An Efficient Algorithm for Image Enhancement

Manglesh Khandelwal
Ph. D. Scholar
Comp.Sc. & Engg.
Bhagwant University,
Rajasthan, India

Shweta Saxena
M.Tech Student
Comp Sc. & Engg.
TCT Bhopal ,
India

Priya Bharti
M.Tech Student
Comp Sc & Engg.
TCT Bhopal
India

Abstract-

In the digital image processing field enhancement and removing the noise in the image is a critical issue. We have proposed a new algorithm to enhance color Image corrupted by Gaussian noise using fuzzy logic which describes uncertain features of images with modification of median filter. **.** The performance of the proposed technique has been evaluated and compared to the existing mean and median filter.

Keyword: *Fuzzy set, image enhancement,, median filter*

1. INTRODUCTION

There are many applications in which color images are used and recorded by many different devices. Image transferring cameras for processing has become a central part of automatic image analysis as color can provide valuable cues for identification and localization of objects [1]. The noise as additional component to the image occurs in image for many reasons. There are many types of noisy images; probably the most frequently occurring noise is Gaussian noise of almost any signal. Gaussian noise is caused by random fluctuations in the signal [2].

Enhancement refers to accentuation or sharpening of image features to remove the noisy, such as contrast boundaries, edges, etc. There are many techniques to enhancing image. In this study the proposed technique compared with mean, median filtering, and vector median filter given in [3].

The Fuzzy Logic is used for the vague and uncertain properties of the Images. In the fuzzy logic we consider the values between the 0 and 1, where as crisp methods assign either 0 or 1. The Applications like the control systems and the Image processing the Fuzzy logic is an indispensable tool for it's application. This technique has gained importance in the last several decades.

In this paper, the different approach known Fuzzy Filter(FZF) have been produced for the image enhancement in fuzzy logic manner for a color image corrupted by Gaussian noise. Section II in this paper give a review of the literature and research in this field and it concerns with the main fundamental concept to understand the idea of enhancement of color image and theoretical foundation on fuzzy logic. We also discuss properties of Gaussian noise and the idea of some existing filter. In section III, we present the problem under consideration and introduce the proposed algorithm and constructing of the fuzzy filter is explained

Section IV, the experimental results are discussed in

Detail, and are compared to those obtained by other filters, the effect of the amount of noise and

type of image explained also in this section. Finally, Section V summarizes the conclusion

2. Color image Enhancement

The term enhancement means that the enrich the substance I.e. in the terms of the Image Enhancement this would refer to the increased the property of the Image for the subsequent use I.e. is for the Viewing , processing and the Analysis. Noise filtering can be viewed as replacing every pixel in the image with a new value depending on the fuzzy based rules. The algorithm which produced filtered image should vary from pixel to pixel based on the local context.

Contrast enhancement of color images is a well studied problem. Boccignone and Picariello [4] have suggested a multi-scale approach to contrast enhancement using a non- linear scale-space representation of image generated by anisotropic diffusion. Another multi-scale contrast enhancement technique is developed by Toet [5] through non-linear pyramid recombination. A scheme for local contrast enhancement of gray-scale images using multi-scale morphology is also proposed in [6]. Tang et. al. [7] has proposed a method of enhancing color images via chromaticity diffusion. A multi-scale approach for color image enhancement has been proposed by Toet [8]. Oakley et. al. [9] has proposed an enhancement scheme for color images in poor visibility conditions.

Now days the Fuzzy logic is used for the development for the sophisticated Control System. The reason for which is very simple. Fuzzy logic addresses such applications perfectly as it resembles human decision making with an ability to generate precise solutions from certain or approximate information. It fills an important gap in engineering design methods left vacant by purely mathematical approaches (e.g. linear control design), and purely logic-based approaches (e.g. expert systems) in system design [10].

To recover the image from its noise there exist many filter techniques which are applications oriented. Some filtering techniques have better effects than the others.

