely marked edge pixel as all the surrounding pixels i.e. P1, P2, P3, P4, P6, P7, P8 & P9 are White. Such types of falsely marked edge pixels are changed to White by the noise removal algorithm.

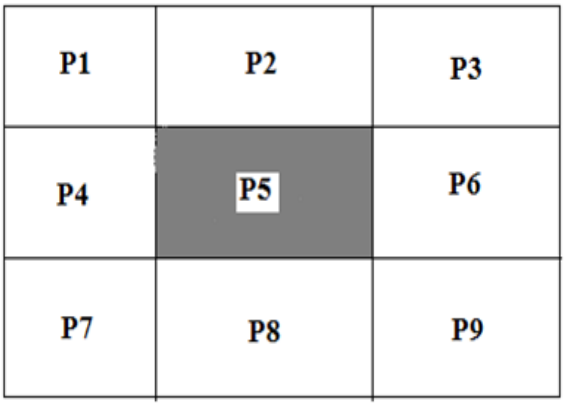

Figure 4.3x3 mask for noise removal

V. SIMULATION RESULTS

In this paper two noisy images of blood cell and circuit are shown. In result we can see that our proposed method showing better result than other traditional methods like sobel, prewitt roberts as well as one another fuzzy based operators(2x2 window method).

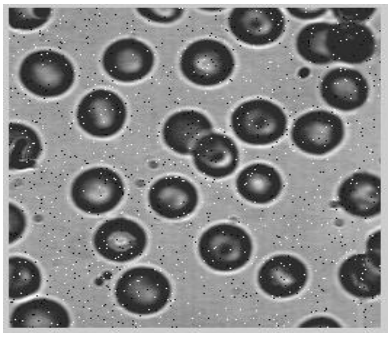

Figure 5(a)

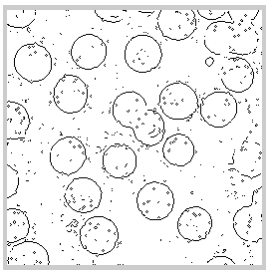

Figure 5(b)

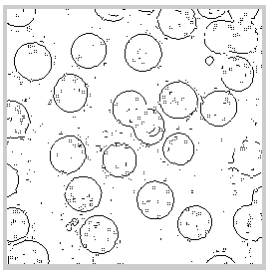

Figure 5(c)

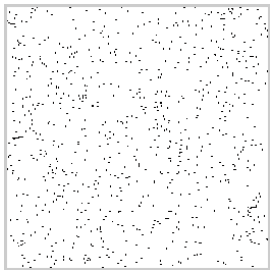

Figure 5(d)

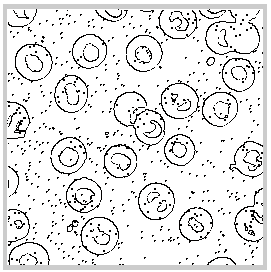

Figure 5(e)

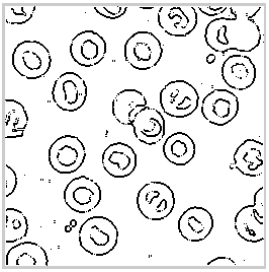

Figure 5(f)

Fig.5 (a) Noisy Blood Cell image (b) Sobel Edge Detection (c) Prewitt Edge Detection (d) Roberts Edge Detection(e) Edge Detection by 2x2 window method(f) Edge Detection by 3x3 window(**Proposed Method**)

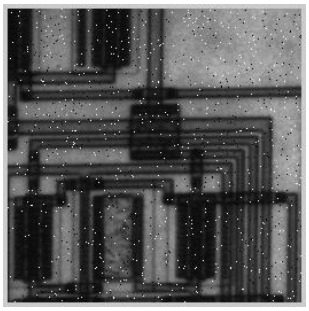

Figure 6(a)

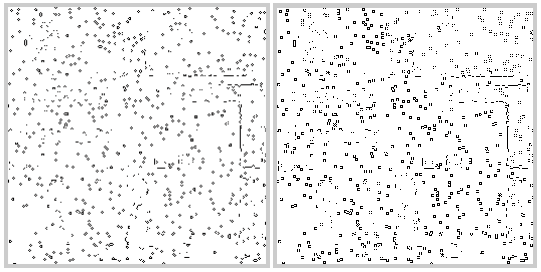

Figure 6(b) Figure 6(c)

