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Efficient Technique to Detect Edge in Images with Fuzzy Rules

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Abstract: There exists an increasing demand to detect edge of an image for many real time applications. In this paper an innovative technique is proposed for detecting text using fuzy rules. The projected system primarily divides the image into fragment of 3 x 3 matrix. The proposed system uses fuzzy rules using input size of eight pixels and one output pixel. The output pixels will either be one among black, white or edge pixel. The fuzzy sytem is applied with sixteen rules for categorizing the pixel as target pixel. Fuzzification is performed which converts the input pixel into the fuzzy interval between zero and one. It is followed by calculating a degree of Hesitation, which is also called as the intuitionstic fuzzy indicator. The last step is the Defuzzification process where the pixel identified as the pixel is converted to its original image pixel with the interval between 1 and 255. The proposed system is weighed against existing edge detecting methods like Canny, Sobel, and ACO algorithm. The proposed algorithm works fine even for exigent scenarios of the image.

Keywords : Fuzzy rules, ACO, Intuitionistic fuzzy indicator.

I. INTRODUCTION

Detecting the edge is prerequisite for any applications dealing with image . It works for a broad variety of applications. Soft Computing is a rising domain in favor of problems having uncertainties. The fuzzy technique gives precise activities during the procedure of mathematical estimation. An Edge is a unexpected transformation within the pixel strength in an image. It contains significant information present in any type of images.

Soft computing can be used to solve Image Processing real time problems. Many Edge detecting methods are introduced like Sobel, Prewitt, Kirsch, Canny and Robert. These methods have drawbacks related to noise. There are some uncertainties in image processing in various aspects, for this reason Fuzzy processing is desirable. Fig 1 Represents 3x3 pixel window masks.

P1	P2	P2
P4	P5	P6
P7	P6	P9

Fig 1. 3 x3 Pixel Window Mask

II. PREVIOUS RESEARCH

In [1] a method is used that does not require the threshold value to be calculated. The image is divided into 3*3 matrices and applied with the fuzzy rules. The algorithm produces better result for images with straight lines. Aijaz et al in [2] proposed a method that takes the gray scale image as input. This work is demonstrated through computer simulation in Pushpajit A.Khaire et al in [3] proposed Image Edge detection approach with the techniques involved in Soft Computing. In this method, histogram analysis is done which improves the edge detection. Suryakant et al in [4] proposed novel method for finding edges. The method is compared against the sobel edge operaor. Bijuphukan et al in [5] used a technique that does not involve the setting of threshold value. The technique was implemented in matlab. It involved the use of just a 2x2 matrix for the fuzzy rules. Shaveta et al in [6] presented a hybrid way of connecting the fuzzy rukes with conventional operators. Kiranpreet et al in [7] proposed a system that is applied with noise removal algorithm and is employed with diverse stages of development. Becerikli et al in [8] proposed a new approach. In these approaches, heuristic rules were applied. Aborisade in [9] used spatial convolution procedure to detect edge. Yong Yang et al in [10] developed an algorithm by introducing a new procedure for calculating the membership.

III. RESEARCH METHOD

In this paper , fuzzy rules are generated using input size of eight pixels and one output pixel. The output pixels will either be one among black, white or edge pixel. The fuzzy sytem is applied with sixteen rules for categorizing the pixel as target pixel. Fuzzification is performed which converts the input pixel into the fuzzy interval between zero and one. It is followed by calculating a degree of Hesitation, which is also called as the intuitionstic fuzzy indicator. The last step is the Defuzzification process where the pixel identified as the pixel is converted to its original image pixel with the interval between 1 and 255. Fig 2 represents the overall workflow of the proposed methodology.