According to noise category. Median Filter is an image filter that is more effective in situations where white spots and black spots appear on the image. For this technique the middle value of the m×n window is considered to replace the black and white pixels as it shown in(1):

$Yn= med(X_{n—k}, X_{n--k},……..,X_n ,……,X_{n+k})$ – (1)

where X_n is median value of the ordered neighborhood pixel values (increasing or decreasing). If there is an even number, one takes the average of the two values closes to the center. With 4 and 8 neighborhoods, we will always have a center value if we include the pixel being transformed in the median. Although noise suppression is obtainable by using median filter (MF), too much signal distortion is introduced, and features such as sharp corners as well as thin lines are lost. To overcome these problems, several variations of median filters have been developed, the input pixel is replaced by the median of pixels contained in the neighborhood [11].

To remove the impulsive noise the median filter which is one of the strong nonlinear filter for the removing the denoising power [12].However, when the noise level is over 50%, some details and edges of the original image are smeared by the filter [13]. Different remedies of the median filter have been proposed, e.g. the adaptive median filter [14], the multi-state median filter [15], or the median filter based on homogeneity information [16] and [17]. These so-called "decision-based" or "switching" filters first identify possible noisy pixels and then replace them by using the median filter or its variants, while leaving all other pixels unchanged. These filters are good at detecting noise even at a high noise level. Their main drawback is that the noisy pixels are replaced by some median value in their vicinity without taking into account local features such as the possible presence of edges. Hence details and edges are not recovered satisfactorily, especially when the noise level is high [18].

There are several vector-valued filters, the classical vector median filter (VMF) based on L1 or L2 norm, the median filter based on reduced or conditional ordering, etc. In this part, the performance of the VMF is evaluated. The formula of the VMF is as in the following [19].

$$\sum_{i=1}^{N}\|y_n - x_{n-i}\|_L \le \sum_{i=1}^{N}\|x_{n-j} - x_{n-i}\|_L$$

(2) For j = 1, 2, …, N. Further, y is the output of the VMF, x is the input data, N is the size of the input data, L is the used norm (L1, L2) and i, j are indices.

Already several fuzzy filters for noise reduction have been developed, e.g., the well-known FIRE-filter, the weighted fuzzy mean filter and the iterative fuzzy control based filter from. Most fuzzy techniques in image noise reduction mainly deal with fat-tailed noise like impulse noise. These fuzzy filters are able to outperform rank-order filter schemes (such as the median filter). Nevertheless, most fuzzy techniques are not specifically designed for Gaussian noise or do not produce convincing results when applied to handle this type of noise [20].

This study will compare the proposed algorithm with other filtering techniques: mean, median filtering, and vector mean. First of all, algorithms will be developed for each of the methods. After writing the code for implementing these methods and conducting necessary testing, a variety of images will be put through the filtering techniques to determine which filtering techniques work best for which types of images. And to compute difference measures each result have been compared with its corresponding original image. The commonly used objective measures are Mean Square Error (MSE), Signal to Noisy Ratio (SNR) and Peak Signal to Noise Ratio (PSNR), which are calculated as in (3) and (4).

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}\left|I(i,j) - K(i,j)\right|^2 \quad (3)$$

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

Where MAXI is the maximum pixel value of the image. PSNR is the most commonly used measure of quality of restored image. It is easily defined by the Mean Squared Error.

Which is for two m×n monochrome images I and K, where one of the images is restored image and the other is original image [21].

The quality or the amount of noise, of the images used will be another independent variable.

3. Proposed Apporach

The proposed algorithm is to avoid the problem that occurs by existing in mean and median techniques by using fuzzy logic in the RGB color space. The proposed algorithm is started by the following steps:

- Input to the system original image.
- Convert it into RGB plane.
- Adding Gaussian noise to the original image.
- Produce fuzzy logic rules.
- RGB Values of image will be passed to fuzzy logic
- Fuzzy output will differentiate between ambiguous colors.
- compare the results with existing methods.

