Improving Digital Image Edge Detection by Fuzzy Systems

Begol, Moslem and Maghooli,Keivan

***Abstract*—**Image Edge Detection is one of the most important parts of image processing. In this paper, by fuzzy technique, a new method is used to improve digital image edge detection. In this method, a 3x3 mask is employed to process each pixel by means of vicinity. Each pixel is considered a fuzzy input and by examining fuzzy rules in its vicinity, the edge pixel is specified and by utilizing calculation algorithms in image processing, edges are displayed more clearly. This method shows significant improvement compared to different edge detection methods (e.g. Sobel, Canny).

***Keywords*—**Fuzzy Systems, Edge Detection, Fuzzy edge detection

I. Introduction

FUZZY techniques have always been utilized as one of the modern methods in different processes. in the value processing debate, one of the aiding methods in stating relations and complex calculations are fuzzy systems. [1, 2, 3] these techniques, relying on neural network methods have been capable of significantly improving image edge detection. [4, 5] today, image processing is one of the best tools for extracting properties, analyzing situations and ultimately, correct decision-making. this also implies to humans; information is sent to the brain through the eyes, and the brain, by processing this information, makes the final decision and issues the command. the goal of image processing is not implementing the human brain function based on data obtained from the eyes, because this operation is very complex and massive. rather, it constitutes preprocesses and execution of certain processes for extracting required properties for achieving predefined goals in the discussion of edge detection, analysis is carried out in form of pixels and by examining vicinity situations. system input is image pixels with levels between 0 and 255 the problem with most edge-detection methods is incapability in detecting real image edges. some edge-detection methods, enter very little edge levels which are not important to users as noise, and on the other hand, some edge detection methods do not extract useful image details. although, some methods based on the fuzzy technique have been created which by utilizing differentiation and pixel gradian [2], have to some deal been capable of extracting more precise image details, methods including prewitt, sobel, robert [6]. however, in images, which only the main image edges are important to us, these techniques have not proven to be remedial in different image edge-detection algorithms, one of the main problems is detecting main image edges in digital images. this is because of unspecified black and white level values, and therefore imprecision in these thresholds. hence, by utilizing fuzzy systems, a method is proposed which edges are extracted by means of determining a dependency function to black and white levels in each pixel and a series of other laws in this paper, a new fuzzy algorithm relative to [1] is used in edge detection, and a method capable of extracting applicable and useful image details and reducing image noise is employed. images used in this method possess gray levels, which are converted to black and white levels while processing the sobel, canny, robert, prewitt, and zero-cross etc. algorithms are some exmaples of common edge revealing algorithms. [7]

Begol,Moslem ; MSc Biomedical Engineering Department, Islamic Azad University Science and Research Branch,Tehran,Iran
(E-mail: m.begol@srbiau.ac.ir)
Maghooli,Keivan; Assistant Prof., Biomedical Engineering Department, Islamic Azad University Science and Research Branch,Tehran,Iran
(E-mail: k_maghooli@srbiau.ac.ir)

II. Method

The reason for edge creation in an image is light contrast between the two edges. Edges are parts of an image specifying its skeleton. Normally, important properties of an image are hidden in the edges.

Different types of edges are vertical, horizontal and diagonal edges. In order to find a vertical, we move horizontally in the first row by which each pixel is compared to its preceding pixel. If the difference is more than a certain specific number, the edge is revealed.

Likewise, in order to find a horizontal edge, we move vertical in the first column by which each pixel is compared to its preceding pixel. If the difference is more than a certain specific number, the edge is revealed.

In order to determine diagonal edges, a similar technique is employed.

A. Edge Detection Operation

In the edge detection technique, the input image format is contrast and the output image format is binary, meaning that the output in the edges is one binary (white) and zero binary (black) in other places.

