Morphological Gradient and Fuzzy Logic Approach for Edge Detection in MRI Images

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Abstract: MRI images form an essential part in the diagnosis and treatment process in medical field. Due to the magnetic field, which is the core operation procedure of MRI, there is a commotion in the acquisition and processing of the image in the form of noise. The diagnosis of the disease cannot be properly done owing to the noise present in the image which will hinder its path of accuracy. In this paper, we present an edge detection method using morphological gradient and type 1 fuzzy systems. These are found to be effective both on noisy and noiseless images and perform better than the conventional edge techniques like sobel, prewitt etc. The analyzing process is done using PFOM and PSNR parameters.

I. INTRODUCTION

Medical image analysis plays a crucial part in the medical field to diagnose and treat medical conditions. These medical images are complex and their complexity has to be decreased and this can be done by segmenting the image and detecting edges so that only crucial information is retained. Magnetic resonance imaging (MRI) of the body uses a powerful magnetic field, radio waves and a computer to produce detailed pictures of the inside of your body. It is used to help diagnose or monitor treatment for a variety of conditions within the brain, chest, abdomen and pelvis. MRI has 2 types of images, T1 and T2. Finding the edges in these images helps the physician to identify the issues and this provides a channel for proper treatment.

The paper is organized as follows. The integrated fuzzy system is described in section ii and the simulations and results are shown in section iii. Section iv and v give the conclusion and future scope respectively.

I. Morphological gradient and Fuzzy logic approach

Various edge detection methods have been developed in the process of finding the perfect edge detector. Most of these detectors can be categorized as gradient based and laplacian based edge detectors. In this paper, an integrated type 1 fuzzy system for edge detection is proposed.

The first step is to apply the morphological gradient to the image.

A. Morphological Gradient

The morphological gradient of a gray scale image can be defined as the difference between intensity values of two neighboring pixels that belong to a given structural element. A classic definition of morphological gradient is given in(1).

We use D instead of $\nabla(f)$. Applying equation 1 for a 3x3 matrix, we obtain the coefficients z_i with figure 2 and the possible direction of edge D_i with equation 1.The edges S can be calculated with equation 3.

$$D1=\sqrt{(z_5-z_2)^2+(z_5-z_8)^2} \quad \text{(2a)}$$

$$D2=\sqrt{(z_5-z_4)^2+(z_5-z_6)^2} \quad \text{(2b)}$$

$$D3=\sqrt{(z_5-z_1)^2+(z_5-z_9)^2} \quad \text{(2c)}$$

$$D4=\sqrt{(z_5-z_3)^2+(z_5-z_7)^2} \quad \text{(2d)}$$

$$S=D1 + D2 + D3 + D4 \quad \text{(3)}$$

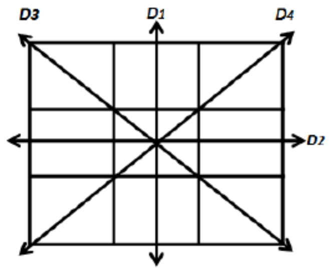

Figure 1*3x3 matrix* indicating the directions D_i

z_1= F(X-1, Y-1)	z_3= F(X+1,Y-1)	z_3= F(X+1, Y-1)
z_4= F(X+1, Y)	z_5= F(X, Y)	z_6= F(X+1, Y)
z_7= F(X-1, Y+1)	z_8= F(X, Y+1)	z_9= F(X+, Y+1)

Figure 2*3x3 matrix* indicating the coefficients Z_i.

A. Fuzzy Inferance System

The outputs D_i of the morphological gradient, are given as the inputs to the mamdani fuzzy inference system. The basic block diagram of fuzzy logic system is shown in figure 3. The crisp inputs are fuzzified using the fuzzification process where the fuzzy sets are created based on the gray scale value of images and membership functions are assigned. The membership functions are shown in figure(4). Gaussian membership functions are used in the entire approach.

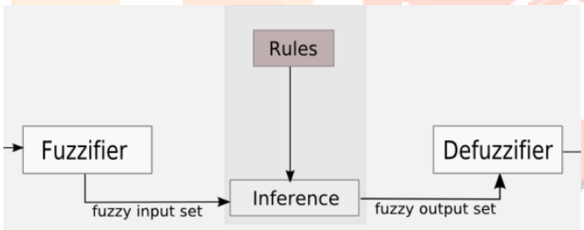

Figure 3**Block diagram of fuzzy inference system.**

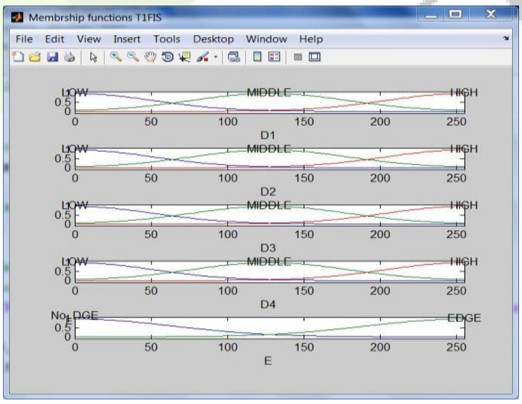

Figure 4 Fuzzy membership functions

lowi= min(Di) (4)

highi= max(Di) (5)

mediumi= lowi+ (highi– lowi)/2 (6)

σi= highi/5 (7)

edgei=1 (8)

no_edgei= 0 (9)

σi = edge/4 ` (10)

Next, we use 3 rules that help describe the existing relationship between the image gradients. The fuzzy rules are the following.

a) If (D1 is HIGH) or (D2 is HIGH) or (D3 is HIGH) or (D4is HIGH) then (S is EDGE)

b) If (D1 is MEDIUM) or (D2 is MEDIUM) or (D3 is MEDIUM) or (D4 is MEDIUM) then (S is EDGE)

c) If (D1 is LOW) and (D2 is LOW) and (D3 is LOW) and (D4 is LOW) then (S is NO_EDGE).

The outputs are now defuzzified using the centroid method and we get the final edge map of the MRI image.

II. Simulation Results:

The images are tested on few MRI images taken from the . The simulation results are shown below.

The PSNR and PFOM values are calculated and tabulated.

Edge Detector Used	PSNR (in dB)	PFOM
Sobel	15.7709	0.7422
	13.9139	0.7153
Laplacian of Gaussian	12.1094	0.7572
	11.5846	0.7263
Morphological Gradient	12.5984	0.7883
	12.2434	0.7739
T1FS +MG	13.6835	0.8794
	13.6456	0.8426

CONCLUSION

It can be seen that Morphological gradient and type 1 fuzzy systems have a greater value of PSNR and PFOM and hence, can be considered a better method to detect edges in the MRI image.

Future Scope: This method can be extended for hugher types of fuzzy systems and also on other kinds of medical images.

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