

# Comparison of Global – Local Contrast Enhancement in Image Processing

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## ABSTRACT

*Enhancement is the modification of an image to alter impact on the viewer. Generally enhancement distorts the original digital values; therefore enhancement is not done until the restoration processes are complete. Contrast enhancement is a strong influence of contrast ratio on resolving power and detection capability of images. Techniques for improving image contrast are among the most widely used enhancement processes. Using global contrast enhancement, low contrast image can be improved in its quality globally. The enhanced output image, with such type of enhancement, may not have the noise and ringing artifacts. Local contrast enhancement attempts to increase the appearance of large-scale light-dark transitions, similar to how sharpening with an "Unsharp mask" increases the appearance of small-scale edges.*

**Keywords:**-Global, Local, Contrast, Histogram Equalization.

## 1. INTRODUCTION

Image enhancement is among the simplest and most appearing areas of digital image processing. Basically, the idea behind enhancement techniques is to bring out detail that is obscured, or simply to highlight certain features of interest in an image. A familiar example of enhancement is when we increase the contrast of an image because "it looks better". It is very important to keep in mind that enhancement is very subjective area of image processing. The principal objective of enhancement is to process an image so that the result is more suitable than the original image for a specific application[1].

Digital image processing is a broad subject that involves mathematically complex procedures, but central idea behind image processing is very simple. In the image enhancement process, an image is taken as input and enhancement algorithm is applied on it. After that enhanced image is taken as output as shown in figure1. Image Enhancement can be subjective or objective. Subjective image enhancement can be repeatedly applied on an image in many forms until the observer feels that output image yields the required necessary details. Objective enhancement process is not repeatedly applied but corrects an image for some known degradations and hence this enhancement is not applied arbitrarily[1,2].

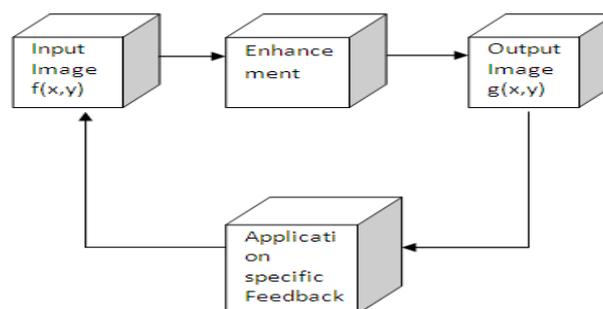
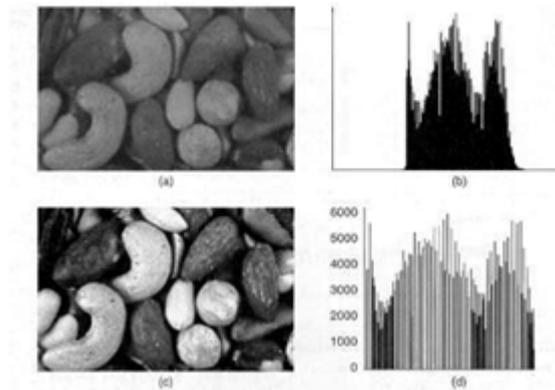


Fig-1. Image enhancement on gray level image

## 2. CONTRAST ENHANCEMENT TECHNIQUES

The commonly used techniques for image enhancement are removal of noise, edge enhancement and contrast enhancement. Contrast enhancement is one of the most popular and important techniques for image enhancement. In this technique, contrast of an image is improved to make the image better for human vision. One of the most common contrast enhancement methods is histogram equalization (HE)[2,3]. The techniques which are widely used for image enhancement are global enhancement techniques and local enhancement techniques. Global techniques are fast and simple, and are suitable for overall enhancement of the image. These techniques cannot adapt to local brightness feature of the input image because only global histogram information over the whole image is used. This fact limits the

contrast ratio in some parts of the image and hence causes significant contrast losses in the background and other small regions. One such example of global enhancement technique is global histogram equalization.