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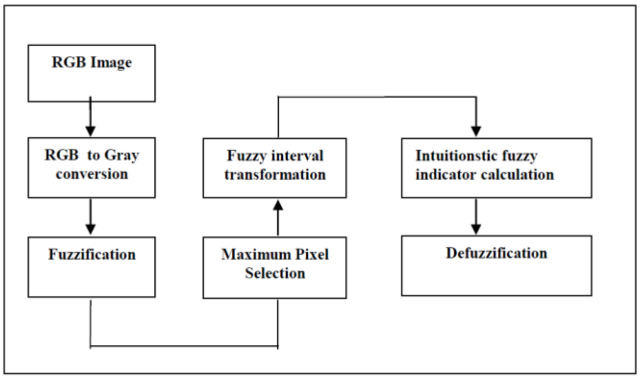


Fig 2. Overall workflow of the Proposed System

3.1 Fuzzy Inference System

This system is designed with 8 inputs. The eight inputs after processing by the algorithm produces one output. The window mask is run over the input image. The eight pixels run over by the window contribute to the input pixels of the algorithm. Two fuzzy rules are designed for the input and three fuzzy rules are designed for the output. The two input fuzzy rules are fixed as White pixel and Black pixel. The three output fuzzy rules are fixed as White pixel , Black pixel and Edge pixel.

The input is comprised of two fuzzy sets namely white and black and the output is comprised of three fuzzy sets namely white, black and edge. Fig 3 represents the fuzzy sets of input and output variables.

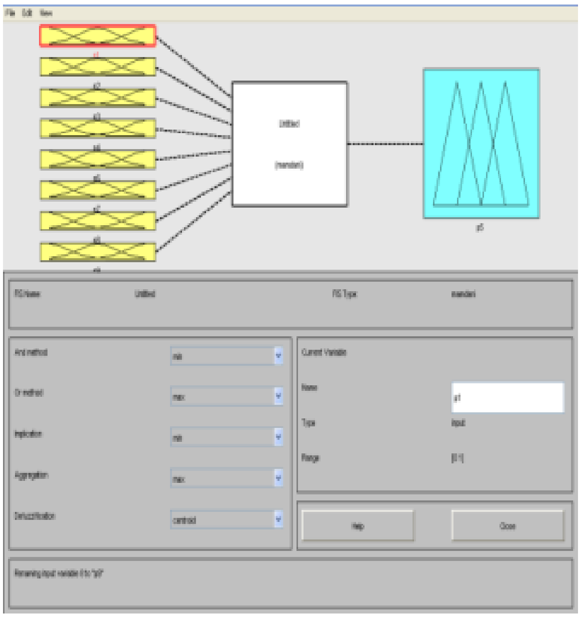


Fig 3. Fuzzy sets for input and output

3.2 Fuzzy rules

Choosing an appropriate membership function is more important. In this paper triangular membership function is chosen. Two fuzzy rules are designed for the input and three fuzzy rules are designed for the output. The two input fuzzy rules are fixed as White pixel and Black pixel. The three output fuzzy rules are fixed as White pixel , Black pixel and Edge pixel.

Membership function design of input and output fuzzy set is shown in fig 4(a) and 4(b). Table 1 Represents the Fuzzy Set Parameters.

