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IMAGE ENHANCEMENT OF GRAYSCALE IMAGE USING FUZZY LOGIC TECHNIQUE

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Abstract- **Image Enhancement process consists of a set of techniques that improve the visual look of an image or to convert an image to a much better type for analysis by an individual's or a machine. The Fuzzy domain methods is used for image enhancement. Fuzzy Technique enables us to manage us problems like vagueness and ambiguity. The theory of Fuzzy image processing is used here, which can be divided into three phase - image fuzzification, membership value modification, and image defuzzification. The proposed algorithm can be used to enhance the medical images to make diagnosis easy and also can be applied to other images. This paper compares some images with some existing methods on the basis of PSNR value. After finding out the PSNR value for the given image , we find that the proposed algorithm gives much better result than other existing techniques and the whole work is implemented in MATLAB 7.0.4.**

Keywords—image;fuzzification; defuzzification; membership function; PSNR; MSE

I. INTRODUCTION

An image with good contrast is called fine quality image while an image with poor quality is said to be low contrast image. Whenever an image is transformed from one form to another, such as, digitizing, scanning, transmitting etc., some degradation may occur at the output. Hence, the image has to pass through some steps called image enhancement.Fuzzy set theory help us to provide a powerful tools to represent and process human and use fuzzy sets in the form of fuzzy inference system. Many difficulties in image processing arise because of uncertainty of data. So this is only fuzzy technique that can manage the uncertainty and imperfection.

I. FUZZY IMAGE ENHANCEMENT

In classical set theory, a set is to define as a collection of numerous elements having a certain property, each belongs to the set. So the characteristic function takes the value of either 0 or 1.

Let us consider a classical set X, called universe whose elements are denoted by x , that is , $X=\{x_1,x_2\ldots\ldots\ldots x_n\}$. consider a subset A of set X is a member of A if

$$\mu_A(x) = 1 \quad \text{if } x \in A$$
$$\mu_A(x) = 0 \text{ otherwise}$$

So Fuzzy set A is defined as

$$A=\{(x, \mu_A(x) : x \in X\})$$

Where $\mu_A(x)$ is a membership function for a fuzzy set. Examples of membership functions are shown in Fig.1:

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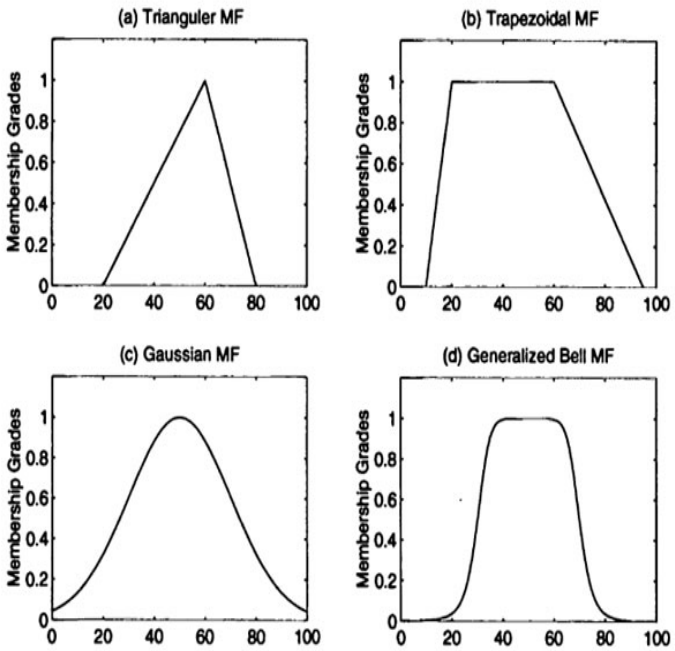


Fig. 1. Membership Functions Examples

Fuzzy image process is that assortment of approaches that facilitate to know, represent, and process the images and their options within the kind of fuzzy sets. The theory of Fuzzy image processing is used here, which can be divided into three phase–

- image fuzzification,
- membership value modification,
- defuzzification of enhanced image.