**Fig-2.** Contrast Enhancement by Histogram Stretching

Several other local enhancement techniques are also used. Local enhancement technique can enhance overall contrast more effectively. In local enhancement, a small window slides through every pixel of the input image sequentially and only those block of pixels are enhanced that fall in this window. And then gray level mapping is done only for the center pixel of that window. Thus, it makes good use of local information[1,2]. However, in local enhancement techniques, computational cost goes very high due to its fully overlapped sub-blocks and causes over enhancement in some portions of the image. Another problem is that it enhances the noise effect in the image as well.

**3. GLOBAL AND LOCAL CONTRAST ENHANCEMENT (GLCE)**

Either global contrast enhancement method or local contrast enhancement method is limited to those images which are poor in global contrast as well as local contrast. For such images, there is the need of a method in which both the global and local contrast enhancement and the local contrast enhancement are applied[3]. The Global-Local contrast enhancement (GLCE) method is a method in which both the global contrast enhancement and the local contrast enhancement are applied. Using equations,

$$f_0 = (1 + C_g) * (f_i - gmean) + 0.5 \quad (1)$$

&

$$f(i,j) = x(i,j) + (C/\varnothing(i,j) + s) * (x(i,j) - m(i,j)); \quad (2)$$

GLCE method can be implemented as follows.

Using equation (1),

$$f_x(i,j) = (1 + C_g) * [x(i,j) - gmean] + 0.5 \quad (3)$$

where,  $x(i,j)$  is the pixel value at location  $(i,j)$  of the original input image,  $C_g$  is the global contrast gain control,  $gmean$  is the global mean of the pixel values of the whole image and the threshold  $too$  and  $f_x(i,j)$  is the enhanced value of the pixel  $x(i,j)$ . Then applying equation (2) on the output values given by equation (3) as,

$$f(i,j) = f_x(i,j) + (C/\varnothing(i,j) + s) \quad (4)$$

where,  $f_x(i,j)$  is the globally enhanced output value of the original pixel value  $x(i,j)$  at location  $(i,j)$  of the original input image using equation (3),  $m(i,j)$  is the local mean at  $(i,j)$  among the neighborhood values of  $f_x(i,j)$ ,  $\varnothing(i,j)$  is the LSD at

(i,j) among the neighborhood values of  $f_x(i,j)$ , C is the local contrast gain control, s is very small and negligible quantity greater than zero and  $f(i,j)$  is the enhanced output value produced by GLCE[3,4].

**HISTOGRAM EQUALIZATION**

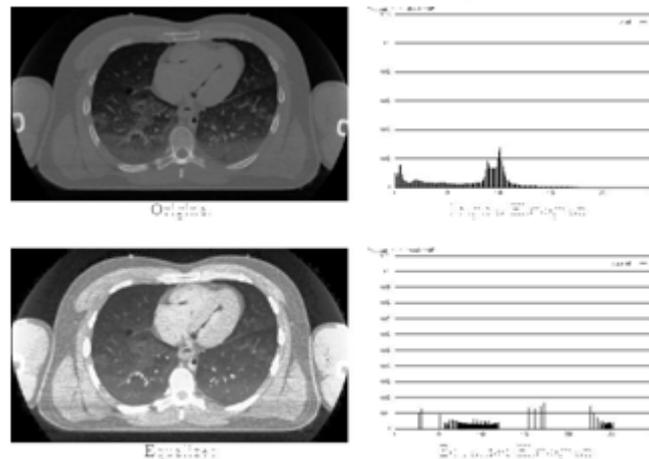
The general form is

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$$S_k = \frac{(L-1) * (r_k - r_{kmin})}{(r_{kmax} - r_{kmin})}$$

Where  $k = 0.1.2.... L-1$  (5)

Where r and s are the input and output pixels of the image, L is the different values that can be the pixels, and  $r_{kmax}$  and  $r_{kmin}$  are the maximum and minimum gray levels of the input image[2].



