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FUZZY LOGIC TECHNIQUE FOR NOISE REMOVAL IN EDGE DETECTION METHODS

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Abstract

Image Edge detection significantly reduces the amount of data and filters out useless information, while preserving the important structural properties in an image. This paper presents a fuzzy rule base algorithm which is capable of detecting edges efficiently from the gray scale images. The following paper introduces such operators on hand of computer vision application. In the proposed algorithm, edginess at each pixel of a digital image is calculated using three 3□3 linear spatial filters i.e. low-pass, high-pass and edge enhancement (Sobel) filters through spatial convolution process. Finally We Have compared results of the proposed algorithm with other algorithms such as Sobel, Robert, and Prewitt. Experimental results show the ability and high performance of proposed algorithm.

Keywords: Edge Detection, WSVM, Fuzzy cognitive map, FNN Noise Removal, Digital Image Processing.

1. INTRODUCTION

Edge detection represents an extremely important step facilitating higher-level image analysis and therefore remains an area of active research, with new approaches continually being developed
Edge detection is an indispensable step in the computer vision and object recognition, because the most fundamental characteristic for image recognition is the edges of an image. Edges are boundaries between different textures. Edge also can be defined as discontinuities in image intensity from one pixel to another [1]. The edges for an image are always the important characteristics that offer an indication for a higher frequency. The goal of edge detection is to convert a 2D image into a set of curves. The salient features are expected to be the boundaries of objects **that** tend to produce sudden changes in the image intensity. They can show where shadows fall in an image or any other distinct change in the intensity of an image. The quality of edge detection is highly dependent on lighting conditions, the presence of objects of similar intensities, density of edges in the scene.

Since different edge detectors work better under different conditions, the objective of this paper is to identity the suitable edge detector for the IR images with the noise present in it [2]. Moreover, the aim is to find the good edge detector for the filtered images and the respective filter used for the identification of the same. The reason for choosing IR image is that quality of the IR images differs from the normal images. The edge detection operators such as the Sobel, Prewitt, Log and Canny are commonly used in the process of the edge detection. The noise taken for this study is Salt and Pepper noise a type of Impulsive noise, where the noise value may be either the minimum or maximum of the dynamic gray scale range of the image.

Common traditional edge extraction algorithms such as Canny use a constant window that can be mixed with some smoothing filters. They need high quality values for their parameters in order to reach extraction efficiency [3, 4]. Despite simplicity, low computational cost and the fact that these parameters are known in high degree of quality based on experiences during last years, but they are still dependent to lightening conditions, noise etc. Lack of any of these dependencies could result in fail of these methods. In addition, using a constant parameter all over the image can result as discontinuity in edges ant this discontinuity in edges is one of the most important weaknesses in such algorithms. Some methods try to extract special edges by applying transformations such as Hough transform but all edges don't meet required conditions. Due to lack of information, using hybrid techniques usually leads the process to fail. .In this paper, fuzzy logic based approach to edge detection in digital images is proposed. Firstly, for each pixel in the input image edginess 'measure is calculated using three 3 x3 linear filters after which three fuzzy sets characterized by three Gaussian membership functions associated to linguistic variable Low [11], Medium and High were created to represent each of the edge strengths. The second phase involves application of fuzzy inference rule to the three fuzzy sets to modify the Membership values in such a way that the fuzzy system out-put (edge) is high only for those pixels belonging to edges in the input image. The Last step is final pixel classification as edge or non-edge using Mamdani de-fuzzification method.

2. APPLICATION OF FUZZY LOGIC BASED EDGE DETECTION

Fuzzy logic represents a powerful approach to decision making [Zadeh 1965, Kaufmann 1975 and Bezdek1981]. Since the concept of fuzzy logic was formulated in 1965 by Zadeh, many researchers have been carried out on its application in the various areas of digital image processing such as image quality assessment, edge detection, image segmentation, etc[3]. Many techniques have been suggested by researchers in the past for fuzzy logic-based edge detection [Cheung and Chan 1995, Kuoet al. 1997, ElKhamy et al. 2000]. In [Zhao,2001].proposed an edge detection technique based on probability partition of the image into 3-fuzzy partitions (regions) and the principle of maximum entropy for finding the parameters value that result in the best compact edge representation of images. For example in [6], adjacent points are assumed as 3×3 sets around the concerned point. By predefining Member-ship function to detect edges. In these rules discontinuity in the color of different 3×3 sets, edges are extracted. It uses 5 fuzzy rules and predefined membership function to detect edges. In these rules discontinuity of adjacent point around the concerned point are investigated. If this difference is similar to one of predefined sets, the pixel is assumed as edge [6].

