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Edge Detection using Fuzzy Logic in Matlab

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Abstract— This paper proposes the implementation of a very simple but efficient fuzzy logic based algorithm to detect the edges of an image without determining the threshold value. The proposed approach begins by scanning the images using floating 3x3 pixel window. Fuzzy inference system designed has 8 inputs, which corresponds to 8 pixels of instantaneous scanning matrix, one output that tells whether the pixel under consideration is "black", "white" or "edge" pixel. Rule base comprises of sixteen rules, which classify the target pixel. The proposed method results for different captured images are compared to those obtained with the linear Sobel operator.

Keywords— Edge detection, Fuzzy logic, Fuzzy inference system

I. INTRODUCTION

Images have always been very important in human life. Soft Computing is an emerging field that consists of major seminal theories which include fuzzy logic, genetic algorithms, evolutionary computation, and neural networks In the last few years there is an increasing interest on using soft computing (SC) techniques to solve image processing real-world problems covering a wide range of domains. Edge detection refers to the process of identifying and locating sharp discontinuities in an image. The discontinuities are abrupt changes in pixel intensity which characterize boundaries of objects in a scene. Edge detection i is usually done with a first and/or second derivative measurement following by a comparison with threshold which marks the pixel as either belonging to an edge or not. The result is a binary image which contains only the detected edge pixels. 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 neighbor pixels. A very important role is played in image analysis by what are termed feature points, pixels that are identified as having a special property. Feature points include edge pixels as determined by the well-known classic edge detectors of PreWitt, Sobel, Marr, and Canny Recent research has concerned using neural Fuzzy Feature to develop edge detectors, after training on a relatively small set of proto-type edges, in sample images classifiable by Classic edge detectors. This work was pioneered by Bezdek et. al, [9] who trained a neural net to give the same fuzzy output as a normalized Sobel Operator.

In the system described in [7, 8], all inputs to the fuzzy inference systems (FIS) system are obtained by applying to the original image a high-pass filter, a first-order edge detector filter (Sobel operator) and a low-pass (mean) filter. The whole structure is then tuned to function as a contrast enhancing filter and, in another problem, to segment images in a specified number of input classes. The adopted fuzzy rules and the fuzzy membership functions are specified according to the kind of filtering to be executed. The work of this paper is concerned with the development of a Fuzzy logic rules based algorithm for the detection of image edges. By scanning the images using floating 3x3 pixel window mask .Fuzzy Inference based system in MATLAB Environment has been developed, which is capable of detecting edges of an image. The rule-base of 28 rules has been designed to mark the pixel under consideration as Black, White or Edge. The result has been compared with the standard algorithms