**Fig-3. Histogram Equalization**

of the original pixel value  $x(i,j)$  at location (i,j) of the original input image using equation (3),  $m(i,j)$  is the local mean at (i,j) among the neighborhood values of  $f_x(i,j)$ ,  $\sigma(i,j)$  is the LSD at (i,j) among the neighborhood values of  $f_x(i,j)$ , C is the local contrast gain control, s is very small and negligible quantity greater than zero and  $f(i,j)$  is the enhanced output value produced by GLCE[3,4].

**ALGORITHM**

```
clear all , close all;
input_name = 'text62.jpg';
output_name = 'text62_enh.jpg';
input_image = imread (fullfile ('infiles',input_name ));
input_image_process = input_image;
output_image_process = histeq ( input_image_process );
output_image = im2uint8 (mat2gray ( output_image_process ));
```

```
input_hist = imhist (input_image);

output_hist = imhist (output_image);

subplot(2,2,1), imshow (input_image), title

('Input image');
subplot(2,2,2), imshow (output_image), title ('Output image');

subplot(2,2,3), plot (input_hist), title ('Input histogram');

xlabel ('Gray levels');

ylabel ('Relative frequency');

set (gca, 'xlim', [0 255]);

subplot (2,2,4), plot (output_hist), title

('Output histogram');

xlabel ('Gray levels'), ylabel ('Relative frequency');

get ( gca, 'xlim', [0 255]);

imwrite (output_image), fullfile

('outfiles\',output_name));
```

The method is useful in images with backgrounds and foregrounds that are both bright or both dark. In particular, the method can lead to better detail in photographs that are over or under-exposed. A key advantage of the method is that it is a fairly straightforward technique and an invertible operator. So in theory, if the histogram equalization function is known, then the original histogram can be recovered. The calculation is not computationally intensive. A disadvantage of the method is that it is indiscriminate[2,3].

#### **LOCAL ENHANCEMENT USING HISTOGRAM STATISTICS**

This method is used to enhance details over small areas in an image. The procedure is to define a square or rectangular neighborhood and move the center of this area from pixel to pixel. At each location, the histogram of the points in the neighborhood is computed and either histogram equalization or histogram specification transformation function is obtained. This function is finally used to map the gray level of the pixel centered in the neighborhood. The center of the neighborhood region is then moved to an adjacent pixel location and the procedure is repeated[1,3].



**Fig-4.** Local contrast enhancement

#### **ALGORITHM**

```
clear all, close all;
input_name = 'test.jpg';
output_name = 'test_enh.jpg';
input_image = imread(fullfile('infiles\',input_name));
```

```
input_image_process = double(input_image);

M = mean2(input_image_process);

D= std2(input_image_process); Bsize = [3 3];
[6] = [0.4 0.02 0.4];

E = 4;

Tic

output_image_process = colfilt(input_image_process,Bsize, 'sliding', @local_enh_function,M,D,E,k);

time = toc %display time-consuming

output_image = im2uint8 (mat2gray(output_image_process));

subplot(2,2,1),imshow(input_image),title('I nput image');

subplot(2,2,2),imshow(output_image),title(' Output image');

subplot(2,2,3),plot(input_hist),title('Input histogram');

xlabel('Gray levels');

ylabel('Relative frequency');

set(gca, 'xlim', [0 255]);

subplot(2,2,4),plot(output_hist),title('Outpu t histogram');

xlabel('Gray levels'),ylabel('Relative frequency');

set(gca, 'xlim', [0 255]);

imwrite(output_image,fullfile('outfiles',out put_name));

function g = local_enh_function(Icol,M,D,E,k) Bcenter = floor((size(Icol,1)+1)/2);

g = Icol(Bcenter,:);
%Compute the local mean and variance.

Mcol=mean(Icol);

Dcol=std(Icol);

%Build the local response.

change=find((Mcol<=k(1)*M) & (Dcol>=k(2)*D) & (Dcol<=k(3)*D));

nochange=find((Mcol>k(1)*M) | (Dcol<k(2)*D) | (Dcol>k(3)*D));

g(change)=E*Icol(Bcenter,change);

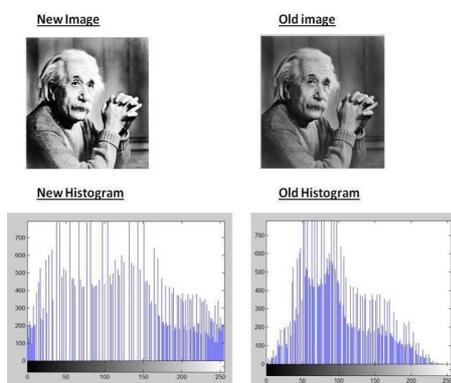
%g(change)=255;g(nochange)=0;
```

