Review and Application of Different Contrast Enhancement Technique on Various Images

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***Abstract*— Image enhancement plays a fundamental role in a variety of applications enhancement is the manner of improving the certain attribute of image and reducing the noise recently much work has already been proposed till now for enhancing the digital images. This paper has presented a relative comparison of a mixture of image enhancement techniques and mostly focused on histogram and fuzzy logic techniques. This paper has shown that the fuzzy logic and histogram based techniques have quite effective results over the available techniques. Use several quality check parameters for analysis purpose such as PSNR, MSE, NAE, AD This paper conclude with suitable future directions to enhance fuzzy based image enhancement technique further.**

Keywords:- image; enhancement; fuzzy logic; histogram; PSNR; MSE; NAE; AD noise; filter etc.

I. INTRODUCTION

An image is a picture which is stored in the electronic form. It is basically the matrix of pixels and it is defined as a two dimensional function f(x, y) where x and y are the spatial co-ordinates. Enhancement refers to accentuation or sharpening of image features to remove the noisy, such as contrast boundaries, edges etc. That can be overcome the difficulties which is arise in bio medical image analysis, remote sensing and traffic control analysis etc. During the transmission of images there is lot of types of noise which is difficult to avoid most probably and frequently occurring noise is Gaussian noise it is caused by random fluctuations in the signal reducing the noise is also a form of image enhancement [10]. We have found some other type of noise such as pepper and salt, impulse noise etc [7]. For removal of noise from the images, different types of filters are there like Median filters, Average filters, Gaussian filters etc [4]. The image which is captured by image capturing device camera the captured image is very dark because aperture of image is not set due to vary narrow light pass to image. The image sensor needs to increase the contrast of the image or to increase the intensity of the image. The main objective behind image enhancement is to modify attributes of an image so that it is more suitable for specific observation. It simply transforms image f into image g using T transformation function where x and y are the pixels in images f and g respectively.

$$v = T(x) \quad (1)$$

Where transformation function T maps a pixel value ***x*** into a pixel value ***y***. Then this transformation result is mapped into gray scale range. Here we are dealing with gray scale Image only having pixel values between "0" to "255" [1].

II. METHODOLOGY

A. Contrast Stretching:

Contrast stretching is an easy piecewise linear transformation techniques used to increase the dynamic range of the gray levels in the image. The images can be enhanced by expanding the number of gray levels to a wider range, so that the overall brightness of image can increase. This process is called contrast stretching. The transformation functions used to convert the values of the original image into corresponding values in the output image may be linear or non-linear functions [4].

1) Linear Contrast Stretching:

The original image are expanded uniformly to fill the total range of the output device, the transformation is called linear contrast stretching.

Transformation function used for contrast stretching

$$G(x,y) = g_1 + (g_2 - g_1)/(f_2 - f_1)[F(x,y) - 1] \quad (2)$$

Here [f1, f2] Mapping of gray levels on new range [g1, g2] here f1 is minimum intensity and f2 is maximum intensity value of an image. This function enhances contrast of an image, which shows equal distribution of intensity.

2) *Non-linear Contrast Stretching*:

Nonlinear contrast stretching often involves histogram equalizations through the use of an algorithm. In the digital number of pixels value are not linearly stretched to uniformly occupy the entire display range. Different non-linear contrast stretching methods are available.

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a) ***Piece-wise Linear Stretch:*** In the piece-wise linear stretching different linear functions are used for enhancing the pixel values in different ranges within the same image.

b) ***Power law transformation:*** Use for enhance the image Power law device.

$$y = T(x) = cx^n \quad (3)$$

Where c and n are positive constants.

B. Histogram Equalization method [HE]:

Histogram Equalization is the simplest and commonly used method in low level image enhancement using the histogram [3]. It is known an automatic technique with no parameter is required to set. The theory is that in which image is thought to be the best in visual appearance, when its histogram looks like the regular distribution. Probability density function is the central point operator in histogram equalization technique. A original image which is equally spread intensity of pixel value from the lowest pixel value "0" to the highest pixel value "L-1" is shaped using probability density function that handicapped pixel intensity values are increased but extreme intensity values are decreased as a result the contrast of the image is improved. Probability density functions in the Histogram equalization methods are described below in the form of pixel value.

$$P(x) = \frac{n^k}{n} \quad (4)$$

For k = 0, 1.. .... L-l, here P(X_k) represents pixels value of an definite intensity X_k for the histogram of input image.