A. noise generation to an image

Gaussian noise is statistical noise that has a probability density function of the normal distribution. It is widely used to model thermal noise and, under some often reasonable conditions, is the limiting behavior of other noises, e.g., photon counting noise and film grain noise. The density function of univariate Gaussian noise, **q**, with mean μ and variance σ^2 is

$$p_q(x) = (2x)^{-1/2} e^{-(x-\mu)^2/2\sigma^2} \quad (5)$$

For $-\infty < x < \infty$, notice that the support, which is the
range of values of x where the probability density is nonzero,
is infinite in both the positive and negative directions. But, if we regard an image as an intensity map, then the values must be non-negative[1].

In this study, for the problem of interest here, assuming an input 24-bit bitmap color image which each 3-byte sequence in the bitmap array represents the relative intensities of red, green, and blue, respectively for image sized 256×256 RGB pixel corrupted by considering additive noise with a Gaussian distribution to Lena, Baboon, and Pepper image with different value of σ.

B. fuzzy rules

Rule form the basis for the fuzzy logic to obtain fuzzy output. The fuzzy rule-based system uses IF_THEN which is expressed as the form:
IF x is P THEN y is Q where P and Q are fuzzy values and x and y are fuzzy variables. The if-part of the rule "x is P" is called the antecedent or premise, while the then-part of the rule "y is Q" is called the consequent or conclusion. Statements in the antecedent (or consequent) parts of the rules may well involve fuzzy logical connectives such as 'AND' and 'OR'. That is, A AND M operator is replaced with minimum - min (A,M) operator, A OR M with maximum - max (A,M) and NOT M with 1-M[22].
The range of crisp values is 0-255 since 24-bits are used to represent each pixel. To represent colors, the most common color space is probably the RGB space, where the three primary colors Red, Green and Blue take their values between 0 and 1 or between 0 to 255, where each color is a fuzzy set and their union is a fuzzy set also. The black color is represented by the triplet (0,0,0). On the other hand the point (255,255,255) represents the white color which is corresponding the maximum value. This space is widely used in color histograms where the pixels are distributed on the three axes R, G and B. Many classification methods compute the similarities between histograms to determine a similarity between images [23].
The proposed algorithm is based on separating the color data and processing each one of these components. This method assigns a color class to each pixel of an input image by applying a set of fuzzy rules on it. Rules will be framed in Fuzzy Sets to differentiate between different levels and shades of colors in human sense (DEEP, DARK, THIN, LIGHT, and MEDIUM).
For each color pixel is considered as three array byte to produce the percentage of brightness, for each color the value of each byte must be divided by 256, this percentage represent the membership value between 0 and

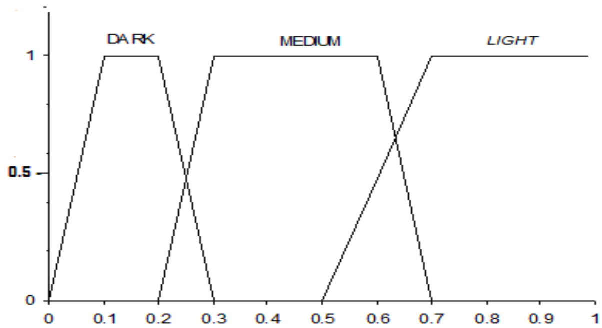

Figure 1. Membership Function
For DARK, MEDIUM, and THIN.

In Fig. 1 the horizontal axis represents the possible color values between [0, 255] and the vertical axis represents a membership degree (∈ [0, 1]). A membership degree indicates the degree in which a certain gradient value matches the predicate.

Color values situated in the interval [0,75] are most likely non-edge and non-noisy pixels. So these pixels can be classified as noise free, resulting in a zero membership degree in the fuzzy set. The values which are situated in the interval [75,155] are most likely edge pixels or noise pixels. Here we have some kind of uncertainty which is expressed by the membership degrees in the fuzzy set, these membership degrees are now situated between zero and one. Finally the values which are situated in the interval [155,255] are most likely noise pixels and the membership degrees in the fuzzy set noise are one.

