ISSN: 2348 9510
International Journal Of Core Engineering & Management (IJCEM)
Volume 1, Issue 10, January 2015

Fuzzy Inference System based Edge Detection in Images

Anjali Datyal[1] and **Satnam Singh**[2]
[1]M.Tech Scholar, ECE Department, SSCET, Badhani, Punjab, India
[2]AP, ECE Department, SSCET, Badhani, Punjab, India
Email:anjali.datyal@yahoo.com , jeevanjot1999@gmail.com

***Abstract* — Edge detection is an important aspect of image processing and is also an essential pre-processing step in image segmentation. Edges in images are pixels at which the intensity of an image function changes suddenly and edges are sets of connected edge pixels. This paper gives an overview of wide range of methods of edge detection, their application, performance, and implementation. We present conventional techniques for edge detection as well as proposed a Fuzzy rule based Edge Detection technique. The comparison of proposed Fuzzy based edge detection with conventional techniques like sobel and prewitt methods are done in this paper.**

***Index Terms* –Edge detection Image segmentation, Fuzzy logic, De-fuzzification, Fuzzy Inference system**

I. INTRODUCTION

The objects discrimination from their background is the crucial task in image processing. The extraction of an object from their background requires the detection of the edges forming that object. Edge detection in image processing has wide range of applications like image enhancement, recognition, morphing, restoration, registration, compression, retrieval and watermarking etc. Edge detection is a method or technique that detects the location of edges constituted by sudden changes in colour intensity or brightness of an image.

Computer vision includes techniques for acquiring, processing, analyzing, and understanding digital images [1]. Object Recognition is a task of finding a given object in an image or video sequence and is the main task in computer vision. Peoples recognize a multitude of objects in images with little effort regardless of the fact that the image of the objects may vary somewhat in different viewpoints, in many different sizes / scale or even when they are translated or rotated. A digital image is divided into multiple segments (sets of pixels) for correctly recognize objects, in computer vision. Image segmentation is used to locate objects and their boundaries in images. Image segmentation is the technique of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics.

Several image segmentation techniques have been defined so far. Edge detection is one of the image segmentation techniques [2, 3]. Therefore edge detection is a key research work in image processing, image analysis, pattern recognition and computer vision techniques. In recent years, edge detection is widely used in different areas like in biomedical image segmentation. It is a segmentation technique which detects sharp, local changes in intensity. Edge pixels are pixels at which the intensity of an image function changes suddenly. Various edge detection methods are proposed recently [4].

The edge detection techniques can be divided into three steps. In first step, a noise removal form images is performed. Image noise should be reduced as much as possible in order to get better performance of edge detection. The noise reduction is usually achieved by a low-pass filter because the additive noise is normally a high frequency signal. However, the edges can possibly be removed at the same time because they are also high frequency signals. Therefore, we have to set the best trade-off between noise reduction and edges information preservation. In the second step, a high pass filter (HPF) like differential operator is usually employed to find the edges. In the last step, an edge localization process is performed to identify the genuine edges.

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II. Edge Detection Methods

This Section gives the basic of conventional/classical and Fuzzy rule based edge detection methods. The advantages and disadvantages of each method are also discussed.

(A) Classical Methods

Classical edge detectors have no smoothing filter and are based on a discrete differential operator. The earliest popular works includes the methods developed by Sobel, Prewitt, Kirsch, Robinson, and Frei-Chen. They compute an estimation of gradient for the pixels and look for local maxima to localize step edges. The methods are simple in computation and capable to detect the edges, but due to lack of smoothing stage, they are very sensitive to noise.

