An Analysis of Non-Linear Contrast Enhancement Methods of Digital Image

Thillai Sivakavi Saravanan, Shenbaga Priya V

Abstract*: *Digital image distinction sweetening is that the technique of enhancing the character of the digital image by using varied strategies so as to seem higher. Image distinction sweetening techniques ar divided into Linear and Non-Linear distinction sweetening. Linear distinction sweetening works by increasing the first input worth of the info associate degreed Non -linear distinction sweetening normally works by utilizing bar graph feat through the utilization of an rule. This paper analyses the non-linear distinction sweetening techniques in terms of image sweetening. From the analysis, it's found that bar graph feat outperforms alternative non-linear distinction sweetening techniques.

Keywords*: *Image Enhancement, Non-Linear contrast Enhancement, Contrast Enhancement, Histogram Equalization.

I. INTRODUCTION

Image distinction improvement may be a established approach and crucial application in image process technology. the most intention of image improvement is to improvise visual impact of a picture so as to construct a picture for easier understanding and for higher recognition. the improved image plays a big role in several applications like medical image process, remote sensing image analysis, automatic character recognition, microscopic imaging and lots of different areas [1]. The brightness value's place a picture is distinction. to extend the distinction in a picture, the vary of brightness worth must be modified. distinction improvement technique develops the image options leap out accurately and fewer imprecise supported the colors accessible on the digital worth of the image [2][12].

Generally distinction sweetening technique constructs a lot of competent results. several techniques square measure offered for distinction sweetening and also the most generally used techniques for distinction sweetening square measure divided into linear and non-linear techniques [3][13].Linear distinction sweetening technique linearly expands the particular digital price of the image. the complete vary of sensitivity is used whereas increasing the particular input price of a picture. therefore there'll be delicate variations inside the info. The 3 ways of linear distinction sweetening square measure Min-Max Linear distinction Stretch, proportion Linear distinction Stretch, and Piecewise Linear distinction Stretch. The non-linear distinction sweetening technique utilizes bar chart leveling by victimisation associate algorithmic rule. The ways of non-linear distinction sweetening square measure bar chart leveling, adaptive bar chart leveling, Homomorphic Filter, and Unsharp Masking [3][4][13].

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II. NON-LINEAR CONTRAST ENHANCEMENT METHODS

Non-linear distinction improvement could be a technique supported bar graph equalization through by using AN algorithmic rule. The four ways of non-linear distinction improvement are:

- Histogram Equalization
- Adaptive Histogram Equalization
- Homomorphic Filter
- Unsharpmasking

A. Histogram Equalization

Histogram equalisation (HE) [5] is often operated technique for distinction improvement. In sensible distinction image, the bar chart uniformly distributes over the complete vary of the intensity. The visual quality of the image is elevated by utilizing the HE. In HE technique the vary of bar chart is extended by applying the worth of chance Density Function(PDF) of the image. The HE has several blessings like economical computation, quicker in manufacturing results and it's extremely applicable for real time pictures [6].

Consider an image I={(i,j)} with Y discrete gray values (I0, I1, I2.........IY-1).Then the Probability Density Function(PDF) P(Ik) of the given image is expressed as

$$P(I_k) = \frac{n_k}{N} \qquad (1)$$

Where nk depicts the number of apperaence of gray level in I. N is the sum of pixels in the image I. The Cumulative Distribution Function (CDF) corresponding to P (Ik) is expressed as:

$$C(I) = \sum_{j=0}^{k} P(I_j) \qquad (2)$$

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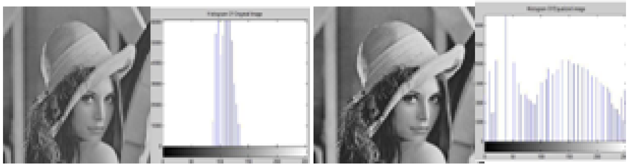
Where I is Ik for k=0,1….Y-1 and 0≤ C(Ik)≤1.

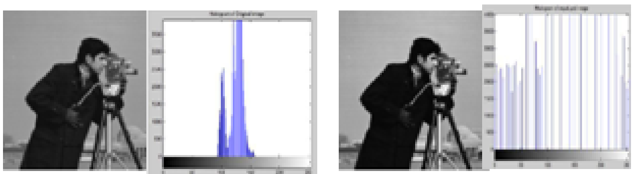
By using the CDF, HE maps the given input image into the entire dynamic range (I0, IY-1) as a level transformation function [11] and function f (I) based on the CDF is defined as:

$$f(I) = I_0 + (I_{Y-1} - I_0)C(I) \qquad (3)$$

The output of contrast enhanced image based on the technique Histogram Equalization is shown in the figure 1.



(a)Original Image 1 (b)Histogram of Original Image 1 (c)Enhanced Image 1 (d)Histogram of Enhanced Image 1



(e)Original Image 2 (f)Histogram of Original Image 2 (g)Enhanced Image 2 (h)Histogram of Enhanced Image 2

Figure 1 Output of Histogram Equalized Enhancement

B. Adaptive Histogram Equalization

Adaptive histogram equalisation (AHE) is associate extension of HE and it works by using the HE mapping perform on native window to notice every elevated density price.

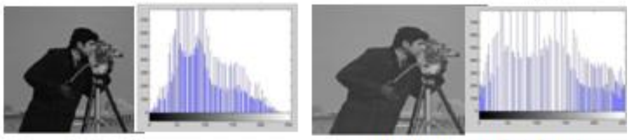
Here it divides the image into range of windows and therefore the transformation perform is applied to every native window of grey scale image. so the results of transformation perform and accumulative Distribution perform (CDF) of neighbourhood values ar proportional and therefore the distinction within the native region is increased. If there's an additional sweetening want then the bar chart of given pixels neighbour needs to be changed. it'll end in most distinction sweetening.