For processing each pixel its 3x3 neighborhood is considered. The distance between the center and each of its

8 neighbors is calculated. To decide if a central pixel (P(i,j)

Is noisy pixel or not the following fuzzy rules are used:

- IF P(i-1, j+1) is DARK AND P(i+1, j-1) is LIGHT OR P(i-1, j)| is DARK AND P(i+1, j) is LIGHT OR P(i, j-1) is DEEP AND P(i, j+1) are THEN OR P(i-1, j-1) is MEDIUM AND P(i+1, j+1)AND P(i, j)are DARK THEN P(i, j) is need filter function.
- IF most of the eight neighborhood of P(i, j) are DARK THEN P(i, j) is need filter function.

The function for filtering the noisy pixel is shown in the following steps:

1. Find maximum and minimum values in the image for three color components.
2. dP(i,j)= ∑max-min
3. Average=1/9∑dP(i,j)
4. Calculate the overall contrast which is defined as the minimum of the average contrasts of the three color components.

IV. EXPERIMENTAL RESULTS

To evaluate the performance of the presented approach several experiments have been conducted. In this study, the proposed algorithm has been tested on a set of color images and the results have been compared with the other existing methods. Results on Lena images are shown here only. Fig. 2(a) show the original color images, Gaussian noise with variant σ is 5 and amount of 50% noisy is added to the image as it shown in Fig. 2(b). For comparison purpose with the other methods we present Fig.2 (c) that reconstruct noisy image by mean filter(MF), Fig. 2(d) represents recovering image that reduces noisy by using Arithmetic median filter(AMF), Fig.2(e) for vector median filter(VMF), and the last Lena image Fig.2(f) is for showing the result of proposed algorithm(FZF).

In Fig. 3 the PSNR of sample noisy images for different noise levels are plotted. From Table 1, when we have an image that its content have more details, the proposed filter works less better, than the other images.

As it shown in Table 1, the proposed algorithm has the least processing time.

Figure 2. Restoration of Lena image. (a) Original image, (b) Corrupted image with Gaussian noise σ=15, (c) recovered image by median filter, (d) recovered image by mean filter, (e) recoverd image with vector median filter, and (f) is the result of recovering image by proposed fuzzy filter.

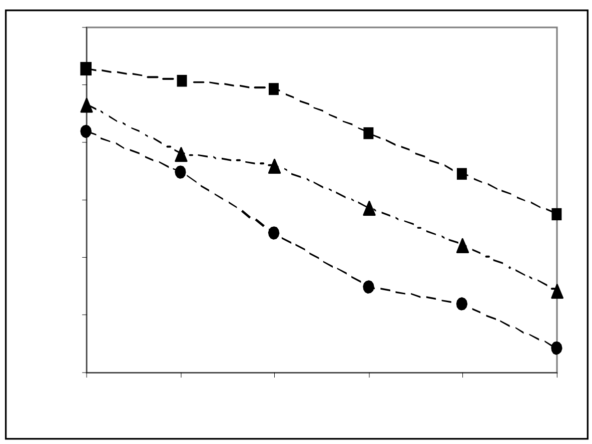

Figure 3. The effect of noise on images and effects on PSNR value

image	Filter	MSE	*PSNR*	*Ttime (second)*
Lena	MF	124	27.2	14
	AMF	96	28.3	12
	VMF	56	30.6	9
	FZF	34	32.8	8

V. CONCLUSION

In this paper the new method has been developed to remove the noise in the image by the Gaussian noise. The method tested on different images and compared with some existing filters. The experiments demonstrated that this new method is faster and more accurate and the reconstructed image is more sensitized, while the images that has many details are less insensitive and need more time.

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