C. Equalized Histogram Equalization Image Enhancement Method [EHE]:

The EHE method is an improved conventional histogram equalization method [6]. The input image is enhanced using the algorithm. Obtain output image is sum with input image by this way recover loss parts of the output image.

Algorithm:

Step i: To calculate probability density function (pdf) of the input image where L is highest intensity value of pixel.

$$\text{pdf(x)} = \frac{\text{number of the pixel with intensity x}}{\text{total number of pixel in image f}} \quad 0 < i < l \quad (5)$$

Step ii: Determine the cumulative distribution function (cdf) allowing for pdf (x) of each pixel.

$$cdf(x) = \sum_{k=0}^{L-1} pdf(x) \quad (6)$$

Step iii: To get the pixel value of image and multiply cdf (x) by L-1 and then round it to the near integer.

$$S_k = \sum_{k=0}^{L-1} (L-1) * pdf(x) \quad (7)$$

Step iv: In this step add new image to the input image then get the enhanced output image.

$$E = S_k + f \quad (8)$$

Where E is enhanced output image and f is input image.

D. Contrast Limited Adaptive Histogram Equalization Technique (CLAHE):

In the CLAHE is generalization of advance histogram equalization technique AHE [9]. The method is more flexibility for choosing local histogram mapping function to avoid undesired noise amplification. In the clipping level of CLAHE of the histogram is selected. Boundary artifacts can be reduced by the method of background subtraction.

Algorithm:

Step-1 Divide the pixel value of image into tiny regions.

Step-2 Decide the mapping functions of local histogram.

Step-3 Choose the clipping point of histogram.

Step-4 Apply the function to every region.

Step-5 The noise can be compact by the background subtraction method.

Limitations:

This method cannot be practical for large range of low contrast image.

E. Fuzzy Logic Contrast Enhancement:

We considered as the key goal of fuzzy set theory image improvement technique [6]. The algorithm can be summarized as to start with input image is taken into digital form atmosphere. Then the histogram of image is compute to be able to choose whether analogous image histogram is appropriate for fuzzy set theory during s-shape membership function of image enhancement method or not. It is accomplished that fuzzy logic s-shape image enhancement method is appropriate to this specific noisy image if histogram range near down in a narrow band image is converted to fuzzy plane. In this step membership

function is modified by suitable membership function modification formula. Finally improved image is displayed as output.

Algorithm:-

Step-1: To get histogram of image by using some software technique. If histogram range is deceit down in a narrow band of fuzzy set theory with s-shape membership function of image improvement procedure is applicable to this precise noisy image.

Step-2: Once sure that aforementioned method is appropriate assign the minimum intensity value (gmin) and maximum intensity value (gmax) of the image.

Step-3: In the next de-fuzzification step in that shift minimum intensity value to "0", maximum intensity value to "1", and other intensity values between "0" and "1" using fuzzy formula shown below.

$$\mu(g) = \frac{g - g_{min}}{g_{max} - g_{min}} \tag{9}$$

Step-4: Membership function modification is discussed in this step. Here many membership functions are present best choice for choosing membership function is dependent on image basic content such as image histogram. The paper s-shape membership function is used which is suitable for image histogram. Membership function is modified using following formula given below.

$$S(z;a,b,c) = \begin{cases} 0 & z < a \\ 2\left(\frac{z-a}{c-a}\right)^2 & a \le z \le b \\ 1 - 2\left(\frac{z-a}{c-a}\right)^2 & b < z \le c \\ 1 & z > c \end{cases} \tag{10}$$

This spline-based curve is a map to vector z, and is named because of its S-shape, where a and c are parameters which locate the extremes of the sloped portion of the curve where b is arithmetic mean of a and c.

Step-5: To stretch the contrast of processed image by multiplies each pixel to constant number.

Step-6: To change image to its original plane from fuzzy plane (defuzzification) and observe the enhanced image.

III. QUALITATIVE ATRIBUTES

To find the performance of enhanced image which is measured based on performance parameter matrix like Mean Square Error (MSE), Peak Signal to Noise Ratio, Normalized Absolute Error (NAE), and Average Difference (AD) etc.