#### **4. EXPERIMENTAL RESULTS**

##### **Histogram Equalization**

Histogram equalization makes the histogram to expand between all the range (0,255) and gets more smooth transitions

between the pixels of the image[3]. The algorithm average time is 0.1590 seconds for a 240\*320 image. It is quite fast because we can process more than 6 images per second. This transformation affect to the histogram as it is shown in the output it has pixels values in all the grayscale range.

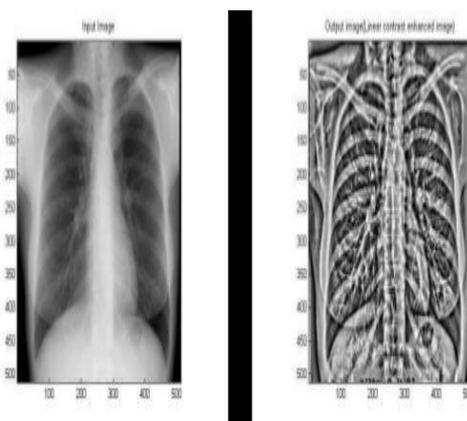


**Fig-5.** Results of Histogram Equalization

**Local Enhancement Using Histogram**

**Statistics**

Local enhancement it is to improve the contrast on an image that has different partial areas, for example, an image that need to be improve in dark areas and also in the light areas, then it would be used this algorithm. The clue point of this method is to choose well the values of the relative dispersion to find the optimum pixels that it has to improve[2,4]. The average time is almost half a second, 0.4208, but it is normal because it has to make the calculations with all sub images.



**Fig-10.** Local enhancement using histogram statistics

**Global – Local Contrast Enhancement**

**Table – Comparison details**

GHE	Method of SAGCE	Method of Equation (2)	GLCE (Proposed Method)
Automatic and global enhancement	Semi-automatic and global enhancement	Local adaptation of enhancement	Both global and local enhancement
No	Single	Single	Two user

user defined parameter control	user defined parameter control	user define parameter control	defined parameter control
It improves the quality with global contrast, however, it is poor in local contrast	It improves the quality with global contrast, however, it is poor in local contrast	It improves the quality with local contrast, it is poor in global contrast	It improves the quality with global contrast as well as local contrast
Most User friendly	User friendly	User friendly	Slightly Complicated
Unchangable	Adjustable with one parameter	Adjustable with one parameter	Adjustable with two parameters

**5. CONCLUSION**

Global contrast enhancement methods improve the quality of a low contrast image with global contrast only. On the other hand, local contrast enhancement methods improve the quality of a low contrast image with local contrast only. However, for a very low contrast image which is poor in both of global contrast and local contrast, neither global contrast enhancement method only nor local contrast enhancement method is sufficient. The subjective result depends on the input image and each transformation works better for a type of image and worse for other types. For image with low contrast in grayscale the better methods are histogram equalization and contrast stretching. If the image has dark and light areas with low contrast and the objective is increase the contrast in that areas instead the all image it will be use the local enhancement.

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