In the edge detection discussion, processing pixel vicinities is considered. Two types of vicinities exist, which are:

1. *Four pixel vicinities*
2. *Eight pixel vicinities*

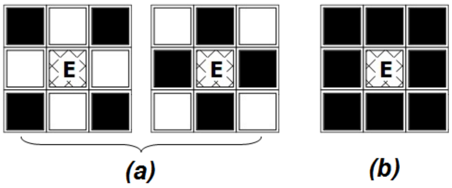

Fig. 1 (a) Four-pixel vicinity, (b) Eight- pixel vicinity

B. Fuzzy Membership Functions

The 3x3 mask selected for image scanning passes on pixel values to the fuzzy system input. In this mask, each pixel is considered an input image possessing values between 0 to 255. Two black and white functions are employed at the input and a triangular membership function is utilized at the output as the edge. The function center defuzzicator and the output display interval are selected between 0 to 255. (Figure 2)

The values of black and white membership functions are obtained by trial and error.

The B and W membership function were selected from 0 to 80, and 80 to 255 respectively. [1]

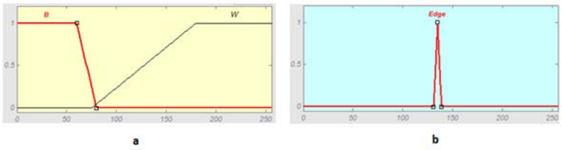

Fig. 2 (a) Input membership functions related to each pixel, (b) Output membership function for the edge pixel

C. Rules

Rules are determined based on pixel vicinity status. These rules have been written studying different states and special edge conditions. The considered 3x3 mask scans all image gray surfaces and pixels are examined according to predefined rules.

Rules are selected based on various forms of vicinity including 32 rules in six different series. (Figure 3)

For example, four rules in the first series examine horizontal and vertical edges; if vicinity conditions are correspondent to the above laws, the central pixel is selected as the edge.

Edge conditions are examined against other rules and in this way, edge pixels are specified.

AND and OR functions are considered as Min and Max and the function center difuzzicator is selected.

Some problems accompany these sets of rules. One of the basic problems is rule series 4 and 6. In these sets of rules, if a noise is spotted inside an image, it is mistakenly detected as the edge.

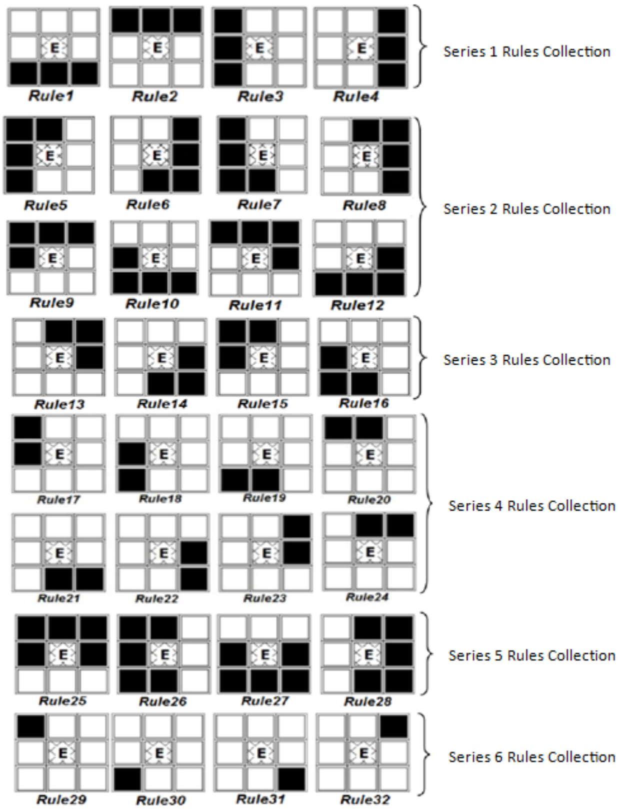

Fig. 3 The collection of edge detection rules employed in the fuzzy system

In order to remedy this situation, after carrying out the edge detection algorithm, a mask is placed over the output image, which attempts to scan the whole image.