Image Fuzzification and Membership modification are the main steps of Fuzzy Image Enhancement. Therefore, the conversion of image data into fuzzy data and then decoding of the results back into image data are steps that process images with fuzzy techniques . The steps for Fuzzy Image Enhancement Technique are shown in Fig. 1:-

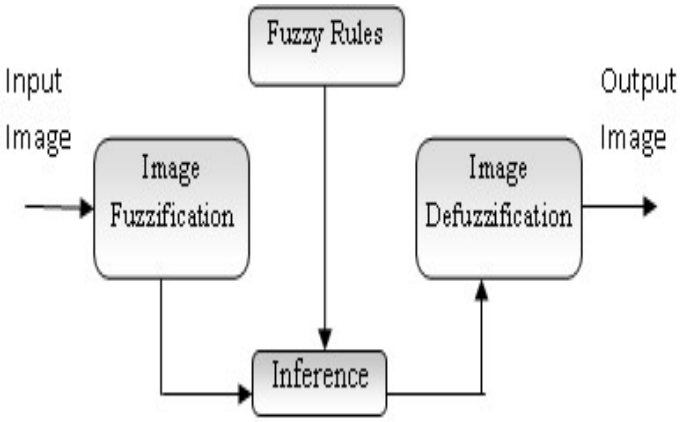


Fig. 2. Fuzzy Image processing [2]

The three main basic steps of Fuzzy Image Enhancement can be explained as:-

A. Image Fuzzification

Gray Level Intensities of image are mapped into a fuzzy plane using a membership transformation function. Gray values lies in range of [0 255]. The aim is to transfer these values in range of 0 and 1.

Gray level Intensity values lies in range={0,1,2,3……254,255}

Bright membership degree is calculated using following formula:

BM=Bright Membership Degree

BM = intensity_of_graylevel/255

So BW ={0,0.0039,……..,1}

Dark membership degree is calculated using following formula:

DM = Dark Membership Degree

DM = 1 - (intensity_of_graylevel /255)

So DW={1,0.9960,……,0}.

B. Fuzzy Membership Modification

To enhance the quality of image, we need to modify the values of the pixel and this can be done by making dark pixels more darker and bright pixels more brighter. Membership modification algorithm can be expressed as:-

if*(BM <= 0.5)*

input = 5*(BM)3;

else

input =1-5*(1 - BM)3

where BM is bright membership degree and input is modified membership degree.

C. Image Defuzzification

Image Defuzzification is inverse transformation in which the proposed algorithm maps the fuzzy sets back into gray level intensities in the range of [0 255].

BM values = {0,0.0039,……..,1}

DM values= {0,0.0039,……..,1}

Gray level intensity = BM*255

OR

Gray level intensity = (1-DM)*255

II. PROPOSED ALGORITHM

Step 1:- Read Grayscale image I and also find the size of image in terms of rows and columns [m n]

Step 2:-Crop the image and new image is d.

Step 3:- Find maximum and minimum intensity of I

mx = max(max (d))

mn = min(min(d))

Step 4:- Fuzzification

One image function μ_{mn} can be calculated as:-

$\mu = (d - mn)/(mx-mn)$

where mn ,mx , d denotes minimum gray and maximum gray and any gray level.

Step-5:- Membership Modification

Define all the pixels (i,j)th inside the image

For i=1:m

For j=1:n

If((μ (i,j) >= 0)&&(μ (i,j) <= 0.5))

input (i,j) = 5*μ(i,j)^3

Elseif ((μ (i,j) > =0.5)&&(μ (i,j) <= 1))

input (i,j) =1-5*(1-μ(i,j))^3

end

Step-6 Defuzzification (if necessary)

Now convert fuzzy data into grayscale enhanced data.Set maximum intensity and minimum intensity for enhanced image.

maxI = 255 , minI = 0

For i=1:m

For j=1:n

if (d(i,j) <= mn)

enhanceimage(i,j) = 0

elseif ((d(i,j) > mn)&&(d(i,j) < mx))

enhanceimage(i,j) = (maxI – minI)*input(i,j) +minI

else

enhanceimage(i,j) = 255

end

The proposed algorithm is compared for more than 5 images with some existing methods. On the basis of PSNR value we find that the proposed algorithm gives much better result.