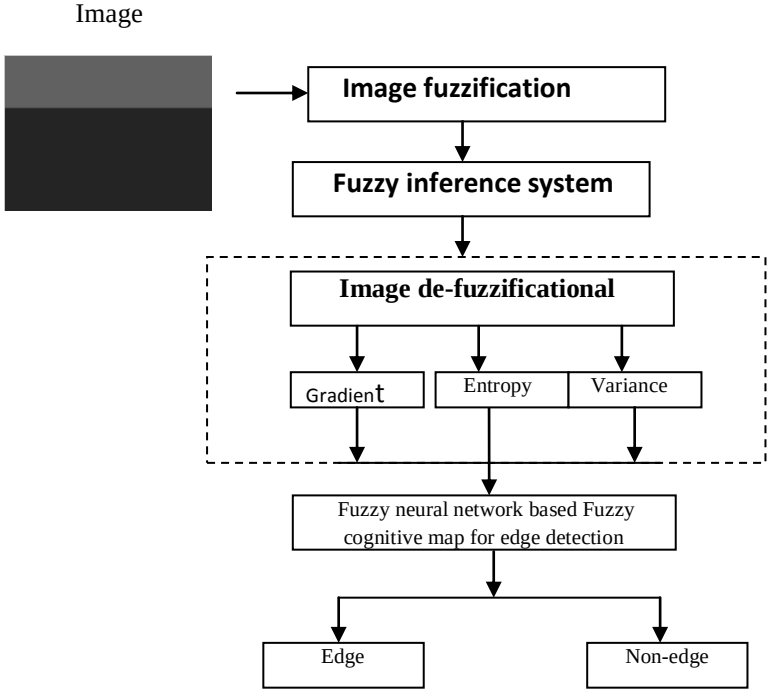

Figure 1 : Flow diagram of proposed edge detection

3. PROPOSED METHODOLOGY

In this paper, at first an input image is pre-process to accentuate or remove a band of spatial frequencies and to locate in an image where there is a sudden variation in the grey level of pixels. For each pixel in the image edge strength value is calculated with three 3×3 linear spatial filters i.e. low-pass, high-pass and edge enhancement filters (Sobel) through spatial convolution process. In carrying out a 3×3 kernel convolution, nine convolution coefficients called the convolution mask are defined and labelled as seen below.

P1	**P2**	P3
P4	P5	P6
P7	P8	P9

Fig. 2. Applied mask to compute standard deviation

$$I(x, y) = g(k, l) * I(x, y)$$

where: g (k, l) = convolutional kernel
I (x,y) = original image
I'(x,y) = filtered image
2N + 1 = size of convolutional kernel

If SD value of a pixel being equal to k1 , and gradient be equal to k2 , the fuzzy rules are defined as the following:

1-If k1 in SDL & k2 in GL then P Edge classified to EL
2-If k1 in SDL & k2 in GM then P Edge classified to EL
3-If k1 in SDL & k2 in GH then P Edge classified to EM
4-If k1 in SDM & k2 in GL then P Edge classified to EL
5-If k1 in SDM & k2 in GM then P Edge classified to EM
6-If k1 in SDM & k2 in GH then P Edge classified to EH
7-If k1 in SDH & k2 in GL then P Edge classified to EM
8-If k1 in SDH & k2 in GM then P Edge classified to EH
9-If k1 in SDH & k2 in GH then P Edge classified to EH

After the image data are transformed from gray-level plane to the membership plane (fuzzification), appropriate fuzzy techniques modify the membership values. This can be a fuzzy clustering, a fuzzy rule-based approach, a fuzzy integration approach and so on, [29]. In this paper a novel FIS method based on fuzzy logic reasoning strategy is proposed for edge detection in digital images without determining the threshold value or need training algorithm. This study is assaying all the pixels of the processed image by studying the situation of each neighbor of each pixel. The condition of each pixel is decided by using the floating 3x3 mask which can be scanning the all grays. In this location, some of the desired rules are explained.

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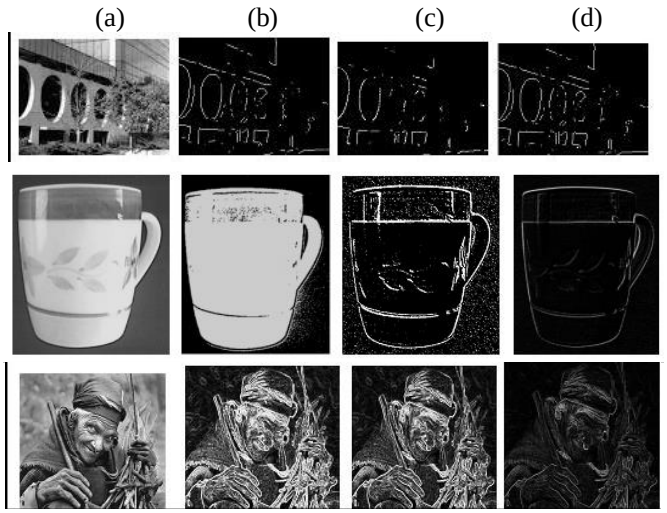

Fig. 3 (a) Original images, (b) Sobel operator results, (c) Kirsch operator results, (d) Proposed fuzzy edge detection algorithm results.