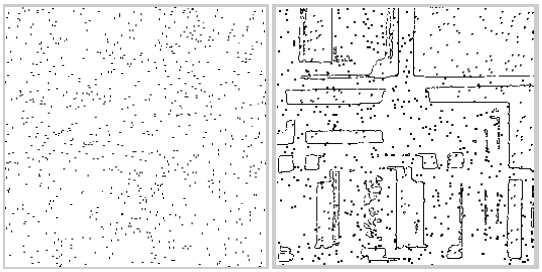

Figure 6(d) Figure 6(e)

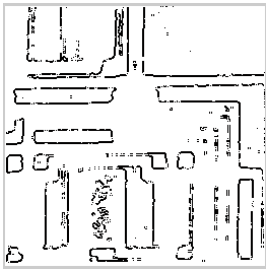

Figure 6(f)

Fig.6 (a) Noisy Circuit image
(b) Sobel Edge Detection(c) Prewitt Edge Detection (d) Roberts Edge Detection(e) Edge Detection by 2x2 window method (f) Edge Detection by 3x3 window method (**Proposed Method**)

VI. CONCLUSIONS

In this paper, emphasis has been to develop a very simple & small but a very efficient, fuzzy rule based edge detection algorithm to abridge the concepts of artificial intelligence and digital image processing. The algorithm and associated GUI has been developed in MATLAB environment. Comparisons were made with the various other edge detection algorithms that have already been developed. Displayed results have shown the accuracy of the edge detection using our proposed fuzzy rule based algorithm as shown in figure 5(f) and 6(f) over the other algorithms. Sample output has been shown to make the readers understand the accuracy of the proposed algorithm. Thus developed proposed algorithm exhibits tremendous scope of application in various areas of digital image processing.

VIII. REFERENCES

[1] Zhengquan He et. al.” Edge Detection With BP Neural Networks” proceedings of ICSP’98

[2] Mohsen Sharifi et. al. “A Classified and comparative Study of Edge Detection Algorithms” Proceedings of the International Conference on Information Technology 2002 IEEE

[3] Mohd Ashri Abu Hassan et. al.” Evaluation of Sobel, Canny, Shen & Castan Using Sample Line Histogram Method” IEEE 2008.

[4] Hamed Mehrara et. al.” Novel Edge Detection Using BP Neural Network Based on Threshold Binarization” in conference ” Second International Conference on Computer and Electrical Engineering”2009 IEEE

[5] Wafa barkhoda et. al.” Fuzzy Edge Detection Based on Pixel's Gradient and Standard Deviation Values” Proceedings of the International Multiconference on Computer Science and Information Technology, 2009 pp. 7 – 10, ISBN 978-83-60810-22-4

[6] Er Kiranpreet Kaur et. al.” Fuzzy Logic Based Image Edge Detection Algorithm in MATLAB”in journal “International Journal of Computer Applications” (0975 - 8887) Volume 1 – No. 22 in 2010.

[7] Sabina Priyadarshini et.al.” A New Edge Detection Method based on Additions and Divisions” International Journal of Computer Applications (0975 – 8887) Volume 9– No.10, November 2010

[8] H. Farahanirad et. al.” A Hybrid Edge Detection Algorithm for Saltand- Pepper Noise “Proceeding of the International MultiConference of Engineers and Computer Scientists 2011 Vol I ,IMECS 2011,March 16-18,2011,HongKong

[9] A. Jayachandran, R. Dhanasekaran, T. Sudarson Rama Perumal” A Novel Fuzzy Information System Based Edge Detection of Noisy Digital Images”,International Conference ” European Journal of Scientific Research” ISSN 1450-216X Vol.73 No.2 (2012), pp. 254-265

[10] Pinaki Pratim Acharjya et. al.” A Study on Image Edge Detection Using the Gradients” International Journal of Scientific and Research Publications, Volume 2, Issue 12, December 2012

[11] Mrs.R.Shenbagavalli et. al. “Satellite Image Edge Detection Using Fuzzy Logic” The International Journal of Engineering and Science (IJES) Volume 2 Issue 1 Pages 47-52 2013 ISSN: 2319 – 1813 ISBN: 2319 – 1805

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