PSNR can be calculated using the mathematical models/formulas in Equations below. First MSE is calculated using the following equation:

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

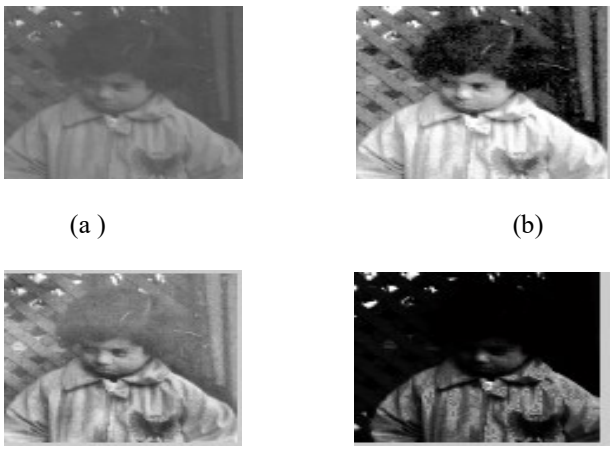
Where MSE is the Mean Squared Error of $m \times n$ grayscale images I and K, where one of the images is considered a noisy approximation of the other, where lower is better. Thereafter, PSNR can be calculated using the following equation:

$$PSNR = 10.\log_{10}\left(\frac{MAX_I^2}{MSE}\right) = 20.\log_{10}\left(\frac{MAX_i}{\sqrt{MSE}}\right)$$

Where, MAX_i is the maximum pixel value of the image. In other words $MAX_i = 2^b - 1$, where b is the bit depth of the original image (e.g., $MAX_i = 255$ in the case of 8 bits depth grayscale images).

III. COMPARISON & RESULTS

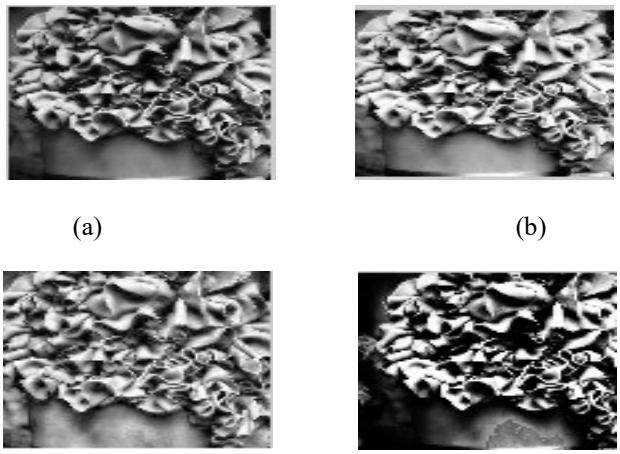
To evaluate the performance of the presented approach several experiments have been conducted. The proposed Fuzzy technique is able to improve contrast of original image and is compared with some other existing technique using PSNR value The proposed algorithm has been tested on several grayscale images and the result has been compared with other existing methods. Fig. 3, Fig.4, Fig.5, Fig.6 shows some experimental results. (a) is original image , (b) shows enhanced image by Histogram Equalizations Technique, (c) shows Adaptive Histogram Equalization technique ,(d) shows the enhanced image by proposed algorithm in this paper.



(a) (b)

(c) (d)

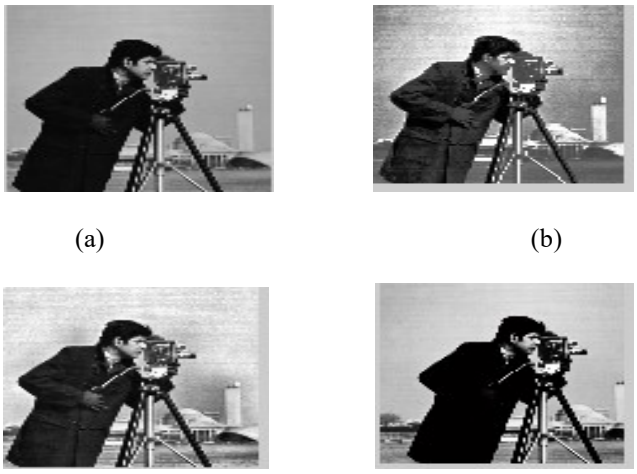
Fig. 3. Pout



(a) (b)