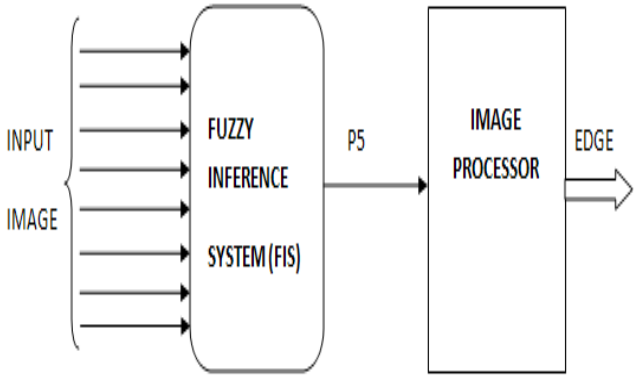

Figure 1. Basic Block Diagram

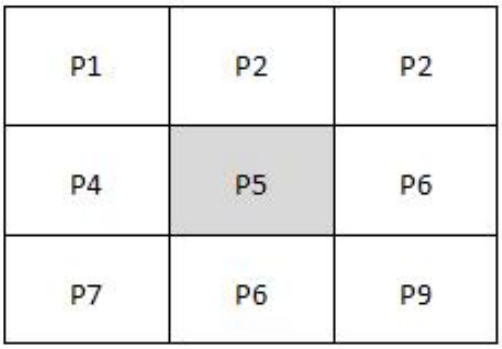

Figure 2. Floating 3x3 pixel window mask

II. FIS METHOD

The designed fuzzy inference system is given eight inputs and one output. The Eight inputs are the Eight pixel values (p1,p2,p3,p4,p6,p7,p8,p9) of the window mask used.. The trapezoidal membership functions are used for the inputs and the triangular membership functions are for the output. Two fuzzy sets are used for the input Black & White and three fuzzy sets are used for the output. Fuzzy sets for input and output variables are designed as shown in the table below

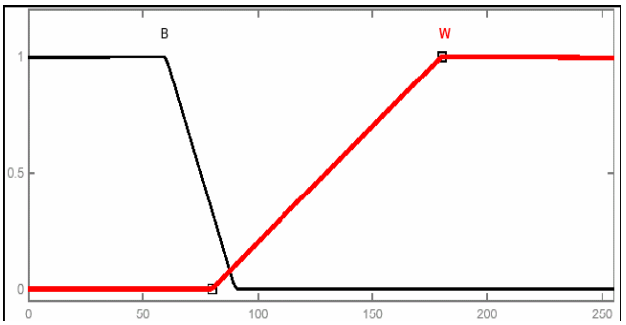

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Figure 3. Membership functions of the fuzzy sets associated to the input

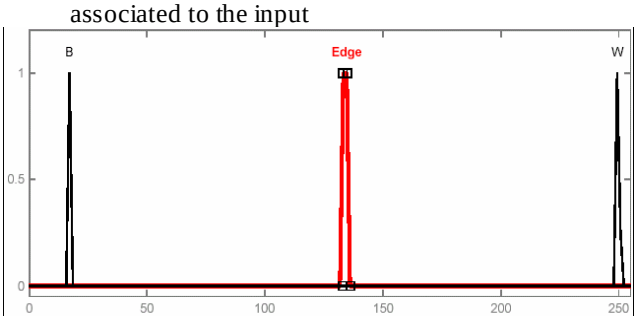


Figure 4. Membership functions of the fuzzy sets associated to the output (p5)

The inference rules is depends on the weights of the eight neighbours gray level pixels, if the neighbours Weights are degree of blacks or degree of whites. The Powerful of these rules is the ability of extract all edges in the processed image directly. The result images contribute the contours, the black and the white areas. From the side of the fuzzy construction, the input greys is ranged from 0-255 gray intensity, and according to the desired rules the gray level is converted to the values of the membership functions . The output of the FIS according to the defuzzification is presented again to the values from 0-255. And then the black, white and Edge are detected

Fuzzy Input								Fuzzy Output
P1	P2	P3	P4	P6	P7	P8	P9	P5
W	W	W	W	W	B	B	B	E
B	B	B	W	W	W	W	W	E
B	W	W	B	W	B	W	W	E
W	W	B	W	B	W	W	B	E
B	B	W	B	W	B	W	W	E
W	W	B	W	B	W	B	B	E
B	W	W	B	W	B	B	W	E
W	B	B	W	B	W	W	B	E
B	B	B	B	W	W	W	W	E
W	W	W	B	W	B	B	B	E
B	B	B	W	B	W	W	W	E
W	W	W	W	B	B	B	B	E
B	B	B	B	B	W	W	W	E
B	B	W	B	W	B	B	W	E
W	W	W	B	B	B	B	B	E
W	B	B	W	B	W	B	B	E
B	W	W	B	W	W	W	W	E
W	W	W	B	W	B	W	W	E
W	W	W	W	W	B	B	W	E
B	B	W	W	W	W	W	W	E
W	W	W	W	W	W	B	B	E
W	W	W	W	B	W	W	B	E
W	W	B	W	B	W	W	W	E
W	B	B	W	W	W	W	W	E
W	B	B	W	B	W	W	W	E
W	W	W	W	B	W	B	B	E
B	B	W	B	W	W	W	W	E
W	W	W	B	W	B	B	W	E

Table 1. Rule base

A rule base of 28 rules is set for the various fuzzy conditions that can occur. Singe output describes whether the output pixel i.e. P5 belongs to White fuzzy set, Black fuzzy set or Edge fuzzy set. Rules are enlisted in the form of a matrix in Table. 1.