A. Peak signal-to noise ratio (PSNR):

The PSNR is used to determine the ratio between the maximum power of a signal and power of corrupting noise that affects the fidelity of its representation. Here signal is the unique data and noise is the error data. The formula of PSNR is given below.

$$PSNR = 20\log_{10}\left(\frac{266}{\sqrt{MSE}}\right) \tag{11}$$

B. Mean square error (MSE):

The MSE is cumulative squared error between the compressed and the original image.

$$MSE = \frac{1}{MN}\sum_{0}^{M-1}\sum_{0}^{N-1}\left|\left|f(x,y) - g(x,y)\right|\right| \tag{12}$$

Where g = matrix of degraded image, M = number of rows of pixels of an image = matrix data of original image, N = no. of columns of pixels value of image, x and y are index of row and column respectively.

C. Normalized Absolute Error (NAE):

The Normalized cross correlation is given by

$$y = NAE = \frac{\sum_{x=1}^{M}\sum_{y=1}^{N}(f(x,y) * g(x,y))}{\sum_{x=1}^{M}\sum_{y=1}^{N}\left(f(x,y)\right)^2} \tag{13}$$

Here MN are the dimension of an image and f(x,y) and g(x,y) are original and distorted images respectively.

D. Average Difference (AD):

The Average difference is determined by given formula.

$$AD = |f(x,y) - g(x,y)| \tag{14}$$

f(x,y) and g(x,y) are original and distorted images.

E. Normalized cross correlation (NK):

Normalized Absolute Error is known as follows

$$y = NAE = \frac{1}{MN}\sum_{X=1}^{M}\sum_{Y=1}^{N}\left(f(x,y) - g(x,y)\right) \tag{15}$$

Here MN is the dimension of an original image f(x, y) and distorted image g(x, y).

IV. LITERATURE REVIEW

A. Image Enhancement using Artificial Neural Network and Fuzzy Logic:

Shweta Narnaware [1], In this paper describe the new technique for image enhancement using artificial neural network (ANN) and fuzzy logic. The neural networks used for detection of noise and the statistical parameters such as PSNR, MSE, NAE, AD, are used for concert evaluation of image for the duration of image transformation image is degraded up to some extent. It improves the visual appearance of an image. Experimental outcome show the success of the proposed method by quantitative analysis and visual illustration.

B. An analysis of image using fuzzy contrast enhancement

Techniques:

Pushpa mamoria[2], This paper present an image enhancement technique based on fuzzy logic in which used different membership values for obtain better performance in this paper show the degree of darkness or brightness of an image this technique based on human perception for better improvement of contrast in image. Different qualitative attributes such as PSNR, MSE, NAE are used for result analysis.

C. Comparative analysis of Contrast Enhancement Techniques with Fuzzy Logic:

Ms Pushpa Mamoria[3], In this paper planned a relative analysis of contrast image enhancement method such as histogram equalization, contrast stretching and fuzzy logic applied on various grey images. For specific application original image is converting into an enhanced image many techniques are available to enhance the images as per requirements. Results are showing that in many cases fuzzy logic gives better result for improvement of images.

D. Comparative analysis of Contrast Enhancement Techniques of different Image:

Vikash Yadav[4], In this paper discuss Contrast enhancement technique of image processing in the spatial domain for the improvement of contrast of an image. Contrast limited adaptive histogram equalization apply on different types of gray images like foggy images, sky images. Tentative result shows that better result for image quality matrix of PSNR and MSE are used for analysis purpose.

E. Edge Detection Techniques Using Fuzzy Logic:

Essa Anas [5], proposed the method to model images consider the fuzzy system performance as an efficient edges detector for the image. This technique used different ways to feed the fuzzy system and various membership functions that depend on the character of the input data. Fuzzy system can be coined according to their feeding technique of Sliding Window and Pre-processing Kernels fuzzy systems. Techniques are used for grouped in two approaches according to the feeding method. First, Sliding Window Fuzzy System characterizes a simplest way of detect edges of image, but the data feeding is slow. Second, Prepossessing Kernels Fuzzy System represents a progress solution and performs enhanced as an edge detector regarding different types of images. Results in the field of the image edge detection presented a improved capability to recast the image to new grey level and offer a better tool to get better image.