Thus the ensuing transformation functions and of picture element values within the neighbourhood ar proportional [7] and therefore the distinction in every native window is increased. If the image want the any distinction sweetening domestically, then bar chart modification needs to be applied to every given picture element by victimization the bar chart of neighbor picture element for optimum distinction sweetening [8][14].

C. Homomorphic Filter

Homomorphic filter functions by rising the high frequencies and controls the low frequencies. thus the distinction within the illumination is suppressed at a similar time the sides

(a)Original Image 1 (b)Histogram of Original Image 1 (c) Adaptive Histogram Equalization Enhanced Image 1 (d)Histogram of Adaptive Histogram Equalization Enhanced Image 1



(a)Original Image 2 (b)Histogram of Original Image 2 (c) Adaptive Histogram Equalized Enhanced Image 2 of Adaptive Histogram Equalized Enhanced Image 2

Figure 2 Output of Adaptive Histogram Equalized Enhancement

details ar preserved. usually the character of the illumination is uniform and gains low-frequency parts within the Fourier rework of the image. The changes of the coefficient operate can cause precise transitions within the intensity of the image as a result of completely different materials imaged next to every alternative. These precise changes ar combined with high frequency parts [9]. a picture will be expressed because the combined product of the sunshine supply illumination and also the object's coefficient, and it will be developed as:

$$f(x, y) = I(x, y)\rho(x, y) \qquad (4)$$

In equation four 'I' represent the intensity of the illuminating source of illumination, f represent the image and zero zero zero zero one is object's coefficient. so as to boost a picture having low distinction, the coefficient element may be boosted with the filters. to separate the 2 parts, they have to be reworked into the log domain, then increasing parts turns additive and it's described as

$$L_n(f) = l_n(I) + l_n(\rho) \qquad (5)$$

Here ln (I) is low pass and ln(zero) is high pass. Then the linear filter are often applied to the additive part of a picture f = Ln(f). so as to reinforce a picture, the homomorphic filter should have a better response within the high-frequency region once scrutiny the low-frequency region and therefore the main points, within the high frequency region, are often accentuated whereas declining the illumination part. The distinction sweetening victimisation the Homomorphic filter is shown within the figure 3((b) and (d)).

Figure 3 Output of Homomorphic Filter Enhancement

D. Unsharp Masking

The basic plan of unsharp masking algorithms is to reinforce the native high frequencies. These high frequencies square measure disclosed in considering the amount of variation gift within a neighborhood window, or by suppressing the low frequencies. this concept acts as a stratum of unsharp masking and Retinex, that mimics the human sensory system. each algorithms is used as world ones or regionally reconciling ones [10].The unsharp masking is that the technique to intensify the sharpness within the image distinction. Unsharp masking is expressed by:

$$y(m,n) = f(m,n) + a * g(m,n) \qquad (6)$$

Where:

f is that the given image. y is that the sharpened image and g spoken be the gradient image. a is spoken be the distinction constant bigger than zero. Figure four depicts the sweetening carried by using unsharpmasking[16].

Figure 4 Output of employing Unsharpmasking Enhancement

III. RESULTS AND DISCUSSION

In this paper an effort is created to analyse the non-linear distinction sweetening techniques. The experiments area unit processed mistreatment the tool MATLAB. The results of the techniques taken for analysis area unit portrayed in figure one,figure 2,figure three and figure four.The quantitative evaluations is completed by mistreatment Mean sq. Error (MSE) and Peak ratio (PSNR) and is expressed within the following equations (7) and (8):

The definition of MSE is:

$$MSE = \frac{1}{M \times N} \sum_{i=1}^{M} \sum_{i=1}^{N} (X'(i,j) - X(i,j))^2 \qquad 7)$$

where i, j square measure the pixel's coordinates, M and N represent the peak and breadth of the image, severally, and X and X^'denotes the given and therefore the processed pictures, severally. A smaller MSE worth indicates that X and X^' square measure a lot of similar.

The PSNR is expressed by using MSE:

$$PSNR = 10log_{10}\left[\frac{255^2}{MSE}\right] \qquad (8)$$

After careful application of the non-linear distinction improvement techniques, it's found that bar graph equalisation outperforms the opposite techniques by manufacturing higher PSNR worth and low MSE worth. The results obtained out of the four techniques for distinction improvement applications area unit shown within the following table 1.

Table1 PSNR and MSE Values of Non-Linear Contrast Enhancement Techniques

Methods	PSNR of Image 1	MSE value of Image 1	PSNR of Image 2	MSE value of Image 2
Histogram Equalization	**7.277265**	**1.35E+04**	**6.91281**	**1.64E+04**
Adaptive Histogram Equalization	6.754456	1.02E+04	6.686456	1.01E+04

Homomorphic Filters	4.324444	0.32E+04	4.456356	0.03E+04
Unsharp Masking	4.223489	0.28E+04	4.656456	0.23E+04

IV. CONCLUSION

Generally, distinction improvement ways with success improvise the low distinction pictures. during this paper, non-linear distinction improvement techniques ar analyzed. The comparison is created between the non-linear techniques like bar chart leveling, adaptative bar chart leveling, Homomorphic Filter and Unsharp Masking. The results ar analysed supported PSNR and MSE values. From the results, it's finished that the bar chart leveling technique offers the minimum MSE and better PSNR worth and outperforms the opposite technique of non-linear techniques.

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