III. NOISE REMOVEL

Noise removal is performed at different intermediate levels of Processing. 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. 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. Fig. 2 shows p5 as falsely marked edge pixel as all the surrounding pixels i.e. p1, p2, p3, p4, p6, p7, p8 & p9 are Black. Such types of falsely marked edge pixels are changed to Black by the noise removal algorithm.

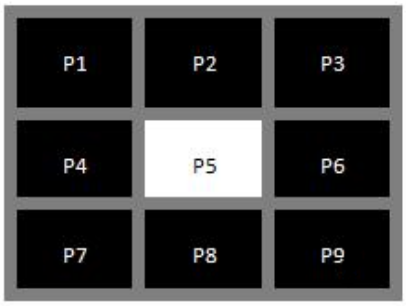


Figure 5. 3x3 masks used to omit noise

IV. EXPERIMENTS

The proposed system was tested with different Images, its performance being compared the existing edge detection algorithms and it was observed that the outputs of this algorithm provide much more distinct marked edges and thus have better visual appearance than the standard existing

It can be observed that the output that has been generated by the fuzzy method has found out the edges of the image more distinctly as compared to the ones that have been found out by the "Sobel" edge detection algorithm. Thus the Fuzzy rule based System provides better edge detection and has an exhaustive set of fuzzy conditions which helps to extract the edges with a very high efficiency.

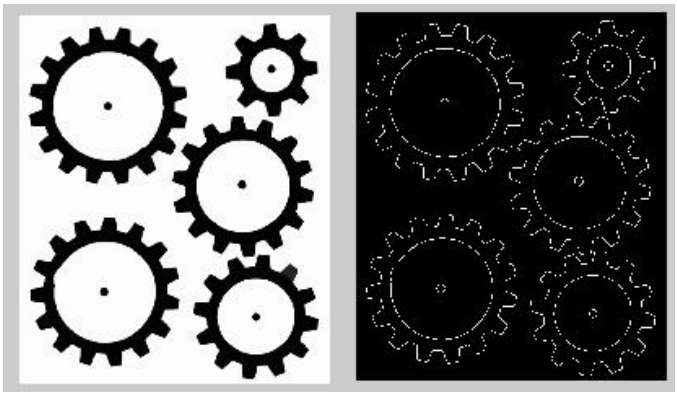
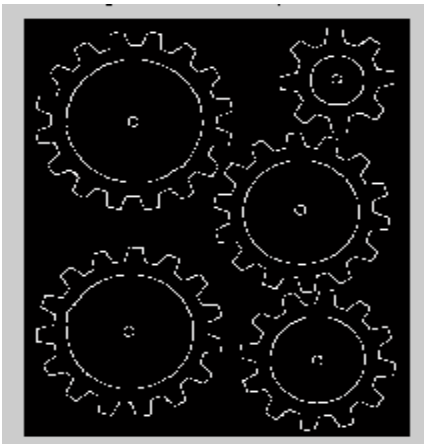


Figure 7. (a) Original image (b) Edge with sobel operator



(c) After applying Fuzzy method

V. CONCLUSIONS

In this paper, we have proposed a very simple & small but a very efficient, fuzzy rule based edge detection algorithm which infuse the concepts of artificial intelligence and digital image processing. Comparisons were made with the Sobel edge detection method. Displayed results have shown the accuracy of the edge detection using the fuzzy rule based algorithm over the other Sobel method

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