The Sobel operator is the most known among the classical methods. The Sobel edge detector applies 2D spatial gradient convolution operation on an image. It uses the convolution masks shown in equation 1 to compute the gradient in two directions (i.e. row and column orientations). It then works out the pixels gradient through g = |gr + gc|. Now, the gradient magnitude is threshold. Sobel edge detector is a simple and effective technique, but sensitive to noise and also the detected edges are thick, which may not be suitable for applications that the detection of the outmost contour of an object is required [5].

$$H_c = \frac{1}{4}\begin{bmatrix} -1 & 0 & +1 \\ -2 & 0 & +2 \\ -1 & 0 & +1 \end{bmatrix}$$

$$H_r = \frac{1}{4}\begin{bmatrix} +1 & +2 & +1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} \quad \ldots\ldots \quad (1)$$

Estimation of a derivative calculated using a relatively large set of neighboring pixels is more robust to noise than using only two pixels. Several operators have been proposed with this idea; some of them are an extended version of the 3x3 detectors mentioned earlier. A mask adopted by the 7x7 Prewitt based operator to estimate the horizontal (column orientation) first order derivative of the image is presented as following.

$$H_c = \frac{1}{21}\begin{bmatrix} -1 & -1 & -1 & 0 & 1 & 1 & 1 \\ -1 & -1 & -1 & 0 & 1 & 1 & 1 \\ -1 & -1 & -1 & 0 & 1 & 1 & 1 \\ -1 & -1 & -1 & \mathbf{0} & 1 & 1 & 1 \\ -1 & -1 & -1 & 0 & 1 & 1 & 1 \\ -1 & -1 & -1 & 0 & 1 & 1 & 1 \\ -1 & -1 & -1 & 0 & 1 & 1 & 1 \end{bmatrix} \quad \ldots\ldots \quad (2)$$

We can use operators of several dimensions.

(B) Fuzzy Logic Based Approach

The fuzzy technique of edge detection has one of the modern methods in variety of processes. Fuzzy image processing is basically assembling all methods that understand, represent and process the images, their segments and features as fuzzy sets.

Fuzzy image processing has three stages: image fuzzification, changing of membership values and image defuzzification. Hence the coding of image data (fuzzification) and decoding of the results (defuzzification) are steps that make possible to process images with fuzzy techniques [6].

There are wide varieties of methods for illustrating the advancement in the field of fuzzy logic based edge detections techniques [7, 8].

III. Proposed Fuzzy Edge Detection

The inference rules depend on the weights of the neighbour gray level pixels, if the neighbour's weights are degree of blacks or degree of whites. The powerful of these rules is the ability to extract all edges in the processed image directly.

The method assigns all the pixels of the processed image by studying the situation of each neighbour of each pixel. The condition of each pixel is decided by using the floating

ISSN: 2348 9510
International Journal Of Core Engineering & Management (IJCEM)
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2x2 mask shown in figure 1 which can be scanning the all greys.

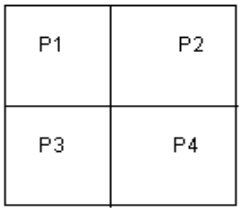

Figure1: 2 x2 Mask for Edge detection

The table 1 below shows the set of rules defined using fuzzy inference system with 2x2 masks.

Table 1: Input –Output Fuzzy sets for 2x2 mask.

Input Fuzzy sets for 2x2	Output Fuzzy sets for 2x2
Black [0 0 60 90]	Edge[0 0 80]
White[80 180 255 255]	Non-Edge[82 255 255]

IV. Steps of Proposed System

To accomplish the task of edge detection using fuzzy logic with a sliding window of 2x2, the step by step methodology is followed as described under:

a) Crisp inputs for P1, P2, P3 & P4 are fuzzified into various fuzzy sets, having conventional crisp 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 as shown in table 2.

d) Aggregate resultant output fuzzy set for all fired rules is achieved by using MAX operator.

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

f) Crisp Output P4_out is the pixel value of the output image i.e. one containing the Edge and Non- edge regions.

Table 2: Fuzzy Rule Matrix for 2x2 mask.

Fuzzy Inputs				Fuzzy Output
P1	**P2**	**P3**	**P4**	**P4_out**
B	B	B	B	NE
B	B	B	W	E
B	B	W	B	E
B	B	W	W	E
B	W	B	B	E
B	W	B	W	E
B	W	W	B	E
B	W	W	W	NE
W	B	B	B	E
W	B	B	W	E
W	B	W	B	E
W	B	W	W	E
W	W	B	B	E
W	W	B	W	E
W	W	W	B	E
W	W	W	W	NE

V. Results

The Results of fuzzy based proposed algorithm using rules defined in table 2 are shown in figure 2. The results of

ISSN: 2348 9510
International Journal Of Core Engineering & Management (IJCEM)
Volume 1, Issue 10, January 2015

conventional methods of edge detection is also shown in figure 2.