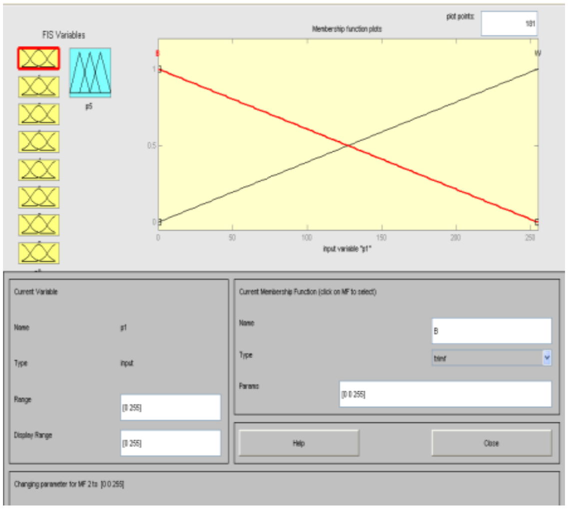


Fig 4(a) . Membership function - Fuzzy Set of Input Pixels

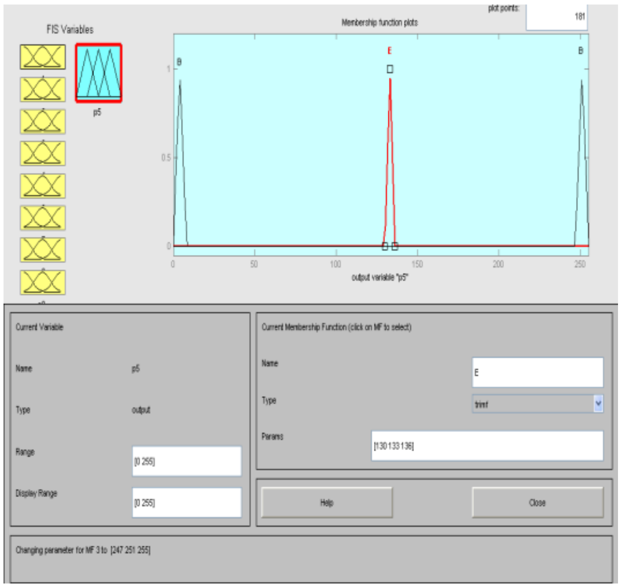


Fig 4 (b) . Membership function - Fuzzy Set of Output Pixels

Table 1 – Fuzzy Set Parameters

Fuzzy Input	Linguistic variable for pixel	Range	MF	Parameter
P1	White	[0 255]	Triangular	[0 255 255]
	Black			[0 0 255]
P2	White	[0 255]	Triangular	[0 255 255]
	Black			[0 0 255]
P3	White	[0 255]	Triangular	[0 255 255]
	Black			[0 0 255]

P4	White	[0 255]	Triangular	[0 255 255]
	Black			[0 0 255]
P6	White	[0 255]	Triangular	[0 255 255]
	Black			[0 0 255]
P7	White	[0 255]	Triangular	[0 255 255]
	Black			[0 0 255]
P8	White	[0 255]	Triangular	[0 255 255]
	Black			[0 0 255]
P9	White	[0 255]	Triangular	[0 255 255]
	Black			[0 0 255]
Fuzzy Output	Linguistic variable for pixel	**Range**	**MF**	**Parameter**
P5	Black	[0 255]	Triangular	[0 4 8]
	Edge			[130 133 136]
	White			[247 251 255]

IV. EXPERIMENTAL RESULTS

The proposed Fuzzy Logic is experimented for different images and edges are detected. It is followed by histogram calculation. Generally in histogram , the highest point will be small in support of images depicting more contrast whereas it will be large for images depicting less contrast . The peaks will be spaced further for light image whereas spaced less for dark image. It is seen that histograms of fuzzy logic image detects the sharp edges more efficiently than Sobel or Canny. Various images are tested with Sobel, canny, ACO, fuzzy algorithms.

V. PERFORMANCE MEASURES

5.1 Histogram Comparison

Generally in histogram , the highest point will be small in support of images depicting more contrast whereas it will be large for images depicting less contrast . The peaks will be spaced further for light image whereas spaced less for dark image. It is seen that histograms of fuzzy logic image detects the sharp edges more efficiently than Sobel or Canny. Fig 6 represents the histograms of Sobel, Canny and Fuzzy method. Table 2 shows the comparison of PSNR value between different edge detecting algorithms.

1) Index Image

(a) (b) (c) (d) (e) (f) (g)

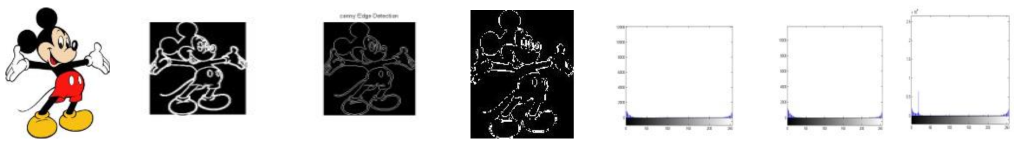
2) Leaf Image

(a) (b) (c) (d) (e) (f) (g)