In order to correct the noise created in series 4 rules, a 3x3 mask and for series 6 rules, a 5x5 mask is employed. (Figure4)

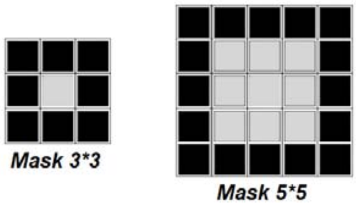

Fig. 4 The 3x3 and 5x5 masks used to omit noises crated in the fuzzy edge detection algorithm

By examining all pixel vicinities by means of the figure 3 mask, the main edges are determined.

Examining noises crated in series 6 rules, if edge pixels are within gray pixels, they are assumed as noise and are omitted from the image. Likewise, each pixel is examined for series 4 rules and the whole image is scanned. With this method, much of the noises are omitted.

The next problem is failing to observe line juncture between edge regions. After edge detection, edge lines in the image appear to be discontinuous. Therefore, in order to solve this problem, while selecting edge pixels, adjoining pixels are

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also selected. In this way, the problem with discontinuous edge lines is resolved. (Figure 5)

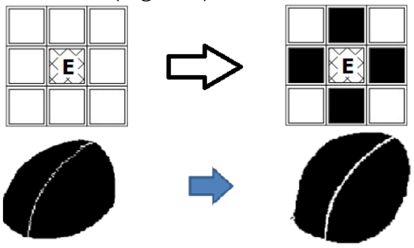

Fig. 5 Resolving the discontinuity problem in lines between edge regions

By applying this method, the continuity between edge lines can be maintained. By this method, another problem arises in which, too much thickness appears on edge lines, which is corrected by thinning in the binary image.

III. Result

In figure 6, Sobel and Canny filters are used for comparison and also, images with low complexity are used, and maintaining image edges has been the main consideration.

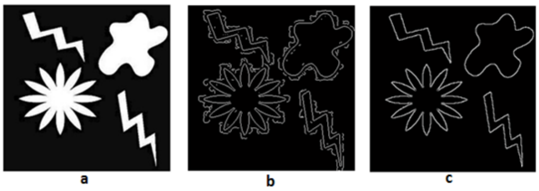

Fig. 6 (a) The main image, (b) Edges with Canny filter, (c) Edge detection using the fuzzy method

In figure 7, it is observed that although the Canny method (Figure 7c) has successfully extracted the main edges, yet it has entered some noise in the image. These noises are actually unwanted edges mistakenly detected as edges by the Canny method.

Our goal is to extract the main image edges. The Sobel method too, did not correctly detect the edges, but also did not enter any noise in the image.

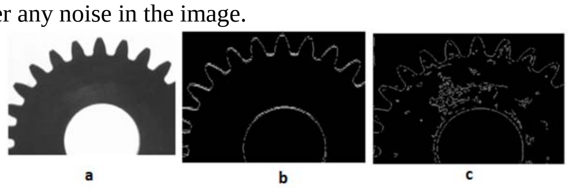

Fig. 7 (a) The main image, (b) Edge detection using the Sobel filter, (c) Edge detection using the Canny filter

The difference between this paper and paper [1] are evident in the image. In this image, the edge lines are discontinuous and some noise is evident in the image. In some parts of the edge lines, coarse line edges can be observed, which in our method, all these problems have been fixed, and while maintaining continuous and monotone lines, image noises are omitted.

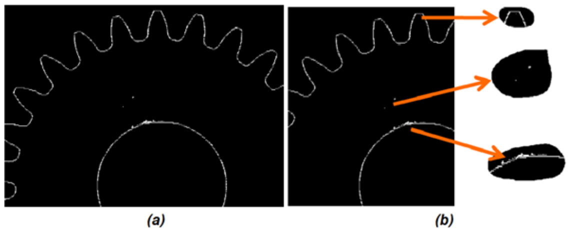

Fig. 8 (a) Edge detection using paper [1] method, (b) Paper [1] method problems

In figure 8-a noisy images are observed and Part from discontinuity between edge lines, coarse lines are observed in some regions. In figure 9, it is observed that image noise is eliminated and line continuity is well maintained. This method while maintaining the image's main edges, is capable of eliminating unwanted image noise.