As it can be visualized from the simulation results shown in figure 2 that the proposed techniques have defined the edges more clearly and are more informative in case of low contrast areas when subjected to different types of images.

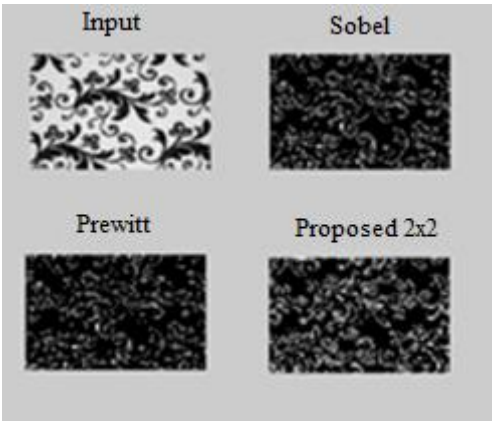

Figure 2: Results of proposed method

Comparison is made by calculating the (MSE) mean squared error and peak signal to noise ratio (PSNR) for 2x2. The table 3 shows the value of mean squared error (MSE) for different operators compared with the proposed method with 2x2 window.

Table 2: MSE for different operators compared with 2x2

OPERATOR	IMAGES TYPE			
	SQUARE	CARPET	HOUSE	NATURE
	MSE			
SOBEL	0.7612	0.5294	0.5213	0.4837
PREWITT	0.7608	0.5296	0.5208	0.4843
PROPOSED 2X2	0.7605	0.5112	0.5113	0.4760

Table 3: PSNR of developed system

OPERATOR	IMAGES TYPE			
	SQUARE	CARPET	HOUSE	NATURE
	PSNR			
SOBEL	49.3192	50.8928	50.9598	51.2848
PREWITT	49.3158	50.8912	50.9641	51.2797
PROPOSED 2X2	49.3198	51.0445	51.0437	51.3546

VI. CONCLUSIONS

The purpose of this paper is to present an overview and survey of various edge detection techniques like Sobel operator technique, Prewitt technique, Fuzzy Edge Detection technique. This paper provides the concept of edge detection and proposed a fuzzy based edge detection. The results shows that the proposed methods gives better results when compared with sobel and prewitt methods.

REFERENCES

[1] Ehsan Nadernejad, Edge Detection Techniques: Evaluations and Comparisons, Applied Mathematical Sciences, Vol. 2, 2008.
[2] D. Marr; E. Hildreth "Theory of Edge Detection", Proceedings of the Royal Society of London. Series B, Biological Sciences, Vol. 207, No. 1167. (Feb. 29, 1980), pp. 187-217.
[3] N. Senthilkumaran1 and R. Rajesh, "Edge Detection Techniques for Image Segmentation – A Survey of Soft Computing Approaches", International Journal of Recent Trends in Engineering, Vol. 1, No. 2, May 2009.

ISSN: 2348 9510
International Journal Of Core Engineering & Management (IJCEM)
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[4] Mr. Salem Saleh amri, Dr. N.V. Kalyankar and Dr. Khamitkar S.D, "Image segmentation by using edge detection", IJCSE International Journal on Computer Science and Engineering Vol. 02, No. 03, 2010.

[5] Mamta Juneja, Parvinder Singh Sandhu, "Performance Evaluation of Edge Detection Techniques for Images in Spatial Domain", International Journal of Computer Theory and Engineering, Vol. 1, No. 5, December, 2009 1793-8201.

[6] Fuzzy Logic Based Digital Image Edge Detection, Aborisade, D.O, Global journal of Computer science and technology,Vol.10 Issue 14 November 2010.

[7] Edge Detection in Digital Images Using Fuzzy Logic Technique Abdallah A. Alshennawy, and Ayman A. Aly, World Academy of Science, Engineering and Technology 51 2009.

[8] Applications of Advanced Fuzzy Logic Techniques in Fuzzy Image Processing Scheme ,M. Hari Krishnan and 2R. Viswanathan, Advances in Fuzzy Mathematics ISSN 0973-533X Volume 5, Number 1 (2010).