3) Aero plane Image

(a) (b) (c) (d) (e) (f) (g)

4) Micky Image

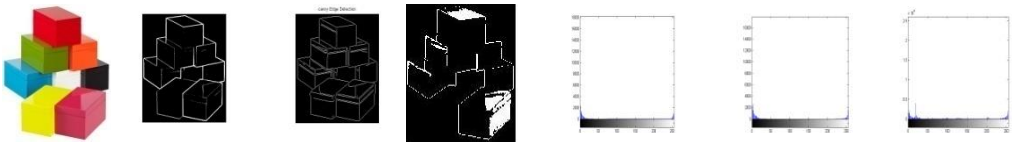


(a) (b) (c) (d) (e) (f) (g)

5) Circles Image

(a) (b) (c) (d) (e) (f) (g)

6) Box Image

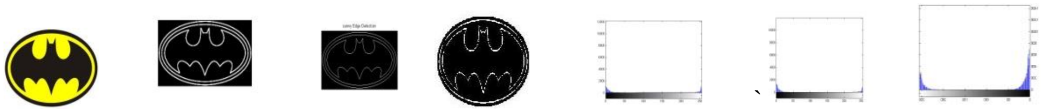


(a) (b) (c) (d) (e) (f) (g)

7) Logo Image

(a) (b) (c) (d) (e) (f) (g)

8) Yellow Image



(a) (b) (c) (d) (e) (f) (g)

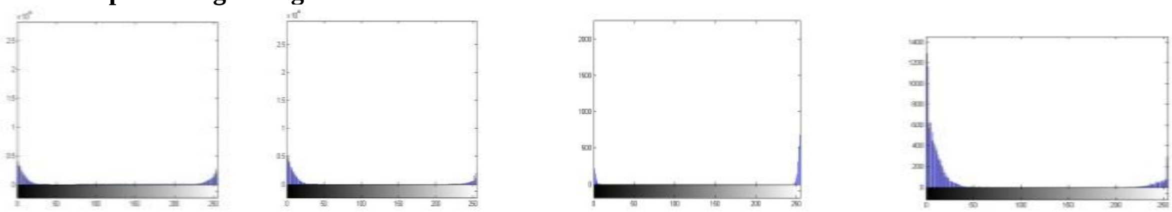
9) Apple Image

(a) (b) (c) (d) (e) (f) (g)

10) Car Image

(a) (b) (c) (d) (e) (f) (g)

Other Results: Fig 5. (a) Original Image (b) Edge detected by sobel operator (c) Edge detected by Canny operator (d) Proposed Method Edge Image (e) Histogram of Image after sobel operator(f) Histogram of Canny Edge Image (g) Histogram of Proposed Edge Image



(A) (B) (C) (D)

Fig 6. Histogram of A) Sobel B) Canny C) ACO Algorithm D)Proposed Fuzzy Algorithm

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Table 2. PSNR CALCULATION

S.No	Image Name	Sobel Edge Image	Canny Edge Image	Proposed Fuzzy Edge Image
1.	Index	+4.99 db	+4.90 db	+ 5.23 db
2.	Leaf	+8.55 db	+8.78 db	+ 9.11 db
3.	Aero plane	+6.75 db	+6.89 db	+6.91 db
4.	Micky	+5.82 db	+5.58 db	+5.95 db
5.	Circles	+4.38 db	+3.34 db	+4.89 db
6.	Box	+5.00 db	+5.00 db	+5.05 db
7.	Logo	+5.32 db	+ 4.88 db	+5.56 db
8.	Yellow	+5.69 db	+5.65 db	+5.79 db
9.	Apple	+6.67 db	+6.62 db	+6.77 db
10.	Car	+6.37 db	+6.67 db	+6.81 db

VI. CONCLUSION AND FUTURE WORK

The fuzzy rules designed in FIS improve the quality of detecting the edges. Moreover noise is removed mostly. This gives a clear and neat detection of edges. This work may be extended by setting more rules and using efficient noise removal algorithms.

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