(c) (d)

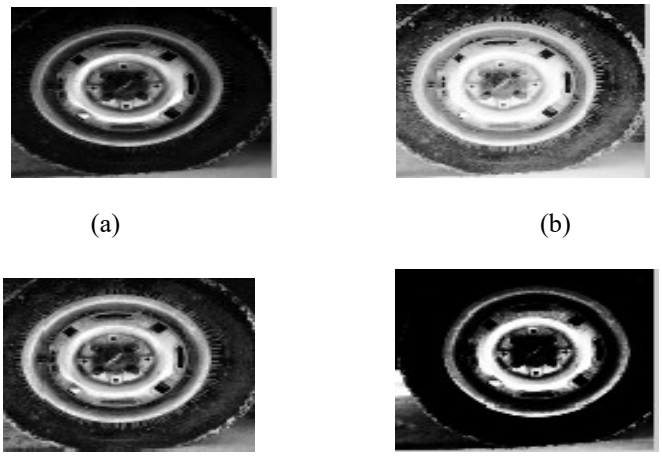
Fig. 4. cake



(a) (b)

(c) (d)

Fig . 5. Cameraman

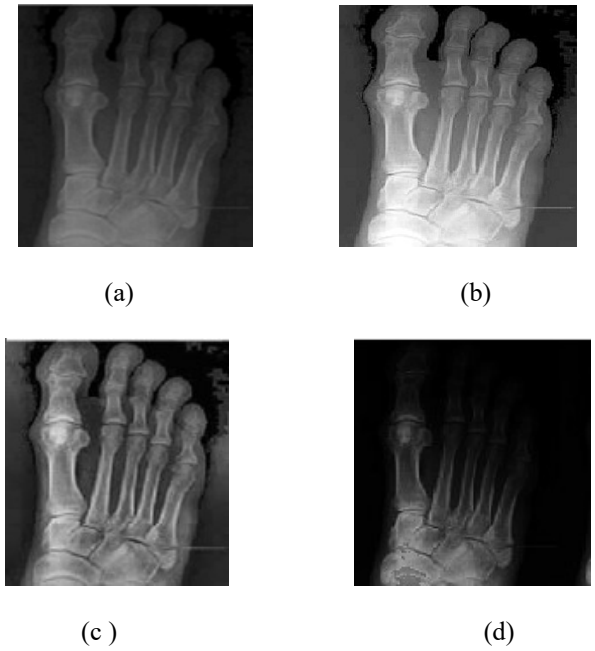


(a) (b)

(c) (d)

Fig. 6. Tire

Also the output of fuzzy image enhancement can be done on medical image(xray of foot) as shown in Fig 7 shows experimental result. (a) is original image , (b) shows enhanced image by Histogram Equalizations Technique, (c) shows Adaptive Histogram Equalization technique ,(d) shows the enhanced image by proposed algorithm.



(a) (b)

(c) (d)

Fig. 7. Medical image(xray foot)

The comparison can be done on the basis of PSNR value which is being compared in Table 1

TABLE 1. Comparison between existing technique and proposed technique

S. No.	Image name	PSNR value of original image	PSNR value of Histogram Equalization technique	PSNR value of Adaptive Histogram Equalization technique	PSNR value of proposed algorithm
1	Pout.tif	25.30	30.28	30.32	33.39
2	Cake.jpg	30.60	27.32	25.34	32.29
3	xray.jpg	25.41	25.42	30.42	33.07
4	Cameraman.tif	25.56	27.42	30.24	33.20
5	Tire.tif	26.12	29.71	30.62	33.56

IV. CONCLUSION

The proposed technique is able to improve contrast of image which is a developing technique in artificial intelligence. This technique is able to give more accurate result and produce more value of PSNR. The proposed method is tested for several images which shows that the proposed technique produce better result as compare to other existing enhancement technique.

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