Table I: Comparisons of different techniques

References	***Year***	***Techniques***	***Features***
[1]	2015	Neural Network and Fuzzy Logic	Artificial neural network determines type of noises whereas Fuzzy logic used for de-noising and enhancement purpose.
[2]	2016	Fussy contrast enhancement technique	This kind of method used to enhance image for better analysis in different application.
[4]	2016	Histogram based techniques	Contrast-limited adaptive histogram equalization gives better image quality result.
[8]	2013	Fuzzy Inference System	Enhance edge preservation and smoothing providing better image quality of image contrast without enhancing existing noise in image.

F. A Review of Robust Image Enhancement Algorithms and Their Applications:

Emrah Irmak[6] author proposed a robust image enhancement and de-noising algorithms based get better visual appearance of

any portion or feature of the images by suppressing the information in other portions or features.

Peak Signal to Noise Ratio (PSNR) and Mean Squared Error (MSE) are used to quality measurement and compare the image enhancement methods systematically. The algorithms are especially able to improve the contrast of finger prints images, selenography images and medical images. Results show the algorithms have been productively applied and preferred enhanced images have been showed.

V. EXPERIMENTAL RESULTS

In this review paper of contrast image enhancement different authors are proposed different kind of images for quality measurement and enhancing purpose as require in the specific application. The results are show below on the various kind of images take into consideration and discuss various quality attributes parameters by using Equalized Histogram Equalization Image Enhancement Method (EHE), Histogram Equalization Image Enhancement Method (HE), Fuzzy Set Theory Image Enhancement Method (Fuzzy), Contrast Stretching and Contrast Limited Adaptive Histogram Equalization (CLAHE) methods. In image processing it is quite difficult to compare the enhancement results by visual appearance and just looking at the images with naked eye. Therefore to compare the result and to make comment image quality metrics are used in this paper. To validate the enhancement in images and the visual quality of image, Peak Signal to Noise Ratio (PSNR), Mean Squared Error (MSE), Normalized Absolute Error (NAE), Average Difference (AD) and Normalized cross correlation (NK) are often used to compare the results of methods [6]. From the table II and table III given below we observed that the golden rule is higher the PSNR, the better noisy images has been enhanced and the better the Enhancement algorithm. This would occur when we minimize the MSE between the images with respect the Maximum signal value of the image [2]. PSNR is the ratio between the maximum possible value (power) of a signal and Power of the noise corrupted by the signal. In image processing, MSE measures the average of the squares of the "Errors", that is, the difference between the enhanced image and noisy image.

Table II. Performance parameters measured using proposed method

Image type	***Method***	***PSNR***	***PSNR***
1.MR image	EHE	31.7524	43.4347
	HE	19.9431	658.8181
	FUZZY	17.9600	1040.1654
2.Fingerprint image	EHE	12.2846	3842.6000
	HE	18.5780	902.1604
	FUZZY	13.4963	2907.1000
3.Selenography image	EHE	12.2846	3842.6000
	HE	10.7374	5487.1000
	FUZZY	10.1107	6338.8000

Some other experimental results [1] are also shown below in the table III where image1, image2 and image3 are salt and pepper noisy image, Gaussian and Non-Gaussian noisy images respectively.

Table III. Performance parameters measured using proposed method

Image	***PSNR***	***MSE***	***AD***	***NK***	***NAE***
Image 1	18.25	31.2	-16.11	1.05	0.25
Image 2	14.07	46.97	-32.87	1.16	0.56
Image 3	16.61	37.68	-18.72	1.06	0.30

VI. CONCLUSION

This review paper proposed a review of different image contrast enhancement techniques. Image enhancement algorithms provide a wide range of approaches to get hold of visually satisfactory images by modifying it according to the specific task, viewing conditions. The Histogram equalization is transformations that stretch the contrast by redistributing the grey level values in a uniform fashion. The Fuzzy logic is new approach for image enhancement described in this paper which is more suitable for enhancement purpose by used to modify the membership function, better performance than available methods in the enhancement of noisy images and has been validated by the performance measures based on their performance parameter such as PSNR, NAK, AD and MSE and it is observed that the performance is improved. As a future scope this kind of method's used to enhance image and video for better analysis in different application with the help of these method's analysis of images becomes rapid, unambiguous and magnify.

VII. References

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