The proposed fuzzy edge detection method was simulated using MATLAB on different images, its performance are compared to that of the Sobel and Kirsch operators. Samples for a set of four test images are shown in Fig. 3(a). The edge detection based on Sobel and Kirsch operators using the image processing toolbox in MATLAB with threshold automatically estimated from image‘s binary value is illustrated in Fig. 3(b) and 3(c). The sample output of the proposed fuzzy technique is shown in Fig. 3(d). The resulting images generated by the fuzzy method seem to be much smoother with less noise and has an exhaustive set of fuzzy conditions which helps to provide an efficient edge representation for images with a very high efficiency than the conventional gradient-based methods (Sobel and Kirsch methods). Now I am applying this method on color image with the help of two degree angle 45 and 30 degree.

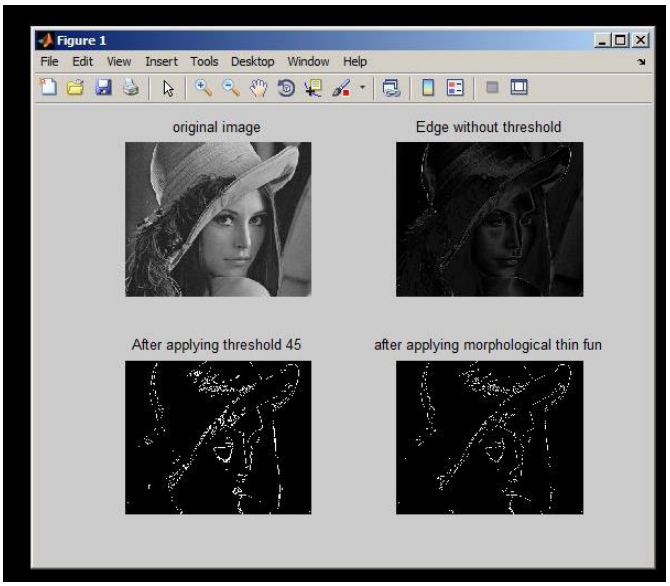

Fig. 4. Color Image with 45º

4. EXPERIMENTAL RESULTS

The proposed edge detection method is simulated using MATLAB on different images. It is observed that this proposed system provide much more distinct marked edges as compared to edge detection algorithms such SVM and weighted SVM. The performance metrics used for analyzing the proposed metrics are MSE, PSNR.

Peak Signal to Noise Ratio

The ratio between the maximum possible powers to the power of corrupting noise is known as Peak Signal to Noise Ratio. It affects the fidelity of its representation .It can be also said that it is the logarithmic function of peak value of image and mean square error.

$$PSNR = 10\log_{10}\left(\frac{MAX_i^2}{MSE}\right)$$

Mean Square error

Mean square error (MSE) of an estimator is to quantify the difference between an estimator and the true value of the quantity being estimated.

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2$$

Methodology	MSE	PSNR	Number of edges detected
SVM	0.3259	34.258	989
WSVM	0.2369	37.259	2045
HFCM-FNN	0.2145	40.256	3125

Figure 5: MSE comparison for edge detection methods

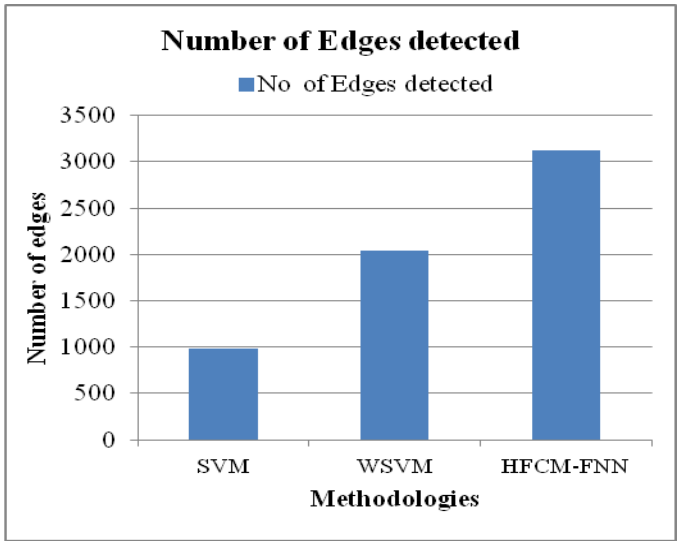

Figure 6 : Number of edges detected results for edge detection methods

5. CONCLUSION

In this paper, effective fuzzy logic based edge detection has been presented. This technique uses the edge strength information derived using three masks to avoid detection of spurious edges corresponding to noise, which is often the case with conventional gradient-based techniques. The three edge strength values used as fuzzy system inputs were fuzzified using Gaussian membership functions. Fuzzy if-then rules are applied to modify the membership to one of low, medium, or high classes. This work presents improved edge detector that uses the Hybrid Fuzzy Cognitive Map based Fuzzy Neural Network(HFCM-FNN) to perform the pixel classification between edge and no edge.

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