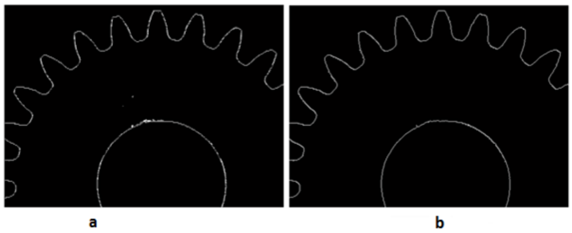

Fig. 9 (a) Edge detection by the fuzzy method explained in this paper, (b) Edge detection by the corrected fuzzy method explained in this paper

Examining the results in figure 10, it is observed that this method performs well in eliminating noises (especially salt and pepper noises).

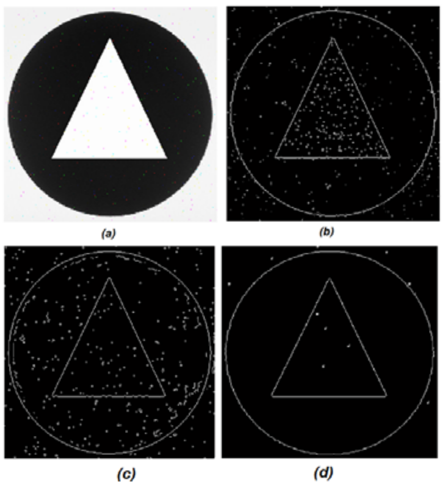

Fig. 10 (a) Original image with Salt & Pepper noise, (b) Edge detection utilizing the Sobel method, (c) Edge detection utilizing the Canny method, (d) Edge detection using the fuzzy technique, applying correction

In this figure, we observe that noises are eliminated perfectly and horizontal and diagonal edges are extracted with high clarity, which compared to paper [1], results have improved significantly.

IV. Discussion

As mentioned above, the fuzzy method and applied corrections in rules and digital processing has significantly improved digital edge detection compared to paper [1]. This method performs well in objects where small image details are not so important. This technique compared to paper [1], has performed well in detecting image edges and while eliminating image noise, has successfully maintained edge lines.

References

[1] Abdallah A. Alshennawy, And Ayman A. Aly, "EDGE DETECTION IN DIGITAL IMAGES USING FUZZY LOGIC TECHNIQUE" . World Academy of Science Engineering and Technology 51 2009. PP 178-186

[2] Wafa barkhoda, Fardin Akhlaqian Tab, Om-Kolsoom Shahryari , "Fuzzy Edge Detection Based on Pixel's Gradient and Standard Deviation Values", Computer Science and Information Technology, 2009. IMCSIT '09.

[3] V. Mittal and M. S. Batra, "Edge Detection Technique By Using Nero Fuzzy System," Proceedings of 2nd National Conference on Challenges & Opportunities in Information Technology (COIT-2008), RIMT-IET, Mandi Gobindgarh. March 29, 2008.

[4] Lu, S., Wang, Z. and Shen, J., Neuro-fuzzy synergism to the intelligent system for edge detection and enhancement. Pattern Recognition. v36 i10. 2395-2409

[5] Suh, I. H. and Kim, T.W, "Fuzzy membership function-based neural networks with applications to the visual servoing of robot manipulators", IEEE Trans. Fuzzy Systems 2(3) (1994), 203–220.

[6] L. Liang and C. Looney, "Competitive Fuzzy Edge Detection," Applied Soft Computing, (3) 123-137, 2003.

[7] R. Gonzalez and R. Wood, "Digital Image Processing", Addison - Wesley, 1992.